JOURNAL OF ARTHROSCOPY AND JOINT SURGERY

JAJS

Official Journal of the International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty (ISKSAA)

Indexed in Scopus & Embase

Volume 9 | Issue 1 | January-March 2022

ISSN: 2542-6001

Wolters Kluwer

https://journals.lww.com/jajs

Medknow

ISKSAA International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

ISKSAA (**I**nternational **S**ociety for **K**nowledge for **S**urgeons on **A**rthroscopy and **A**rthroplasty) is a society of orthopaedic surgeons from around the world to share and disseminate knowledge, support research and improve patient care in Arthroscopy and Arthroplasty. We are proud to announce that ISKSAA membership has crossed the **2000** mark (India & Overseas) with members from **over 40 countries** making it the fastest growing Orthopaedic Association in the country & region in just 9 years of its inception. With over **430000 hits from over 168 countries** on the website **www.isksaa.com** & more and more interested people joining as members of ISKSAA, we do hope that ISKSAA will stand out as a major body to provide opportunities to our younger colleagues in training, education and fellowships.

Our Goals………

- To provide health care education opportunities for increasing cognitive and psycho-motor skills in Arthroscopy and Arthroplasty
- To provide CME programs for the ISKSAA members as well as other qualified professionals.
- To provide Clinical Fellowships in Arthroscopy and Arthroplasty
- To provide opportunities to organise and collaborate research projects
- To provide a versatile website for dissemination of knowledge

ISKSAA Life Membership

The membership is open to Orthopaedic Surgeons, Postgraduate Orthopaedic students and Allied medical personal interested in Arthroscopy & Arthroplasty.

Benefits of ISKSAA Life membership include….

- **Free Subscription** of ISKSAA's official, SCOPUS INDEXED, EMBASE INDEXED peer reviewed, online scientific journal **Journal of Arthroscopy and Joint Surgery (JAJS)**.
- Eligibility to apply for **ISKSAA's Prestigious Fellowship Programme**. We have finalised affiliations with ESSKA, ISAKOS, BOA, BASK, BOSTAA, BESS, Edge Hill University at Wrightington and FLINDERS MEDICAL CENTRE, IMRI AUSTRALIA to provide more **ISKSAA Fellowships** in India, UK, USA, Australia and Europe . We have offered over **400 Clinical Fellowships as of date including 54 in ISKSAA 2014, 40 in ISKSAA 2015, 63 in ISKSAA 2016, 55 in ISKSAA 2017, 20 in ISKSAA 2018 & 100 in ISKSAA 2019 and over 50 ISKSAA Wrightington MCh Fellowships from 2014 to 2018 .**
- We have initiated **ISKSAA JOD & ISKSAA WHA paid fellowship programs** from 2017 for 2 months based in Australia.
- **The Last round of 100 ISKSAA fellowships interviews were held in ISKSAA BESS 2019 in March 2-3rd 2019 for 2019 and 2020 at New Delhi along with the ISKSAA Wrightington MCh Fellowships .**
- **The next round of ISKSAA fellowship interviews will be on 19th and 20th of November 2022 at New Delhi.**
- We had offered **60 1 week ISKSAA certified Fellowships** from 11th – 15th June & 25-29th June 2018 for ISKSAA members registered for ISKSAA LEEDS 2018 on a first come first basis **.**
- Only as a life member, you can enjoy the benefit of **reduced Congress charges** in future ISKSAA Conferences.
- **Member's only section** on the website which has access to the conference proceedings and live surgeries of ISKSAA 2012, 2013, 2014 & 2016 along with a host of other educational material.
- Important opportunity for interaction with world leaders in Arthroscopy & Arthroplasty.
- Opportunity to participate in ISKSAA courses and workshops

To enjoy all the benefits & privileges of an ISKSAA member, you are invited to apply for the Life membership of ISKSAA by going to the membership registration section of the website and entering all your details electronically. All details regarding membership application and payment options are available on the website (www.isksaa.com)

Journal of Arthroscopy and Joint Surgery

Journal of Arthroscopy and Joint Surgery

General Information

The Journal

Journal of Arthroscopy and Joint Surgery (JAJS) is an official, peer reviewed, online scientific journal. The first edition of which rolled out in January 2014. The journal's full text is available online at https://journals.lww.com/jajs and issues are published quarterly in March, June, September, December. The Journal is committed to bring forth scientific manuscripts in the form of original research articles, current concept reviews, meta-analyses, case reports with a clear message and letters to the editor.

Abstracting and Indexing Information

The journal is registered with the following abstracting partners:

Baidu Scholar, CNKI (China National Knowledge Infrastructure), EBSCO Publishing's Electronic Databases, Ex Libris – Primo Central, Google Scholar, Hinari, Infotrieve, National Science Library, ProQuest, TDNet, Wanfang Data.

The journal is indexed with, or included in, the following:
EMBASE, SCOPUS.

Information for Authors

There are no page charges for IPCARES submissions. please check https://journals.lww.com/jajs/Pages/iInformationforauthors.aspx for details.

All manuscripts must be submitted online at https://review.jow.medknow.com/jajs.

Subscription Information

A subscription to the Journal of Arthroscopy and Joint Surgery comprises 4 issues. Prices include postage. Annual Subscription Rate for non-members-

- Institutional: INR 12000.00 for India
  USD 200.00 for outside India
- Personal: INR 5000.00 for India
  USD 150 for outside India

For mode of payment and other details, please visit www.medknow.com/subscribe.asp

Claims for missing issues will be serviced at no charge if received within 60 days of the cover date for domestic subscribers, and 3 months for subscribers outside India. Duplicate copies cannot be sent to replace issues not delivered because of failure to notify publisher of change of address.

The journal is published and distributed by Wolters Kluwer India Private Limited. Copies are sent to subscribers directly from the publisher's address. It is illegal to acquire copies from any other source. If a copy is received for personal use as a member of the association/society, one cannot resale or give-away the copy for commercial or library use.

Nonmembers: All change of address information to be sent to WKHLRPMedknow_subscriptions@wolterskluwer.com

Advertising policies

The journal accepts display and classified advertising. Frequency discounts and special positions are available. Inquiries about advertising should be sent to Wolters Kluwer India Private Limited, WKHLRPMedknow_advertise@wolterskluwer.com.

The journal reserves the right to reject any advertisement considered unsuitable according to the set policies of the journal.

The appearance of advertising or product information in the various sections in the journal does not constitute an endorsement or approval by the journal and/or its publisher of the quality or value of the said product or of claims made for it by its manufacturer.

Copyright

Permissions

For information on how to request permissions to reproduce articles/information from this journal, please visit www.medknow.com.

Disclaimer

The information and opinions presented in the Journal reflect the views of the authors and not of the Journal or its Editorial Board or the Publisher. Publication does not constitute endorsement by the journal. Neither the Journal of Arthroscopy and Joint Surgery nor its publishers nor anyone else involved in creating, producing or delivering the Journal of Arthroscopy and Joint Surgery or the materials contained therein, assumes any liability or responsibility for the accuracy, completeness, or usefulness of any information provided in the Journal of Arthroscopy and Joint Surgery, nor shall they be liable for any direct, indirect, incidental, special, consequential or punitive damages arising out of the use of the Journal of Arthroscopy and Joint Surgery. The Journal of Arthroscopy and Joint Surgery nor its publishers, nor any other party involved in the preparation of material contained in the Journal of Arthroscopy and Joint Surgery represents or warrants that the information contained herein is in every respect accurate or complete, and they are not responsible for any errors or omissions or for the results obtained from the use of such material. Readers are encouraged to confirm the information contained herein with other sources.

Editorial office:
Dr. Pushpinder Singh Bajaj
Managing Editor,
Journal of Arthroscopy and Joint Surgery,
B – 7/5 Safdarjung Enclave, New Delhi - 110029, India
Email: isksaaeducation@gmail.com

Published by
Wolters Kluwer India Private Limited,
A-202, 2nd Floor, The Qube, C.T.S. No.1498A/2 Village Marol,
Andheri (East), Mumbai - 400 059, India.
Phone: 91-22-66491818
Website: www.medknow.com

Printed at
Nikeda Art Prints Pvt. Ltd., Bhandup (W), Mumbai.

Journal of Arthroscopy and Joint Surgery

Volume 9 | Issue 1 | January-March 2022

Contents

Review Articles

Original Articles

Technical Note

Case Reports

Review Article

Extensor Mechanism Failure Following Total Knee Arthroplasty

Samantha Sharkey, Ikechukwu Ejiofor, Bernard van Duren, Hawar Akrawi, Hemant Pandit, Sanjeev Anand, Veysi T. Veysi, Jeya Palan
Department of Trauma and Orthopaedics, The Leeds Teaching Hospitals Trust, Leeds General Infirmary, Leeds, United Kingdom

Abstract

Extensor mechanism failure following total knee arthroplasty is a rare but potentially devastating complication with an overall incidence of 0.17%–2.5%. The 3 main causes of disruption include quadriceps tendon rupture, patellar fracture, or patellar tendon rupture. Clinical presentation can vary from asymptomatic to the acutely painful and swollen knee, but for most patients, there will be evidence of extensor lag and/or difficulty performing straight leg raise. A variety of treatment options have been described in the literature to date including nonoperative management with immobilization, particularly for patients with an extensor lag of <20°. Direct repair may be useful in the management of acute tendon ruptures; however, augmentation is now also recommended in addition. Options for augmentation include tendon autografts or synthetic materials. The use of allografts such as Achilles tendon allografts or complete extensor mechanism allografts and rotational flaps has also been described. Treatment of patellar fractures varies depending on fracture pattern, degree of extensor lag, presence of patellar component loosening, and patellar bone stock. The potential options for treatment include nonoperative management with immobilization, open reduction and internal fixation, patellectomy (either partial or complete), or revision surgery, although this list is not exhaustive. Outcomes are poor with complications including rerupture, postoperative infection, nonunion, or residual extensor lag with associated poor functional outcomes and high reoperation rates. There is a distinct lack of high-quality evidence in the literature at present, and as such, further research is required to make any recommendations for treatment.

Keywords: Arthroplasty, patella, patellar ligaments, rupture, tendon injuries

Introduction

Disruption of the extensor mechanism can occur anywhere along its tract. There are three main areas in which this tends to occur, namely the quadriceps tendon proximally, the patella, and the patellar tendon distally. It is a relatively rare occurrence following total knee arthroplasty (TKA) but can have major negative consequences for patients in terms of functional outcomes and quality of life.[1] Surgical management of these injuries is challenging with significantly high reoperation rates reported.[2,3] A study of quadriceps tendon ruptures following TKA from the Mayo Clinic found a risk of reoperation following index revision procedure of 7%, 20%, and 40% at 1, 5, and 10 years, respectively.[2,4] The poor long term outcomes for patients requiring extensor mechanism repair, as reported in the literature, has led to an emphasis on prevention through meticulous surgical technique during the primary arthroplasty surgery. In particular, attention has been paid to handling of soft tissues during exposure, rotation and patella resection.[2] New approaches to the management of extensor mechanism failure continue to be explored. Over the last decade, there have been new advancements in autografting and allografting techniques and the use of synthetic mesh, all of which aiming to reduce complications such as residual extension lag, re-operation rates and infection.[5,6] Unfortunately, outcomes have remained consistently poorer in this group when compared with extensor mechanism failure in native knee joints.[6] Therefore, it is important to be aware of the outcomes, poor as they may be, in order to adequately counsel and manage the expectations of patients following this injury. In this review, we describe the common types of extensor mechanism failure following TKA as well as the treatment options and outcomes for each.

Access this article online	
Quick Response Code:	**Website:** https://journals.lww.com/jajs
	DOI: 10.4103/jajs.jajs_29_22

Address for correspondence: Miss. Samantha Sharkey, Department of Trauma and Orthopaedics, The Leeds Teaching Hospitals Trust, Leeds General Infirmary, Great George Street, Leeds LS1 3EX, United Kingdom.
E-mail: samantha.sharkey1@nhs.net

Submitted: 22-Feb-2022 **Accepted:** 11-Apr-2022
Published: 09-Jun-2022

How to cite this article: Sharkey S, Ejiofor I, van Duren B, Akrawi H, Pandit H, Anand S, *et al*. Extensor mechanism failure following total knee arthroplasty. J Arthrosc Jt Surg 2022;9:1-7.

Incidence and Etiology

The overall incidence is reported as 0.17%–2.5% for all types of extensor mechanism failure including quadriceps and patellar tendon rupture, patella fracture, and avulsions at the sites of tendinous insertion of either of the aforementioned tendons.[7-10] Clinical presentation remains similar irrespective of the underlying etiology. Patients often complain of knee pain and swelling and develop a new extensor lag or weakness and/or difficulty in performing straight leg raise. A common complaint is inability to stand from a sitting position and using stairs. Tendon ruptures are often associated with a palpable defect on clinical examination.[2,4,6]

Further investigation for patients with suspected extensor mechanism failure often begins with plain anteroposterior, lateral, and skyline radiographs of the affected knee.[6] In a series of 77 patients with patellar fractures by Ortiguera and Berry, 44% of patients were asymptomatic or had minimal clinical symptoms and fractures were identified on routine radiographs at follow-up.[11] Tendinous injury may be identified on radiographs due to the presence of patella alta or baja and it may be possible to see a soft tissue indentation on the lateral view. If unclear, ultrasound assessment or magnetic resonance imaging would be an appropriate next step and would also allow for the assessment of remaining tissues to guide further management.[6]

Failures can occur intraoperatively but are more common in the postoperative period.[6] There are a range of patient-related factors and intraoperative factors, which may make a patient more susceptible to the development of postoperative extensor mechanism failure. Systemic diseases such as rheumatoid arthritis, obesity, diabetes mellitus, and hyperthyroidism have been shown to predispose to extensor mechanism failure.[3,4,6,12] In addition, history of other procedures before undergoing TKA such as high tibial osteotomy or recurrent corticosteroid injections have also been thought to increase risk.[3,4,6] Local factors such as poor patellar alignment, limited remaining bone stock following insertion of the patellar component (<12 mm anteroposteriorly), and surgical exposure during TKA, in particular, lateral release, have also been implicated due to further compromised blood supply.[1,4,6] Pawar *et al*. showed that transient patellar hypovascularity was 3.95 times higher in patients who had undergone lateral release during TKA.[6,13] Previous or active infection resulting in local tissue necrosis is another commonly observed predisposing factor.[14]

Postoperative extensor mechanism disruption may be traumatic in nature, for example, following a fall, but for some, it occurs following seemingly innocuous events. The mechanism of injury varies depending on whether the injury is osseous or tendinous.[2,4,6,11,12]

Quadriceps tendon rupture

Quadriceps tendon rupture after TKA has a prevalence of 0.1% and 1.1%.[15,16] It may be a result of high energy trauma, but more commonly, it occurs as a result of indirect forces through the flexed knee during everyday activities such as rising from a low chair.[4,12] In the presence of risk factors such as systemic conditions predisposing to tendinopathy as described and with the potential for a degree of devascularization following surgery, the quadriceps tendon is more likely to rupture as a result of the forces generated from these simple everyday tasks. Patients with a quadriceps rupture are more likely to be older with a mean age 61 years (±13.1, range 20–92 years) and have a higher body mass index (mean 30 kg/m^2 ± 6.05) than those presenting with patellar fracture or patellar tendon rupture.[12] These patient groups are more likely to have medical comorbidities, which may increase their susceptibility to tendon ruptures, particularly endocrine disorders.[12]

Patellar fracture

The average incidence of periprosthetic patellar fracture after TKA is reported to be approximately 1.19%.[17,18] Studies have also noted a correlation between increased incidence of patellar fractures and patellar resurfacing, with the reported prevalence in the unresurfaced patella being 0.05% compared with 0.2%–21% in those which have been resurfaced.[11,17,19,20] A number of other surgical risk factors have also been shown to be important in the development of these injuries and include patellar resection, oversized patellar component, use of metal-backed cementless patellar components, and malrotation, leading to malalignment in the coronal plane.[6,11,17,20] Surgical exposure is also a significant factor and care to preserve lateral vessels during lateral release and minimise fat pad resection are believed to reduce hypovascularity of the patella. Hypovascularity of the patella can lead to increased risk of postoperative patellar fracture and also interrupt subsequent fracture healing.[20]

Postoperative patellar fractures have two principle etiologies: as a result of direct trauma or as atraumatic stress fractures secondary to osteonecrosis of the patella.[4,12,21] There is also an association between patellar fractures and prothesis loosening with 50% of patients with patellar fractures complicated by a loose component.[17] The potential atraumatic nature of these injuries explains why a large proportion of patients (up to 88%) have minimal or no clinical symptoms and injuries are identified on routine follow-up imaging within the first 2 postoperative years.[17,21]

Patellar tendon rupture

Rupture to the patellar tendon most commonly occurs distally due to avulsion from the tibial tubercle.[6] Overall, it is rare after TKA and is becoming even more so with improvements in surgical technique with a recent reported incidence of <1%. It is more commonly seen in patients with multiple previous operations, which has resulted in significant scarring and stiffness.[3,6] Postoperatively, the most common mechanism of injury is trauma with a fall on to hyperflexed knee, although it may occur due to repeated contact or impingement on a prominent tibial insert.[6,10] To reduce this risk, modern TKA designs include an anterior bevel. Patellar tendon ruptures typically occur in younger cohort of patients than quadriceps tendon ruptures and are more frequent in patients engaging in sports, although this can vary and surgeons should continue to suspect patellar tendon rupture in a patient with clinical symptoms, particularly in those with multiple previous operations, history of infection, and/or multiple comorbidities.[8,12]

Treatment Options

Quadriceps tendon rupture

Conservative management should be considered for patients with <20° extensor lag and usually take the form of immobilization in a cast or hinged knee brace locked in full extension for a minimum of 6 weeks.[2,3,6,18] After this point, gradual active flexion may be introduced, but locking in full extension for mobilization has been advocated to reduce the risk of further falls for the 1st few weeks.[2]

Surgical intervention may be indicated for patients, in whom there is an extensor lag of >20°.[2,3,6,18] That said, despite good results from direct end-to-end suture repair alone in patients with native joints, the complication rates for patients with TKA who underwent operative management for acute quadriceps tendon rupture were significantly high.[4,6] Therefore, although direct repair is advocated in acute quadriceps rupture following TKA in patients with a significant extensor lag, it is recommended that this also be augmented.[3] Direct repairs should be performed as soon as possible following injury to minimize soft tissue retraction.[2] Repair can be achieved through the use of end-to-end sutures or through drill holes or suture anchors, if there is disruption to the insertion point into the proximal pole of the patella.[2] Options for augmentation include tendon autografts using semitendinosus and/or gracilis, synthetic materials, or allografts such as Achilles tendon allografts or more complex complete extensor mechanism allografts.[3,6,8,16] Extensor mechanism allografts are most commonly fresh-frozen as freeze drying is thought to potentially weaken the graft.[7] Patients are immobilized postoperatively for minimum of 6 weeks in the majority of studies available.[1]

Patellar fracture

The management of patellar fractures is dependent on variant factors such as whether the fracture is comminuted, closed versus open, or displaced. Of course, the presence of a patellar component will have implications for management and components should be assessed to determine whether they remain well fixed or not. Furthermore, as with quadriceps ruptures, an extensor lag of >20° is an indication for surgical management either alone or in combination with a loose patellar component.[2,3,18] A classification system has been developed by Ortiguera and Berry to guide management and is summarized in Table 1.[11] It is based on stability of the patellar implant, integrity of the extensor mechanism, and quality of patellar bone stock with poor bone stock defined as <10 mm or significantly comminuted that fixation or resurfacing would not be possible.[6,11]

Table 1: Classification system for periprosthetic patellar fractures developed by Ortiguera and Berry

	Stability of patellar implant	Extensor mechanism integrity
Type I	Stable	Intact
Type II	Either	Disrupted
Type IIIa	Loose implant, good patellar bone stock	Intact
Type IIIb	Loose implant, poor patellar bone stock	Intact

For Type I injuries, conservative management with immobilization in a locked brace or cast is recommended as this has been shown to yield excellent results.[2,6] For Type II injuries, open reduction and internal fixation with tension band wires or screws with additional tendon repair if applicable may be indicated if the extensor lag is significant. This can sometimes be difficult if there is little remaining patellar bone and patellar tendon tissues are often poor.[6,11] Figure 1 demonstrates a case of periprosthetic patellar fracture managed with tension band wiring and hamstring tendon autograft. With such poor outcomes reported in the literature, it has been suggested that nonoperative management may be appropriate in the initial phase. The benefits in undertaking a surgical repair at an early stage remain to be proven.[1,11] Chalidis *et al*. recommended extensor apparatus reconstruction without revision of the patellar component for this subgroup to minimize risk of further fragmentation and Benkovich *et al*. proposed partial patellectomy or nonoperative management.[17,22] Should the component be found to be loose, this should be investigated further to identify the underlying cause preoperatively and allow any other issues to be addressed at the time of revision surgery if required.[2,20] In some cases, partial or complete patellectomy has been described for patients in whom initial patella fracture repair has failed, and while this did lead to improved pain levels, there was a negative impact on function; therefore, if this option is to be considered, patients should be counseled appropriately.[2,6] Some type III fractures may be appropriate for nonoperative management also if the patient has minimal symptoms and good function.[11] Surgical management for Type IIIa fractures tends to be with revision of the patellar component and patelloplasty, while Type III b fractures are often managed with removal of implant and either partial or complete patellectomy.[11]

There is little available evidence for the management of open patellar fractures. Case reports have been described, but there is a lack of good quality evidence or large case series from which to base any recommendations for treatment.[21]

Patellar tendon rupture

Conservative management with immobilization is an option for some patients, particularly those with partial rupture or with low functional demands. Direct repair with end-to-end sutures for midsubstance defects or the use of drill holes or suture anchors for avulsions is helpful but often not sufficient in

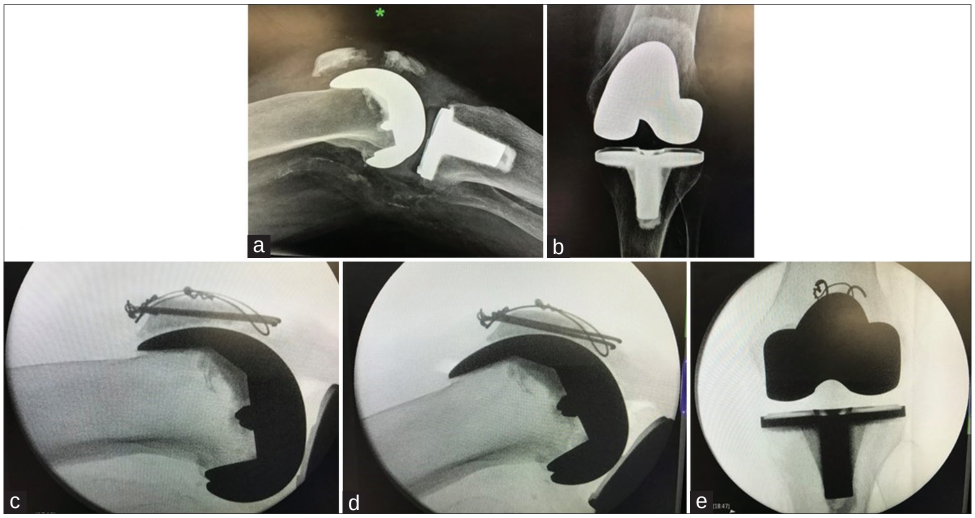


Figure 1: Preoperative radiographs of a patient with periprosthetic patellar fracture (a-b) followed by intraoperative imaging following open reduction and internal fixation with tension band wires and hamstring tendon autograft augmentation (c-e)

isolation due to the poor tissue quality.[2,4,6] As with quadriceps tendon ruptures, due to the high incidence of complications, it is now recommended to reinforce repair using additional augmentation.[6] Acutely, this was classically achieved with semitendinosus with or without gracilis tendon autografts if additional length is required.[2] More recently, synthetic materials such as Marlex mesh or knitted and monofilament polypropylene grafts have been introduced with good results.[2,5,6] Examples of augmentation techniques are illustrated in Figure 2. In the case of concurrent infection, arthrodesis is an option.[6]

Chronic patellar tendon ruptures can be made more difficult due to retraction of the tissues. For such challenging cases, additional augmentation techniques have been described such as Achilles tendon allograft with calcaneal bone block or bone-patellar tendon-bone allograft techniques.[2,6] In some cases, even more extensive reconstruction is required with complete allograft extensor mechanism reconstruction.[2] Indications include significant alterations in anatomy such as patella damage, necrosis, nonunion, severe patella baja, chronic retraction, or extensor ossification. On rare occasions, this approach is used following procedures such as patellectomy or for arthrodesis conversion.[2] Burnett *et al*. conducted a study to compare 2 tightening techniques in complete allograft extensor reconstruction. The first technique was the initial technique which was described by Emerson *et al*. and involved loose tightening allowing around 60° of flexion intraoperatively.[23] The second was a modified technique by Nazarian and Booth[24] where the graft was tightened in full extension. They reported 100% failure in the original loosened technique with associated poor final knee scores.[7] There was a significantly reduced mean extensor lag at final follow-up for the modified technique group compared to the original technique group as well as significantly improved postoperative knee scores and better overall mobility in the postoperative period.[7] This supports the more recent recommendation that grafts for augmentation of extensor mechanism reconstruction should be tightened in full extension and range of motion should not be assessed intraoperatively.[2,7] An example of the use of a complete extensor mechanism allograft is shown in Figure 3.

Due to the poor soft-tissue coverage over this region of the knee, additional considerations should be made for wound closure. Surgeons should have a low threshold for use of soft-tissue flap reconstruction to provide additional coverage if required.[2] Gastrocnemius rotational flaps were previously used for this purpose and more recently have been studied for their use in reconstruction and certain advantages such as lack of reliance on intact patella.[15]

Outcomes of Treatment

Acute quadriceps or patellar tendon ruptures treated with direct repair alone without augmentation have been associated with poor outcomes, with complication rates reported almost as high as 50%.[1] Therefore, recommendations have been made for patellar tendon repairs and, more recently, for quadriceps tendon repairs to all be augmented with some form of autograft or allograft as described. The most appropriate augmentation technique is not clear and likely will depend on a number of factors including degree of tear, quality of patients' soft tissues, and surgeon expertise to name a few.

Case series in the use of these reconstruction techniques have reported varied outcomes and of particular note are concerns around high rates of periprosthetic joint infection and failure due to new extensor lag following reconstruction.[1] A study by Courtney *et al*. designed to compare outcomes in patients who underwent direct repair of extensor mechanism disruption after TKA with those who underwent allograft reconstruction found that there was no statistically significant improvement in Knee Society Score between the 2 groups. They found that the reoperation rates in each group were similar (26% vs. 24%),

Figure 2: Intraoperative images from patellar tendon repair with hamstring tendon autograft augmentation (a) or neoligament augmentation (b) and quadriceps tendon repair with additional augmentation using neoligament (c)

with infection being the most common indication, accounting for 16%.[1] When patients were grouped according to timing of surgery, those who had their operation within 2 weeks were significantly less likely to have a poor outcome and were also more likely to have a direct repair. However, when analyzing those who had surgery at >2 weeks from injury, there was no significant difference in rates of poorer outcomes between the 2 types of surgery.[1] The overall postoperative infection rate was approaching 20%.[1] Patellar tendon ruptures had the highest rates of reoperation and were also significantly more likely to have poorer outcomes; however, it is important to note that this study did not employ augmentation techniques which may have improved outcomes.[1]

Quadriceps tendon rupture

Patients in whom conservative management is appropriate tend to have satisfactory outcomes with series showing nonoperative patients having the highest functional scores; however, it is unclear if this reflects the severity of injury.[4] Where surgical intervention is required, outcomes are better with early intervention.[2,4,16] Even with this, rerupture rates are approximately 15% but have been quoted to be as high as 33%–36% in complete ruptures. Infection rates are around 12% following direct repair with or without augmentation.[4]

Figure 3: Complete extensor mechanism allograft for chronic patellar tendon rupture. Preoperative imaging is shown (a-b). Intraoperative images illustrate initial patient positioning (c), exposure achieved (d), removed patella and patellar component (e), and allograft preparation (f-g) including imaging with allograft *in situ* (h). Postoperative radiographs are also demonstrated (i-j)

Patellar fracture

A systematic review by Chalidis *et al*. supported the use of conservative management due to overall satisfactory functional outcomes, especially in comparison to those undergoing surgical intervention. Where surgical intervention was performed, open reduction and internal fixation with tension band or cerclage wiring were discouraged as this was associated with failure and nonunion rates possibly as high as 90%.[17,22] In Ortiguera and Berry's study, fixation of the extensor mechanism or fracture surgically was associated with a significant reoperation rate of 42%, a residual extensor lag rate of 58%, and overall complication rate of 50% including nonunion, rerupture, secondary fracture, or infection. Interestingly, despite 39% of patients achieving nonunion in this study, only one patient was considered to have a failure of treatment based on functionality and pain, which suggests that nonunion may not be a significant outcome measure in this group.[11]

Patellar tendon rupture

Patellar tendon ruptures have been associated with the poorest outcomes of the three forms of extensor mechanism failure.[1,25] It is rare to achieve return to full extension following patellar tendon repair.[2,25] As mentioned, augmentation techniques have been explored but insufficient evidence is available to make recommendations at present. Browne and Hansen published a case series of 13 patients describing the use of a polypropylene graft reconstruction which achieved extensor lag of <10° in 69% of patients and significantly improved pain and function scores.[2,6] Failure rate in this series was 23% and only one patient developed infection within the follow-up timeframe.[9] Results from Achilles tendon allografts have been more conflicting with failure rates ranging from 22% to 41.4% in larger series.[8,9] While a significant proportion of these patients are found to have a residual extensor lag at follow-up, it has not had a negative impact on function which is encouraging.[25] Medial gastrocnemius rotational flaps may also improve outcomes in patients where allografts are contraindicated due to infection, or where soft tissue coverage is a significant problem for example. Although, these flaps do have their own complications such as difficulties with uphill walking, running and reduced step length postoperatively.[26] In a review of a study of 50 complete extensor allografts for chronic patellar tendon rupture, there was a failure rate of 38% at a mean of almost 5 years and survivorship at 10 years was calculated at 56.2%.[2] Reasons for failures included four patients who underwent further revision for recurrent extensor lag, five patients with deep infection, and ten patients who had unsatisfactory functional outcomes.[2]

Conclusion

Although rare, extensor mechanism failure is a potentially devastating complication for patients following TKA. The literature reporting in this injury and its sequelae is limited and comparisons among case series is difficult due to heterogeneity in the study populations and surgical approaches (even within the same series).[1,11,14,19,27] Further research is necessary before consequential recommendations for treatment options can be made. However, based on the available literature, there is near-universal support of nonoperative management where patients present with a minimal extensor lag as defined as a lag of <20° or in some cases 30°.[2,5,16,18,21] For patients for whom surgical intervention is indicated, they should be adequately counseled on the often poor and sometimes devastating outcomes associated with these procedures.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Courtney PM, Edmiston TA, Pflederer CT, Levine BR, Gerlinger TL. Is there any role for direct repair of extensor mechanism disruption following total knee arthroplasty? J Arthroplasty 2018;33:S244-8.
2. Rosenberg AG. Management of extensor mechanism rupture after TKA. J Bone Joint Surg Br 2012;94:116-9.
3. Assiotis A, To K, Morgan-Jones R, Pengas IP, Khan W. Patellar complications following total knee arthroplasty: A review of the current literature. Eur J Orthop Surg Traumatol 2019;29:1605-15.
4. Dobbs RE, Hanssen AD, Lewallen DG, Pagnano MW. Quadriceps tendon rupture after total knee arthroplasty. Prevalence, complications, and outcomes. J Bone Joint Surg Am 2005;87:37-45.
5. Nodzo SR, Rachala SR. Polypropylene mesh augmentation for complete quadriceps rupture after total knee arthroplasty. Knee 2016;23:177-80.
6. Nam D, Abdel MP, Cross MB, LaMont LE, Reinhardt KR, McArthur BA, *et al.* The management of extensor mechanism complications in total knee arthroplasty. AAOS exhibit selection. J Bone Joint Surg Am 2014;96:e47.
7. Burnett RS, Berger RA, Paprosky WG, Della Valle CJ, Jacobs JJ, Rosenberg AG. Extensor mechanism allograft reconstruction after total knee arthroplasty. J Bone Joint Surg Am 2004;86-A: 2694-9.
8. Ares O, Lozano LM, Medrano-Nájera C, Popescu D, Martínez-Pastor JC, Segur JM, *et al.* New modified Achilles tendon allograft for treatment of chronic patellar tendon ruptures following total knee arthroplasty. Arch Orthop Trauma Surg 2014;134:713-7.
9. Brown NM, Murray T, Sporer SM, Wetters N, Berger RA, Della Valle CJ. Extensor mechanism allograft reconstruction for extensor mechanism failure following total knee arthroplasty. J Bone Joint Surg Am 2015;97:279-83.
10. Lamberti A, Balato G, Summa PP, Rajgopal A, Vasdev A, Baldini A. Surgical options for chronic patellar tendon rupture in total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc 2018;26:1429-35.
11. Ortiguera CJ, Berry DJ. Patellar fracture after total knee arthroplasty. J Bone Joint Surg Am 2002;84:532-40.
12. Garner MR, Gausden E, Berkes MB, Nguyen JT, Lorich DG. Extensor mechanism injuries of the knee. J Bone Joint Surg Am 2015;97:1592-6.
13. Pawar U, Rao KN, Sundaram PS, Thilak J, Varghese J. Scintigraphic Assessment of Patellar Viability in Total Knee Arthroplasty After Lateral Release. J Arthroplasty 2008;24:636-40.
14. Vaishya R, Agarwal AK, Vijay V. Extensor mechanism disruption after total knee arthroplasty: A case series and review of literature. Cureus 2016;8:e479.
15. Bates MD, Springer BD. Extensor mechanism disruption after total knee arthroplasty. J Am Acad Orthop Surg 2015;23:95-106.
16. Chhapan J, Sankineani SR, Chiranjeevi T, Reddy MV, Reddy D, Gurava Reddy AV. Early quadriceps tendon rupture after primary total knee arthroplasty. Knee 2018;25:192-4.
17. Chalidis BE, Tsiridis E, Tragas AA, Stavrou Z, Giannoudis PV. Management of periprosthetic patellar fractures. A systematic review of literature. Injury 2007;38:714-24.
18. Vyas P, Cui Q. Management options for extensor mechanism discontinuity in patients with total knee arthroplasty. Cureus 2020;12:e9225.
19. Parvizi J, Kim KI, Oliashirazi A, Ong A, Sharkey PF. Periprosthetic patellar fractures. Clin Orthop Relat Res 2006;446:161-6.
20. Govil G, Tomar L, Dhawan P. Peri-prosthetic trans-patellar fractures after Total knee Arthroplasty: A case series and review of literature. Arthroplasty 2020;2:35.
21. Masmoudi K, Grissa Y, Benzarti S, Cheikhrouhou H, Mensi Z. Open

periprosthetic patellar fracture after total knee replacement. J Orthop Case Rep 2016;6:89-91.
22. Benkovich V, Klassov Y, Mazilis B, Bloom S. Periprosthetic fractures of the knee: A comprehensive review. Eur J Orthop Surg Traumatol 2020;30:387-99.
23. Emerson RH, Head WC, Malinin TI. Extensor Mechanism Reconstruction With an Allograft After Total Knee Arthroplasty. Clin Orthop Relat Res 1994;303:79-85.
24. Nazarian DG, Booth Jr RE. Extensor mechanism allografts in total knee arthroplasty. Clin Orthop Relat Res 1999;367:123-9.
25. Parker DA, Dunbar MJ, Rorabeck CH. Extensor mechanism failure associated with total knee arthroplasty: Prevention and management. J Am Acad Orthop Surg 2003;11:238-47.
26. Busfield BT, Huffman GR, Nahai F, Hoffman W, Ries MD. Extended Medial Gastrocnemius Rotational Flap for Treatment of Chronic Knee Extensor Mechanism Deficiency in Patients with and without Total Knee Arthroplasty. Clin Orthop Relat Res 2004;428:190-7.
27. Barrack RL, Stanley T, Butler RA. Treating Extensor Mechanism Disruption After Total Knee Arthroplasty. Clin Orthop Relat Res. 2003;416:98-104.

Functional Outcomes in Quadruple Arthroplasty of the Hips and Knees: A Literature Review of 306 Cases with a Minimum Follow-Up of 2 Years

Raju Vaishya, Chandra Bhusan Yadav, Abhishek Vaish

Department of Orthopaedics and Joint Replacement Surgery, Indraprastha Apollo Hospital, New Delhi, India

Abstract

Quadrupled arthroplasties of the lower limb are required mostly in cases with chronic and severe inflammatory arthritis. There may be a requirement of additional surgery for the foot and ankle or joints of an upper limb, especially in inflammatory arthritis, to improve the functional outcomes. The patient's self-motivation and patient selection for four joint arthroplasties are necessary for favorable outcomes. Surgical technique, prosthetic design, and postoperative rehabilitation play a vital role in functional outcomes. More multicenter, large series and registries are required with long-term follow-up in the future to frame the clinical practice guidelines.

Keywords: Arthroplasty, functional outcome, hip, joint replacement, knee, quadruple, rheumatoid arthritis

Introduction

Multiple joint involvements are a common occurrence in cases suffering from chronic inflammatory arthritis, and some of these cases require quadruple arthroplasties of major joints of the lower extremities. The arthroplasties of four major lower limb joints are often needed in these cases to relieve pain, remove disability, improve joint function, and restore mobility. Quadrupled arthroplasties are being done most commonly in cases with inflammatory arthritides such as rheumatoid arthritis (RA), juvenile rheumatoid arthritis (JRA), ankylosing spondylitis (AS), and hemophilia. Less commonly, these procedures may be required in osteoarthritis (OA) and metabolic syndromes (like obesity and hypothyroidism). Arthroplasties of four major joints of the lower extremities are less commonly performed, and simultaneous replacements of all four joints are even further rarer.[1,2]

The arthroplasties of all four major joints of lower limbs are challenging to execute as it requires multiple surgeries, greater surgical time, and increased chances of risk of complications. The main objectives of quadruple arthroplasties are to eliminate pain and improve the performance of the arthritic joints enabling activities of daily living smoothly. Long-term goals of these procedures are to regain physical independence by attaining good overall functional outcomes. The patients with RA and other inflammatory arthritides may also have other associated comorbidities. Hence, it is difficult to predict functional outcomes after quadruple arthroplasty in such cases.[3]

Till date, there have only a few studies that have evaluated the functional outcomes of patients with arthroplasty of bilateral hips and knees. Most of these studies have reported a reduction of pain and increased mobility of joints. However, there were concerns regarding the radiographic evaluation, choice of prosthetic design, complications, and lesser predictions of overall functional ability of the patients when other joints of

Address for correspondence: Dr. Abhishek Vaish,
Department of Orthopaedics and Joint Replacement Surgery,
Indraprastha Apollo Hospital, Sarita Vihar, New Delhi - 110 076, India.
E-mail: drabhishekvaish@gmail.com

Submitted: 26-Jan-2022 **Revised:** 14-Mar-2022
Accepted: 14-Mar-2022 **Published:** 09-Jun-2022

How to cite this article: Vaishya R, Yadav CB, Vaish A. Functional outcomes in quadruple arthroplasty of the hips and knees: A literature review of 306 cases with a minimum follow-up of 2 years. J Arthrosc Jt Surg 2022;9:8-16.

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jajs

DOI: 10.4103/jajs.jajs_2_22

the body are also affected with arthritis.[1-5] This review was aimed to evaluate the functional outcome of patients with arthroplasties of bilateral hips and knees.

Methodology

An electronic search of the PubMed, Scopus, and Google Scholar databases was conducted on October 10, 2021, using keywords ("bilateral hip and knee replacement") OR ("Combined arthroplasties of hip and knee"). After applying Boolean operators (AND, OR), the search identified 524 studies. These were further stream lined by only including full articles, review articles, and papers published in English. This methodology yielded 55 papers. These were then carefully read and accepted or rejected based on modified Coleman scoring which yielded 30 papers, out of which ten articles were found relevant for this review. These were assessed to obtain the functional outcomes of quadruple arthroplasties of the major joints of the lower extremities.

It yielded 30 articles. The articles were screened, and 20 of the original articles were selected after removing the duplicate articles. Out of these, five articles were further excluded as these were not limited to hip and knee arthroplasties. The full text of the screened article was read, the relevance was assessed, and further selection was made as per our inclusion and exclusion criteria.

We included the retrospective and prospective studies in the English language, where primary arthroplasty of bilateral hips and knees was performed, with a minimum 2-year follow-up. The case reports, letters to editor, and studies with lesser than 2-year follow-up were excluded. We also excluded studies involving revision arthroplasties and replacements of lesser than four joints. A secondary search was also done from the bibliography list of all the selected articles to check on any missing articles.

Results

A total of ten studies of interest were included in this review [Figure 1], which met our inclusion and exclusion criteria. One of the ten studies was a comparative study between one staged versus two-stage bilateral total hip and knee arthroplasty. One study was focused on functional evaluation. The remaining studies dealt with various outcomes of bilateral hip and knee arthroplasties. One study evaluated the outcomes in cases of JRA, five in RA, two in OA, and the remaining two studies dealt with both inflammatory and noninflammatory arthritis. The maximum number of 125 cases was presented by Meding *et al.*,[4] while the least number of six cases by Mulhall *et al*.[6] The total number of cases in these ten studies was 306, with 1224 joints. Their mean age was 52.6 years (range: 14.7–69.5 years).

These studies were published between 1978 and 2019. The majority of the studies addressed clinical outcomes of patients on various parameters, who had replacements of all four joints of lower limbs. A total of 306 patients were reviewed collectively by all studies [Table 1]. The mean age group was 13–85, but mostly included patients with younger age groups. 68.6% of patients were females. Meding *et al*.,[4] reported 83% knee cases and 86% hip cases had no pain postoperatively, whereas, Catherine *et al*., found the mean pain scores of 83.57 + 20.5 for hip and 74.52 + 18.5 for knee postoperatively. The range of motion of the hips and knees improved significantly after quadrupled arthroplasty, and combined hip, and knee flexion of >190° was achieved in most patients.

In most patients who had significant flexion contractures of hips and knees preoperatively, the flexion deformity was corrected largely after the surgery. Most of the nonambulatory patients were able to ambulate outdoors, the need for walking aids was decreased, and the walking distance of the patients increased. Hui *et al*.[3] reported a high risk of fall 71% (10/14) of patients based on the timed up and go test and in 57% (8/14) of patients based on the berg balance test. Meding *et al*.[4] observed that 98% of patients were able to negotiate stairs, but Yoshino *et al*.[5] found that 14 out of 18 of their patients were unable to negotiate stairs. Hoekstra *et al*.[7] and Hui *et al*.[3] reported that 10 out of 13 and 13 out of 14 patients, respectively, were unable to negotiate stairs.

Yoshino *et al*.[5] and Hoekstra *et al*.[7] noted improvement in sexual function in 7 and 5 of their patients, respectively. An early complication of urinary tract infection (UTI) was seen in 21/306 (6.8%) cases and wound infection in 12 (3.9%) cases. Late complications such as loosening were reported in 27/1224 (2.2%) joints, dislocations in 15 (1.2%), periprosthetic fractures in 5 (0.4%) cases, and transient nerve palsies in 3 (0.2%) of the cases were seen.

Discussion

The cases requiring quadrupled arthroplasties of four major joints of the lower extremities are mostly affected by inflammatory arthritides and are younger, as seen in our review, where their mean age was 52.6 years. Only Stafeno *et al*.[1] included elderly patients, and Mulhall J *et al*.[6] included younger cases with JRA, where the mean age was only 14.7 years. Gruer *et al*.[2] reported improved functional outcomes in all the age groups. On the contrary, Harry *et al*.[8] and Hoekstra *et al*.,[7] in a short follow-up, reported age as an important factor in the functional outcome improvement in RA patients. Mcelwain and Sheehan.[9] stated that 6/10 of their nonambulatory patients were able to walk after the surgery. The older age group patients required longer rehabilitation and follow-up to attain significant gain in functional outcomes. The incidence of quadruple arthroplasties was found comparatively more in females (68.6%), which may point toward the higher prevalence of inflammatory arthritis in females.[10]

The studies included in this review mostly dealt with the cases of inflammatory arthritis, and RA accounted for the maximum of 49.6% of cases. The remaining cases included OA, AS, hemophilic arthritis, and vasculitis-associated arthritis. Six

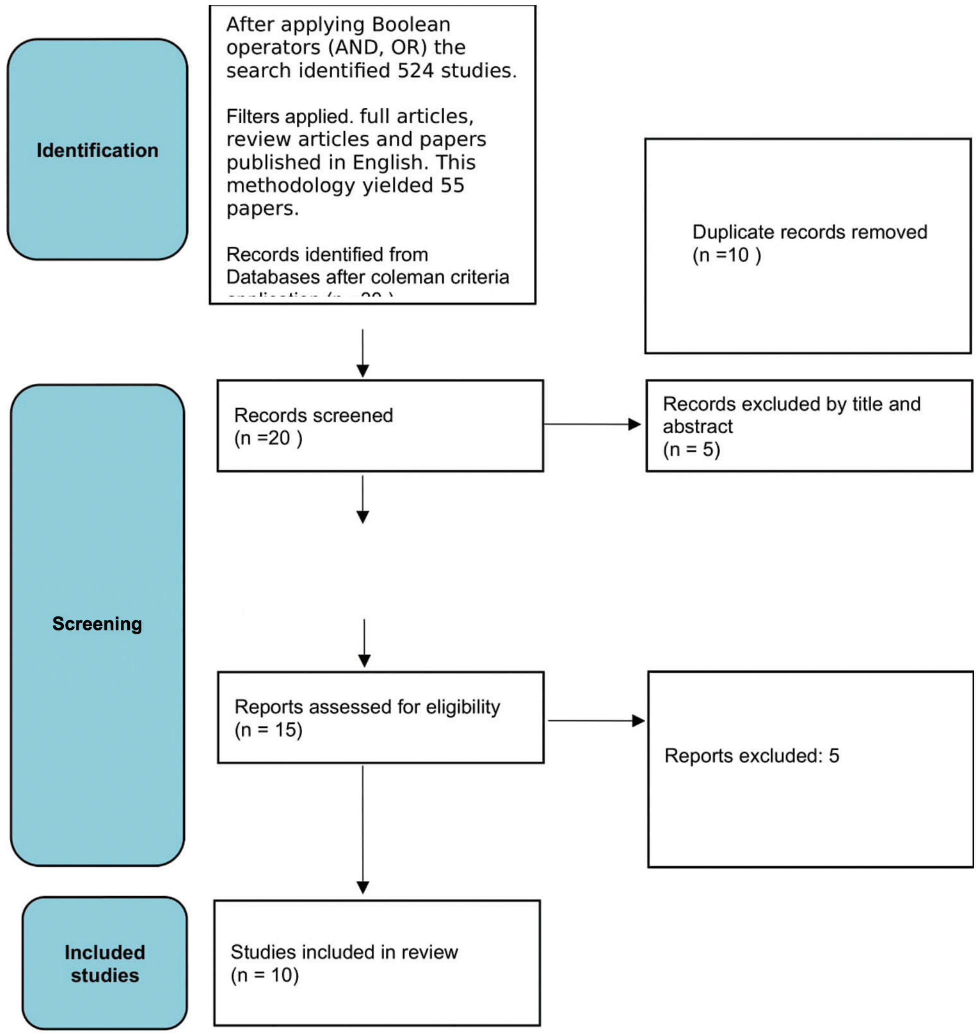


Figure 1: PRISMA chart describing the selection of the studies in this review

out of ten studies included RA patients only. Meding *et al*.[4] found RA as the most common cause for quadruple arthroplasty due to widespread involvement of multiple joints. Combined arthroplasties are mostly required in inflammatory arthritis. Grauer *et al*.[2] further elaborated that the destruction in lower limb joints in RA is more severe than the destruction caused by weight-bearing in noninflammatory arthritis. These authors have described that the functional outcome improvement is limited in RA patients with foot and ankle involvement, upper extremities involvement, and systemic involvement. Hoekstra *et al*.[7] have identified several limiting factors in RA patients for the poorer functional outcomes such as old age, long-duration disease, severe concomitant disease, and poor patient motivation. Good functional outcomes are also reported in patients with OA.[3]

The quadrupled arthroplasties are often performed as staged procedures. Stefano *et al*.[1] compared cases in two groups, as one-staged versus two-staged. The study included small samples, but the evaluation at long-term follow-up demonstrated that the arthroplasties that were done at one stage had a lesser duration of hospital stay, but blood loss was more. Similar results were also reported by Mcelwain and Sheehan.[9] The quadruple arthroplasties that were done in one-stage were cost-effective, safe, and avoided hospital-related complications due to longer stay. The interval between the surgeries was decided according to the severity of the joint involved. Grauer *et al*.[2] categorized the stages as <1 year, 1–2.5 years, and >2.5 years, interval. Mcelwain and Sheehan.[9] classified the surgery interval as a short interval (2–12 weeks) and a longer interval (6–28 weeks) between the surgeries. Similar functional outcomes were reported in all the staged groups.[2,9]

The surgeries were also done in varying patterns. Most of the studies suggested that the hips be replaced before the knees to avoid mal-alignment of knees. The reported advantages and basis of this strategy included (a) knee flexion deformity is not adequately correctable if associated with the hip disease, (b) avoiding the risk of implant loosening, (c) less requirement of energy to move lower limb in pain-free hips, and (d) in quadruple joint involvement, the knee pain is mostly referred from hip or due to residual deformity of the hip.[6,8,11,12]

Table 1: Clinical details of the studies included in the review

Authors and publication year	Number of patients	Type of study	Mean age group (years)	Preoperative ROM	Postoperative ROM
Petrillo *et al*. (2019)[1]	42	Retrospective Comparative	69+10.2	A (hip) Flexion-61.4°±35.8° IR/ ER-2.1°±4.1°/13.6°±8.1° Add/Abd-11.6° (±5.5°)/12.4°±(9.8°) (knee) Flexion-115.2°±6° Loss of extension-1.6°±2.8° B (hip) Flexion-33.5°±18.4° IR/ER-1.7°±4.5°/11.5°±5.1° Add/Abd - 11°±7.2°/14.3°±8.6° (knee) Flexon-99.7°±29.7° Loss of extension-3.9±4.9°	A (hip) Flexion-111.9°±8.7° IR/E-36.6°±6.7°/41.2°±(4.4°) Add/Abd-40.7°±4.3°/38.1°±5.8° (knee) Flexion-117.3°±9.4° Loss of extension-0.3°±1.2° B (hip) Flexion-115.3°±9.9° IR/ER-35°±8.6°/43.6°±2.9° Add/Abd- 37°±7.5°/40.3°±6.9° (knee) Flexon-119.3°±12.6° Loss of extension-0.2°±1.3°
Grauer *et al*. (1986)[2]	28	Prospective	46.2	Hip: Flexion: 88° (10°–130°) Knee: Preoperative-94° (15–140°) Mean flexion contracture 18° (0–90°)	Hip: Flexion: 96° (50°-125°) Mean flexion contracture: 23° (0-55°) Knee: Preoperative-88° (20-115°) Mean flexion contracture 3° (0-25°)
Hui *et al*. (2012)[3]	14	Retrospective	69.5		Hip: mean flexon90.9° (60°-110°) mean Abduction26.1° (10°-65°) Flexon contracture10° Knee: Mean flexon - 96.6° (0°-125°) Mean extension 2.3° (0°-35°)
Meding *et al*. (2017)[4]	125	Retrospective	63.7		
Yoshino *et al*. (1984)[5]	22	Prospective	51.5	Hip: Flexon-60° (25-100) Knee: Flexon-103° (90-150) Combined knee and hip flexon-163° (120-210) Hip: Flexion contracture-29° (10-70) Knee: Flexion contracture-42° (15-110)	Hip: Flexon-82° (40-100) Knee: Flexon-82° (30-110) Combined knee and hip flexon-164° (70-200) Hip: Flexion contracture-8° (0-15) Knee: Flexion contracture – 0° (0-20)
Hoekstra *et al*. (1989)[7]	14	Prospective	45.5	Hip: Flexon-47° Abd-7° Flexion contracture 28° Knee: Flexon-54° Flexion contracture-25°	Hip: Flexon-79° Abd-29° Mean flexion contracture 4.5^0 Knee: Flexon-81° Flexion contracture-2°
Mulhall *et al*. (2008)[6]	6	Retrospective	14.7	Knee: Flexion-extension arc-38° Flexion contractures - 41.1° (20-74^0) Hip: Flexion-contractures (10-60^0)	Knee: Flexion-extension arc-76° Flexion contractures-(10) knees-no contractures 2 knees-15°, 25° contractures Hip: (9) hips-no contractures (3) hips-residual contractures (10-15°)
McElwain and Sheehan *et al*. (1985)[9]	19	Prospective	53.8	Hip: Flexon-61.5° Knee: Flexion extension arc-85° Flexion contracture-25 (10-52°)	Hip: Flexon-98° Knee: Flexion extension arc-85° Flexion contracture-14^0 (0-42^0)
Suman and Freeman *et al*. (1986)[14]	20	Prospective	63.5	Hip: Flexion-80° Knee: Flexion-extension arc-90° Flexion contracture-17 (10-20°)	Hip: Flexion-100° Knee: Flexion-extension arc-90° Flexion contracture-7° (0-10°)
Jergesen *et al*. (1978)[8]	16	Prospective	48.5	Hip: Flexion-92° Flexion contracture-19° Knee: Flexion-98° Flexion contracture-17° Combined hip + knee flexion-190°	Hip: Flexion-105° Flexion contracture-9° Knee: Flexion-100° Flexion contracture-8° Combined hip + knee flexion-205°

Contd...

Table 1: Contd...

Authors and publication year	Pain relief	Outcome measures	Complications	Observations
Petrillo *et al*. (2019)[1]	Postoperative hip pain - (0) Postoperative knee pain- (5)	A (hip) HSS - 96.6±4.1 h-WOMAC - 94.1±5.8 (knee) KSS - 93.1±4.5 k- WOMAC-91.9±4.2 B (hip) HSS - 95.8±5.2 h-WOMAC - 97.2±3.7 (knee) KSS - 94±6.8 k-WOMAC - 94±6.8	Wound infection (1) Urinary tract infection (1) Hip dislocation (1) Knee flexion contracture (1)	Significant Improvement in the functional outcomes
Grauer *et al*. (1986)[2]	Pain score: (hip) - 3.6 (preoperative)-8.8 (postoperative) (Knee) - 3.8 (preoperative) - 8.4 (postoperative)	Mean walking score: 3.6 (preoperative) - 5.1 (postoperative) Mean function score: 3.1 (preoperaive)-4 (postoperaive) Walking distance Increased - (15) No change (9) Decreased-(2) Walking with support Decreased-(14) No change-(7) Increased-(5) With cane (9) Cutches (4) Unable (1) No support-10 Stair up and down Improved-7 No change-12 Decreased-7	Periprosthetic fracture (1) hip, (1) knee Dislocation (2) hips Wound infections (2) Urinary tract infection (12) Pulmonary embolism (2)	Significant improvement in the joint function after quadrupled arthroplasty in RA
Hui *et al*. (2012)[3]	Hip: (mean)-83.57+20.5 Knee: (mean)-74.52+18.5	Hip: WOMAC score: Mean-75.04 (SD 19.3) Knee: WOMAC score: Mean-74.52 (SD 18.5) Walking distance: Nonambulatory (1) Housebound (2) <1 block (3) 15 blocks (3) 6–10 blocks (2) Unlimited (3) Walking aids None (5) Cane (3) Crutches (2) Walker (4) Wheelchair (1) Stair climbing: Any fashion (10) With rail (1) Unable (2) Normal (1) TUG test-<14 s BBS-38.5	Dislocation (1) hip Loosening(10) hips, (7) knees Periprosthetic fracture (2) knees Infection (2) knees	Good out comes can be achieved with a high level of patient satisfaction and considerable improvements in pain and function despite many patients requiring revision surgery

Contd...

Table 1: Contd...

Authors and publication year	Pain relief	Outcome measures	Complications	Observations
Meding *et al.* (2017)[4]	HHS pain score-43 points (20-44) 86% hips-no pain 83% knee-no pain	HHS (THA) gait score-29 (4–33) KSS function Score-78 (30–100) HHS walking score-9.8 (5–11) KSS walking score-42.8 (20–50) HHS stair score-2.5, 5 (0–4) KSS stair score-(27.290–50) 98% patients were able to ascend and descend stairs No patient housebound	Infection (4), (7) hip dislocation Loosening (10) hip, (3) knee	Excellent clinical, functional, and radiographic outcomes of both THA and TKAs in patients with all Four major lower extremity joints are replaced At an average follow-up of over 10 years, 86% of hips and 83% of knees were rated with no or mild pain, 68% of patients rated walking As unlimited, and 98% of patients were able to satisfactorily negotiate stairs
Yoshino *et al.* (1984)[5]	Postoperative hip pain - (0) Postoperative knee pain-(5)	Walking ability Preoperative Unable to walk (11) Postoperative Unable to walk (2) Outdoors>30 min (7) Outdoors<30 min (9) Rising from a chair Preoperative (7) Postoperative (16) Up and down-stairs Preoperative (0) patients Postoperative (6) up only (4) (up and down) Use of transportation Preoperative (0) Postoperative (4) Able to perform sexual intercourses Preoperative (0) Postoperative (7)	(1) Hip loosening	Good outcomes in RA after replacements if following: 1. Strong motivation 2. Good relationship with a physician 3. No severe extra-articular disease 4. RA activity is controlled by Medications.
Hoekstra *et al.* (1989)[7]	Postoperative-Mild pain: Hips (2) knees (9) Ankle (2)	Preoperative Unable to walk (7) Indoor walker (5) Wheel-chair bound-(10) Postoperative Walk without aid (7) Walk with crutches (4) Wheel chair bound-(2) Improved sexual function (5) HSS score: Preoperative-16 Postoperative-70.5 Aichroth knee function assessment score Preoperative-23 Postoperative-39.95 Groningen scale Preoperative-44 Postoperative-141.4	Trochanteric fracture (1) Loosening (1) Urinary tract infection (1) Wound infection (1) Hypoaesthesia over lateral side of patella (4)	13 severely handicapped patients of rheumatoid arthritis with Destruction of hip and knee joint Quadruple arthroplasty consistently eliminated pain and improved Function. Application of extensive Rating scale gives Better judgment Than evaluation of single joint

Contd...

Table 1: Contd...

Authors and publication year	Pain relief	Outcome measures	Complications	Observations
Mulhall *et al*. (2008)[6]	Postoperative- Pain Persisted in 3 knees in 2 patients and 5 hips in 3 patients, required revision surgery	Preoperattive Wheel chair bound (5) Limited community ambulatory (1) Postoperative Unlimited ambulatory (4) Limited community (3) ambulators Household ambulatory (1)	Supracondylar femur fracture (2) Transient peroneal nerve palsy (1)	All the cases functioning independent
McElwain and Sheehan *et al*. (1985)[9]	Hip pain persisted in: (1) Knee: (9) complete relief of pain, (8) mild pain, (2)-patella-femoral pain	Preoperativ Wheel chair bound (10) Walk with crutches (3) Walk without aid (3) With a stick (3) Postoperative Walk without an aid (8) Walk with a stick (7) Wheel-chair bound (2) Walk with crutches (2) Improvement in stair climbing, walking distance, rising from a chair	Dislocation (2) hips Fracture femur (1) patient Progressive knee contracture (4) patients	Significant improvement in the functional ability in all cases, except those with cervical myelopathy and Still's disease
Suman and Freeman *et al*. (1986)[14]	Postoperative Pain relief in (39) hips Pain persisted-(1) hip Pain relief in 20 knees (14) knees- mild discomfort, (5) knees- retro patellar pain	In ambulatory patients-walking distance increased* (9) In non ambulatory patient- became ambulatory (1) *Patient could walk without aid (6) Patient could walk with an aid (4)	Infection (1) Hip dislocation (1) Loosening-hips (2), knee (1)	Significant improvement in the functional outcomes
Jergesen *et al*. (1978)[8]	15 of 16 patients had pain relief (6)-pain eliminated (9) -occasional pain (1) – no pain relief	Walking distance>4 blocks preoperative-0 Postoperative-5 2–3 blocks preoperative-2 Postoperative-8 Indoor walker Preoperative-11 Postoperative-3 Unable to walk Preoperative-3 Postoperative-0 Use of walking aid None Preoperative-0 Postoperative-6 1 cane Preoperative-0 Postoperative-4 2 cane Preoperative-9 Postoperative-6 Walker Preoperative-4 Postoperative-0 Bed chair Preoperative-3 Postoperative-0	Transient nerve palsy (2) patients Malposition of components (2) patients Hip dislocation (1)-Wound infection (1) Wound haemorrhage (1) Urinary tract infection (8) Transient chest pain (1) ECG changes (1)	88% improvement in the postoperative functional score

Contd...

Table 1: Contd...

Authors and publication year	Pain relief	Outcome measures	Complications	Observations
		Arising from chair Slight push off Preoperative-0 Postoperative-7 Max effort: Preoperative-6 Postoperative-3 Unable: Preoperative-10 Postoperative-6 Stair climbing Improved-11 patients No change-5 patients		

ROM: Range of motion, SD: Standard deviation, TUG: Timed up and go, BBS: berg balance scale, ECG: Electro cardio gram, IR: Internal rotation, ER: External rotation, HSS: Harris hip score, WOMAC: Western ontario and mcmaster universities osteoarthritis index, KSS: Knee society score

Table 2: Tips, Tricks and pitfalls while undertaking quadruple arthroplasty of the hips and knees

Tips and tricks	Pearls	Pitfalls
Hip should be operated first	Patient should be transferred safely with care to and fro from the operating table to avoid fractures	Higher chances of peri operative bleeding
The perioperative management should be focussed on multidisciplinary approach	The surgeries should be adequately staged and individualised, depending on the patient's disability and requirements	Higher chances of postoperative infection and increased need for blood transfusion
Involve a Rheumatological from the start	Avoid lengthening of the limb in cases of hip as chances of patient's disability and neurovascular complications are higher	Due to osteoporosis, higher chances of periprosthetic fractures exist
Arrange adequate blood for transfusion	Keep stem extensions, other augments and wiring set stand by	Prolonged surgical time

The clinical and functional evaluation of the quadrupled arthroplasties was done heterogeneously. Mcelwain and Sheehan.[9] reported that most of their patients were satisfied with higher WOMAC hip and knee, HHS, and KSS clinical and function scores.[3] Hoekstra *et al*.[7] emphasized the importance of using Groningen-Aichroth's extensive rating score for the evaluation of function,[13] as it is a standard scoring system better judgment than the scoring system that evaluated single joint at a time. Most studies claimed that combined hip and knee flexion of >190° is required for stair climbing and rising up from the chair. A good surgical technique is needed to achieve combined flexion of >190°. Unlike other studies, Hui *et al*.[3] reported against combined knee and hip flexion of >190° necessity for stair climbing and rising from the chair. However, their study included mostly OA patients, and their observations are therefore not applicable to inflammatory arthritis cases. These authors have also reported a high risk of a fall due to alterations in proprioception present in patients with multiple joint arthroplasties.

Improvement in sexual function was noticed after quadruple arthroplasties by Hoekstra *et al*.,[7] and Yoshino *et al*.[5] due to their ability to walk *P* better, regaining physical energy, and elimination of pain in the affected joints. A strong patient motivation, a thorough examination of patients for extra-articular manifestations before the operation, and comprehensive medical treatment are essential to achieve favorable outcomes after multiple joint arthroplasties in RA patients.[5,14] Meding *et al*.[4] evaluated 125 patients, mostly with OA, and reported 98% of them were able to negotiate stairs. On contrary, Hui *et al*.,[3] Yoshino *et al*.,[5] and Hoekstra *et al*.[7] found that their patients were unable to negotiate stairs. This difference was because of the nature of the patients included in these studies. The series with OA patients did better in this regard, compared to inflammatory arthritis cases, where stairs negotiation becomes difficult if the foot, ankle, and upper extremities are also involved. In RA patients, functional outcome was improved with the concomitant use of disease-modifying anti rheumatoid drugs.[15]

C Riietter *et al*.[16] (1C5) reported following arthroplasty of one joint in OA patients, the incidence of OA increases in the contralateral joint, especially with increasing obesity and aging. Therefore, unilateral lower limb arthroplasty increases the need for contralateral arthroplasty, as also supported by Sayeed *et al*.[17]

The most commonly reported medical complication was UTI. The main surgical complications included wound infections, loosening of the prosthesis, periprosthetic fractures, residual pain, dislocation, residual contractures especially in RA, and JRA.[6] Loosening of the implant was found to be the major cause of revision surgeries.[3,7,14] Additional surgeries of the foot, ankle, elbow, and cervical spine were also required in RA with severe disease.[6-9,14] The durability of the prosthesis was doubtful in patients with JRA, and hence an uncemented prosthesis was considered to be more durable than cemented prosthesis by Mulhall *et al*.[6] Tips, tricks and pitfalls have been briefly described in the table below [Table 2].

Conclusion

Quadrupled arthroplasties of the lower limb are required mostly in cases with chronic and severe inflammatory arthritis. These cohorts were younger and had more females. Good outcomes can be achieved in these patients, with a high level of patient satisfaction and considerable improvements in pain and function. The patients were continuing the medical management in the peri operative period. These patients were under the supervision of the rheumatological team for dose adjustments (if any). Hip arthroplasty is preferred first, followed by knee arthroplasty. There may be a requirement of additional surgery for the foot and ankle or joints of an upper limb, especially in inflammatory arthritis, to improve the functional outcomes. The patient's self-motivation and patient selection for four joint arthroplasties are necessary for favorable outcomes. Surgical technique, prosthetic design, and postoperative rehabilitation play a vital role in functional outcomes. More multicenter, large series, and registries are required with long-term follow-up in the future to frame the clinical practice guidelines.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Petrillo S, Marullo M, Corbella M, Perazzo P, Romagnoli S. One-staged combined hip and knee arthroplasty: Retrospective comparative study at mid-term follow-up. J Orthop Surg Res 2019;14:301.
2. Grauer JD, Cracchiolo A 3rd, Finerman GA, Dorey FJ. Bilateral hip and knee arthroplasty. J Arthroplasty 1986;1:283-91.
3. Hui C, Ben-Lulu O, Rendon JS, Soever L, Gross AE, Backstein D. Clinical and patient-reported outcomes of patients with four major lower extremity arthroplasties. J Arthroplasty 2012;27:507-13.
4. Meding JB, Faris PM, Davis KE. Bilateral total hip and knee arthroplasties: Average 10-year follow-up. J Arthroplasty 2017;32:3328-32.
5. Yoshino S, Fujimori J, Morishige T, Uchida S. Bilateral joint replacement of hip and knee joints in patients with rheumatoid arthritis. Arch Orthop Trauma Surg 1984;103:1-4.
6. Mulhall KJ, Saleh KJ, Thompson CA, Severson EP, Palmer DH. Results of bilateral combined hip and knee arthroplasty in very young patients with juvenile rheumatoid arthritis. Arch Orthop Trauma Surg 2008;128:249-54.
7. Hoekstra HJ, Veth RP, Nielsen HK, Veldhuizen AG, Visser JD, Nienhuis RL, *et al.* Bilateral total hip and knee replacement in rheumatoid arthritis patients. Arch Orthop Trauma Surg 1989;108:291-5.
8. Jergesen HE, Poss R, Sledge CB. Bilateral total hip and knee replacement in adults with rheumatoid arthritis: an evaluation of function. Clin Orthop Relat Res. 1978;(137):120-8.
9. McElwain JP, Sheehan JM. Bilateral hip and knee replacement for rheumatoid arthritis. J Bone Joint Surg Br 1985;67:261-5.
10. Favalli EG, Biggioggero M, Crotti C, Becciolini A, Raimondo MG, Meroni PL. Sex and management of rheumatoid arthritis. Clin Rev Allergy Immunol 2019;56:333-45.
11. Johnson KA. Arthroplasty of both hips and both knees in rheumatoid arthritis. J Bone Joint Surg Am 1975;57:901-4.
12. Arafiles RP, Gustilo RB. Joint replacement in non-ambulatory patients. J Bone Joint Surg Am 1979;61:892-7.
13. A knee function assessment chart. From the British orthopaedic association research sub-committee. J Bone Joint Surg Br 1978;60-B: 308-9.
14. Suman RK, Freeman PA. Bilateral hip and knee replacement in rheumatoid arthritis. J Arthroplasty 1986;1:237-40.
15. Jain A, Stein BE, Skolasky RL, Jones LC, Hungerford MW. Total joint arthroplasty in patients with rheumatoid arthritis: A United States experience from 1992 through 2005. J Arthroplasty 2012;27:881-8.
16. Ritter MA, Carr KD, Keating EM, Faris PM. Long-term outcomes of contralateral knees after unilateral total knee arthroplasty for osteoarthritis. J Arthroplasty 1994;9:347-9.
17. Sayeed SA, Sayeed YA, Barnes SA, Pagnano MW, Trousdale RT. The risk of subsequent joint arthroplasty after primary unilateral total knee arthroplasty, a 10-year study. J Arthroplasty 2011;26:842-6.

Ultrastructural Characteristics of Chronically Failed Reconstructed Anterior Cruciate Ligament

Gunjar Jain[1,2], Rameshwar Datt[2,3], Hira Lal Nag[2], Asjad Mahmood[2], Shubhankar Shekhar[2], Tapas Chandra Nag[4]

[1]Department of Orthopaedics, All India Institute of Medical Sciences, Bhubaneswar, Departments of [2]Orthopaedics and [4]Anatomy, All India Institute of Medical Sciences, [3]Department of Orthopaedics, ESI PGIMSR Basaidarapur, New Delhi, India

Abstract

Background: In the present study, we have examined the ultrastructure of chronically failed reconstructed anterior cruciate ligament (ACL). We aimed to investigate a faulty ligamentization process of a failed reconstructed anterior cruciate ligament. In other words, we want to study ultrastructural alterations a failed ACL graft undergoes. **Methods:** Two patients who underwent revision ACL reconstruction for nontraumatic failure without discontinuity of the graft were included in the study. The first patient was a 40-year-old male who had undergone ACL reconstruction of his right knee 21 years back using the bone-patellar tendon-bone autograft. The second patient was a 23-year-old male who had sustained an ACL tear with a medial collateral ligament injury treated by isolated ACL reconstruction 3 years back using hamstring tendon autograft. We collected punch biopsy specimens from the failed ligaments of both the patients during revision ACL reconstruction. These specimens were examined for the density of collagen fibrils within a fascicle (per 1.5 μm^2), cellular metabolism, and fibril diameter (nm) by transmission electron microscopy. **Results:** Fibroblasts of both the ligaments showed features of increased metabolism, more so in the first patient. Compared to the second patient, the fascicles of the first specimen were more loosely arranged. Both ligaments had a unimodal distribution of collagen fibrils. The first patient had a mean fibril diameter of 45.2 (+/−8.5) nm and an average fibril density of 376.8 fibrils per 1.5 μm^2. The second patient had an average fibril diameter of 64.1 nm (+/−7) and a mean fibril density of 152.9 fibrils/1.5 μm^2. The difference in these parameters of the two patients was statistically significant ($P < 0.001$). **Conclusion:** Our study suggests that the absence of thicker collagen fibrils with unimodal distribution, the altered density of the collagen fibrils within a fascicle, and ovoid fibroblasts with increased metabolism may symbolize bad ligamentization changes.

Keywords: Anterior cruciate ligament reconstructions, collagen fibril distribution, graft remodeling, hamstring tendon, ligamentization, patellar tendon

Introduction

Anterior cruciate ligament (ACL) reconstruction is one of the most common orthopedic surgical procedures, with more than 120,000 cases being operated on annually in the USA.[1] Long-term failure can occur in up to 11% of patients following the procedure.[2] The understanding regarding the ideal technique and rehabilitation protocol to avoid these failures continue to evolve. The anatomical reconstruction with the restoration of the native ACL footprints, diameter, and collagen orientation improves the functional outcome.[3] Biomechanical studies suggest that it also restores the kinematics of the knee joint.[4]

During healing, the ACL graft undergoes ultrastructural and biochemical modification called ligamentization and gradually transforms into viable ACL-like tissue.[5,6] However, the ultrastructural differences between a reconstructed and a native ACL persist even after ligamentization.[5] Compared to the native ACL, the reconstructed ACL lacks stiffer large-diameter fibrils and contains a higher proportion of the weaker Type III collagen fibrils.[7,8] Many authors suggest that physiological stress on the reconstructed graft promotes ligamentization.[9] However, no one has compared the remodeling of a stressed

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jajs

DOI: 10.4103/jajs.jajs_41_22

Address for correspondence: Dr. Rameshwar Datt, A-26, Street No. 2, East Nathu Colony, Main Mandoli Road, Shahdara, New Delhi - 110 093, India. E-mail: rameshwar5189@gmail.com

Submitted: 24-Feb-2022 **Revised:** 30-Mar-2022
Accepted: 14-Apr-2022 **Published:** 09-Jun-2022

How to cite this article: Jain G, Datt R, Nag HL, Mahmood A, Shekhar S, Nag TC. Ultrastructural characteristics of chronically failed reconstructed anterior cruciate ligament. J Arthrosc Jt Surg 2022;9:17-21.

and an unstressed graft to study the impact of stress on ligamentization. Furthermore, Fulkerson *et al*. have shown that even a free fragment hamstring graft implanted in the suprapatellar pouch undergoes vascularization and produces collagen.[10]

In the present study, we have examined the ultrastructure of nonfunctional yet intact reconstructed ACL grafts. We aimed to investigate a faulty ligamentization process of a failed reconstructed anterior cruciate ligament. No author has previously described the ultrastructural analysis of failed ACL grafts. By studying this, we can distinguish between ideal and faulty ligamentization. This study will increase our understanding of the impact of graft laxity on the ligamentization processes. Increased comprehension of this process can help in selecting the ideal technique of ACL reconstruction.

Methods

Two patients who underwent revision ACL reconstruction for nontraumatic failure without discontinuity of the graft were included in the study after written informed consent from both the patients to collect graft tissue samples for research purposes. The first patient was a 40-year-old male. The primary ACL reconstruction of his right knee was done 21 years back using the bone-patellar tendon-bone autograft. The femoral tunnel was prepared in this patient using the transtibial method, and the graft was fixed using the transfixation technique on the femoral side and metallic interference screw on the tibial side [Figure 1]. He was an amateur football player and has never returned to his preinjury activity level since his injury. He had episodic knee instability for 5 years, which had progressed in frequency and severity in the past 6 months.

The second patient was a 23-year-old male who presented with instability in his left knee. He had sustained an ACL tear with a medial collateral ligament (MCL) injury following a direct blow to his left knee 3 years ago. He had undergone ACL reconstruction 6 weeks following his injury using hamstring (semitendinosus) tendon autograft fixed with a fixed loop suspensory device on the femoral side and with a biocomposite interference screw on the tibial side. The MCL was not repaired or reconstructed during the primary surgery. He also remained symptomatic following the surgery and never attained the preinjury level of activity.

Figure 1: Radiograph of right knee of the first patient (anteroposterior view) showing a vertical femoral tunnel with a transfixation screw

Both patients, operated by a single surgeon, were suffering from chronic atraumatic instability of the knee following ACL reconstruction with a positive anterior drawer and pivot shift test. There was no episode of trauma after the index ACL reconstruction. Furthermore, the grafts, in both cases, as noticed during revision surgery, were only stretched, and the continuity of the graft was intact. Therefore, we believe that the concurrent instability of both the cases was atraumatic. The second patient had additional valgus laxity. We performed revision ACL reconstruction in both of them, with a concomitant MCL reconstruction in the second patient. In both patients, the ACL graft was observed to be intact during the revision surgery but was lax and nonfunctional. During this procedure, using 3-mm basket forceps, we collected punch biopsy specimens from the core of the mid-segment of the failed ACL.

The tissue samples were fixed in 2.5% glutaraldehyde and 2% paraformaldehyde in 0.1 M phosphate buffer (pH 7.3) for 12 h at 40°C. After washing the specimens in 0.1 M phosphate buffer and postfixing in 1% osmium tetroxide, we dehydrated it in graded ethanol (30, 50, 70, 90, 95, and 100%). The specimens were then embedded in Araldite, and blocks were prepared and polymerized in an oven at 60°C for 72 h. Semi-thick sections of the tissue (1 μm), stained with toluidine blue, were used for examining the gross characteristics of the area and the quality of fixation. Thin sections (60–70 nm thick), mounted on 300-mesh copper grids and stained with aqueous uranyl acetate and lead citrate, were observed under Tecnai G2-20 S-twin Transmission Electron Microscope (Fei Company, Eindhoven, The Netherlands) at a suitable magnification (4000×−10,000×).

Two authors (GJ and RD) analyzed several randomly chosen fields independently twice with an interval of 6 weeks using ImageJ software (NIH, USA). They examined all images for the density of collagen fibrils (per 1.5 μm^2), cellular metabolism, and fibril diameter (nm). An ideal part of the section, with densely packed collagen fibrils, was selected under lower magnification for density analysis. Longitudinal sections, where the fibrils thickness was uniform, were used to estimate the fibril diameter. The authors obtained a minimum of 100 observations for each parameter of both the subjects and calculated the mean, median, and absolute deviations of the morphometric data. We used statistical software Stata 14.0 to analyze the data. An independent *t*-test was applied to compare quantitative data expressed as mean ± standard deviation. $P < 0.05$ was considered statistically significant.

Results

The first specimen showed loosely arranged bundles of collagen fibrils with a thicker endoligament [Figure 2]. It had an average fibril density of 376.8 fibrils per 1.5 μm^2. It showed a symmetric distribution of collagen fibrils with diameters ranging from 28 mm to 63 nm and a mean fibril diameter of 45.2 (+/−8.5) nm. The second patient had a mean fibril density of 152.9 fibrils/1.5 μm^2 and an average fibril diameter of 64.1 nm (+/−7) [Figure 3]. The differences in the fibril diameter and distribution between the two patients were statistically significant (P < 0.001). Both the specimens had a unimodal collagen fibrils distribution and lacked large-diameter collagen fibrils of thickness more than 100 nm [Figure 4].

The fibroblasts of the first graft showed features of increased cellular metabolism. It was oval shaped with prominent cytoplasmic processes and nuclear indentations. It had active collagen fibrils synthesis with a high cytoplasm-to-nucleus ratio and abundant cellular organelles related to synthesis, including mitochondria, endoplasmic reticulum, Golgi apparatus, and secretory vesicle [Figure 5a]. Membrane-wrapped collagen fibrils ruptured into the extracellular matrix were observed [Figure 5b]. In the second graft, cellular metabolism was comparatively less prominent. Although the cytoplasm-to-nucleus ratio was high, the number of organelles was fewer, and the collagen fibril synthesis was also limited [Figure 6].

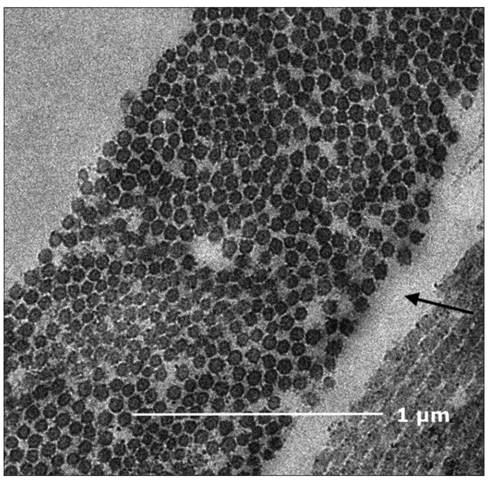


Figure 2: Electron micrograph of transverse section of the graft of the first patient showing the unimodal distribution of collagen fibrils. The arrow is pointing toward the endoligament of the reconstructed tendon

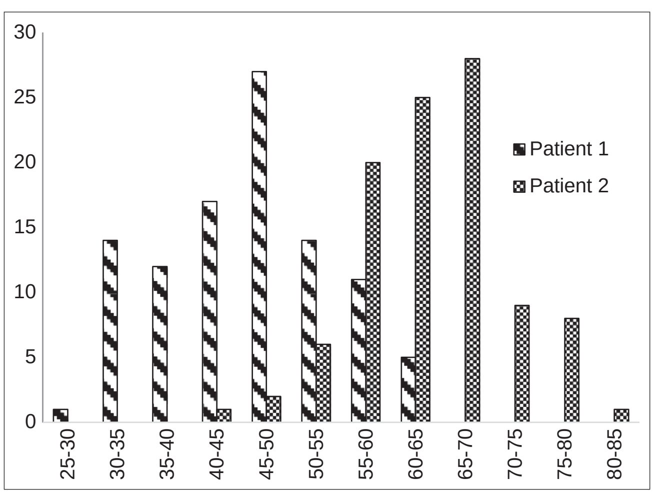


Figure 4: Diameter distribution of collagen fibrils of both the patients showing the presence of significantly thicker fibrils in the second patient

Discussion

Remodeling following graft implantation is a complex process and depends on multiple factors such as graft orientation, restoration of native footprints, the tension of graft, and the type of graft used. In most human studies about ligamentization, authors have procured tissue from the reconstructed ACL

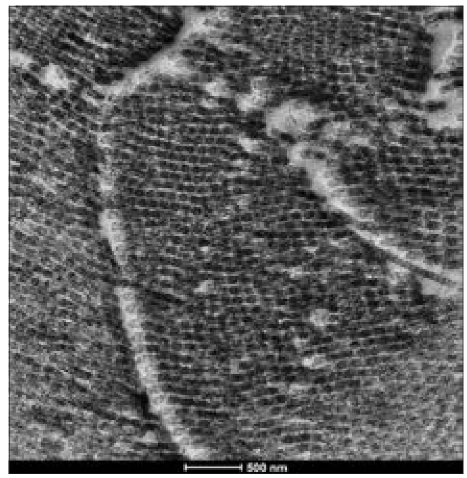


Figure 3: Electron micrograph of transverse section of the graft of the second patient showing the unimodal distribution of collagen fibrils and compactly placed fascicles

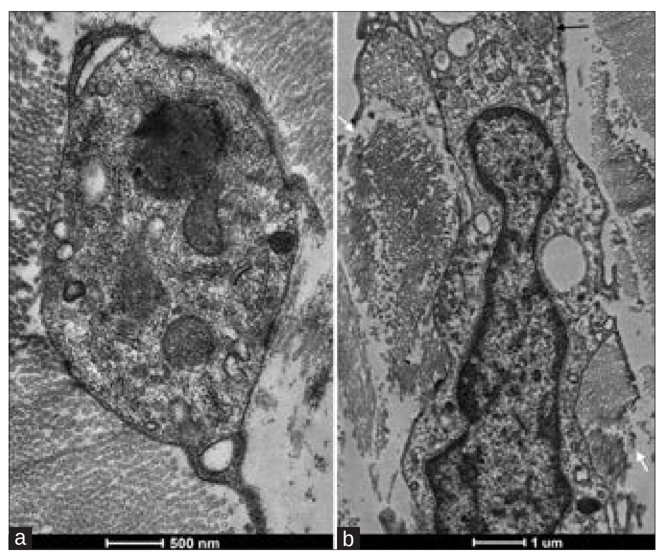


Figure 5: Electron micrograph of fibroblast of the graft of the first patient in transverse section; (a) Note high metabolic activity with increased cytoplasm-to-nuclear ratio and increased number of secretory organelles. (b) Note the presence of collagen fibrils inside the secretory organelles (black arrow) and the release of collagen fibrils into the extracellular matrix (white arrows)

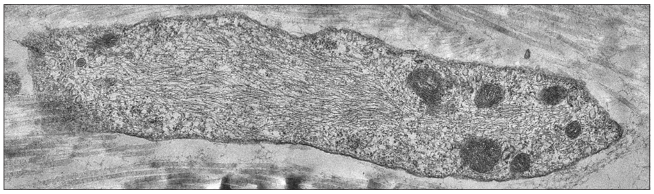


Figure 6: Electron micrograph of fibroblast of the graft of the second patient in longitudinal section showing comparatively less metabolic activity than the first patient

during a relook arthroscopic examination of the knee. Because of the requirement for tissue sampling, few human studies addressing this subject are available in the literature. Moreover, therefore, most researchers have used animal models to understand this phenomenon. However, there is a significant difference in the ligamentization process in animal models and human subjects.[5,8,9] For instance, in human subjects, the intensity of necrosis and subsequent revascularization is limited compared to animals.[8,9] The ligamentization timeline is also different from animals, and the process takes an extended period to complete in humans.[5,8] Therefore, the direct application of the information of animal studies in human subjects might be misleading.

In this study, we have examined the ultrastructural characteristics of nontraumatically failed reconstructed ACL in two patients. The cause of failure in the first patient was a vertically oriented graft, whereas that in the second patient was persistent valgus instability. Both patients showed increased metabolic activity of the fibroblasts, loss of large collagen fibrils with a diameter of more than 100 nm, and a unimodal fibril distribution. However, they differ significantly in the density of collagen fibrils, which were higher in the first patient, and the fibrils thickness, which was more in the second patient. These differences might be explained by the different clinical scenarios of the patients. For instance, the two patients differ by factors such as time since primary ACL reconstruction, graft source, fixation method, graft orientation, and the etiology of failure.

The native ACL, the hamstrings, and patellar tendon autografts contain large and small diameter collagen fibrils with a bimodal distribution.[7,8] Hadjicostas *et al*. had found no difference in the collagen fibril thickness and distribution between the three structures.[11] Most authors have reported that reconstructed ligament gradually loses the large diameter fibrils and achieves a unimodal distribution, with a collagen fibril diameter <100 nm.[7,8] However, Dong *et al*. had recently shown that patients who underwent double-bundle ACL reconstruction using autogenous hamstring tendons attain bimodal collagen fibril distribution at mid-term and long-term.[12] In our study, both our patients had a unimodal distribution of collagen fibril with a mean diameter of 45.2 (±8.5) nm in the first and 64.0 (±7) nm in the second patient. Therefore, the absence of large diameter collagen fibrils seen in our cases and in previous studies may indicate a defective ligamentization.

Cho *et al*. had shown that the collagen fibril density of a reconstructed hamstring tendon ACL graft decreases at the end of 20 months from 399/1.5 μm^2 to 349/1.5 μm^2.[13] Zaffafgnini *et al*. found that although the density of collagen fibrils decreases initially, it increased to almost double that of native hamstring grafts at the end of 2 years.[14] In their study, this increased density gradually reduced, and by 10 years, reached 325.5/1.5 μm^2, which was closer to the level of native ACL, which was 294/1.5 μm^2.[14] In our study, the mean density of fibrils within a fascicle was 376.8/1.5 μm^2 and 152.9 fibrils/1.5 μm^2 in the first and second patients, respectively. This finding shows that the collagen density might depend on factors such as graft orientation, loading of the graft, and residual instability.

Dong *et al*. have classified cellular metabolism based on electron microscopy findings depending on the presence of synthesis-related organelles and cytoplasm-to-nucleus ratio.[12] As per this classification, higher grades with abundant cytoplasm and secretory organelles represent the best possible ligamentization process. However, other researchers have suggested that the fibroblasts of a reconstructed ACL, which are ovoid in the first 12 months, gradually change to less metabolically active elongated spindle-shaped fusiform cells by 13–24 months.[9,15] In the present study, both our patients had ovoid fibroblasts with features of increased metabolism. Therefore, increased metabolism of fibroblasts within the reconstructed ligament may represent bad ligamentization.

Our study has certain limitations. First, since atraumatic ACL reconstruction failure is rare, we have reported only two patients. Second, we had collected the biopsy specimen from the core region from the mid-segment of the graft. However, the graft characteristics would differ in their proximal, distal, and superficial aspects. Thus, our findings cannot be generalized to the entire graft. Furthermore, we have not examined histological properties such as vascularity and cellularity, which are also crucial aspects of the ligamentization process. More extensive studies should be conducted in the future to investigate the ultrastructural characteristics of a failed graft. These changes should also be correlated with the cause of failure. By these investigations, we can evaluate the impact of multiple factors, such as graft orientation, restoration of native footprints, graft tension and laxity, and graft origin, on graft remodeling.

Conclusion

Our study indicates that the absence of thicker collagen fibrils, altered density of collagen fibrils within a fascicle, and ovoid fibroblasts with increased metabolism symbolize a faulty ligamentization process. The primary application of this investigation is to determine the characteristics of a defective ligamentization. We suggest reserving the word ligamentization for only the changes signifying conversion of a tendon to a ligament. All other alterations which a reconstructed graft undergoes can be referred to as remodeling of the graft.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Kiapour AM, Murray MM. Basic science of anterior cruciate ligament injury and repair. Bone Joint Res 2014;3:20-31.
2. Crawford SN, Waterman BR, Lubowitz JH. Long-term failure of anterior cruciate ligament reconstruction. Arthroscopy 2013;29:1566-71.
3. Middleton KK, Hamilton T, Irrgang JJ, Karlsson J, Harner CD, Fu FH. Anatomic anterior cruciate ligament (ACL) reconstruction: A global perspective. Part 1. Knee Surg Sports Traumatol Arthrosc 2014;22:1467-82.
4. Zantop T, Diermann N, Schumacher T, Schanz S, Fu FH, Petersen W. Anatomical and nonanatomical double-bundle anterior cruciate ligament reconstruction: Importance of femoral tunnel location on knee kinematics. Am J Sports Med 2008;36:678-85.
5. Claes S, Verdonk P, Forsyth R, Bellemans J. The "ligamentization" process in anterior cruciate ligament reconstruction: What happens to the human graft? A systematic review of the literature. Am J Sports Med 2011;39:2476-83.
6. Marumo K, Saito M, Yamagishi T, Fujii K. The "ligamentization" process in human anterior cruciate ligament reconstruction with autogenous patellar and hamstring tendons: A biochemical study. Am J Sports Med 2005;33:1166-73.
7. Abe S, Kurosaka M, Iguchi T, Yoshiya S, Hirohata K. Light and electron microscopic study of remodeling and maturation process in autogenous graft for anterior cruciate ligament reconstruction. Arthroscopy 1993;9:394-405.
8. Janssen RP, Scheffler SU. Intra-articular remodelling of hamstring tendon grafts after anterior cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2014;22:2102-8.
9. Scheffler SU, Unterhauser FN, Weiler A. Graft remodeling and ligamentization after cruciate ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2008;16:834-42.
10. Fulkerson JP, Berke A, Parthasarathy N. Collagen biosynthesis in rabbit intraarticular patellar tendon transplants. Am J Sports Med 1990;18:249-53.
11. Hadjicostas PT, Soucacos PN, Koleganova N, Krohmer G, Berger I. Comparative and morphological analysis of commonly used autografts for anterior cruciate ligament reconstruction with the native ACL: An electron, microscopic and morphologic study. Knee Surg Sports Traumatol Arthrosc 2008;16:1099-107.
12. Dong S, Xie G, Zhang Y, Shen P, Huangfu X, Zhao J. Ligamentization of autogenous hamstring grafts after anterior cruciate ligament reconstruction: Midterm versus long-term results. Am J Sports Med 2015;43:1908-17.
13. Cho S, Muneta T, Ito S, Yagishita K, Ichinose S. Electron microscopic evaluation of two-bundle anatomically reconstructed anterior cruciate ligament graft. J Orthop Sci 2004;9:296-301.
14. Zaffagnini S, De Pasquale V, Marchesini Reggiani L, Russo A, Agati P, Bacchelli B, *et al.* Electron microscopy of the remodelling process in hamstring tendon used as ACL graft. Knee Surg Sports Traumatol Arthrosc 2010;18:1052-8.
15. van Groningen B, van der Steen MC, Janssen DM, van Rhijn LW, van der Linden AN, Janssen RP. Assessment of graft maturity after anterior cruciate ligament reconstruction using autografts: A systematic review of biopsy and magnetic resonance imaging studies. Arthrosc Sports Med Rehabil 2020;2:e377-88.

Total Hip Arthroplasty for Failed Osteosynthesis of Proximal Femoral Fractures: Clinical Outcomes from a Low- and Middle-Income Country

Devarshi Rastogi, Shailendra Singh, Ahmad Ozair, Shah Waliullah, Shitanshu Kumar Singh, Rajeshwar Nath Srivastava

Department of Orthopaedic Surgery, King George's Medical University, Lucknow, Uttar Pradesh, India

Abstract

Introduction: Total hip arthroplasty (THA) has a demonstrated utility in the surgical management of patients with proximal femoral fractures that fail internal fixation, with good outcomes reported from high-income countries. Given the lack of data from resource-limited settings, this work sought to report the clinical outcomes of THA for failed proximal femoral osteosynthesis from a low- and middle-income country (LMIC). **Methods:** The work was conducted and reported in accordance with Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. A retrospective cohort study was carried out on all patients who underwent rescue THA for failed osteosynthesis of proximal femoral fractures, from January 2016 to June 2020, at a tertiary care center in Northern India. Primary study outcomes were functional outcomes as assessed by Harris Hip Score (HHS) at 1-year postoperatively and the frequency of perioperative complication as assessed by Clavien-Dindo-Sink Grading System. **Results:** Twenty-eight patients with mean age of 43.25 ± 10.5 years were included, with 18 males and 10 females. For their femur fracture stabilization, the most common method used had been dynamic hip screw (n = 16, 57.1%), followed by cannulated cancellous screw (n = 6, 21.5%), proximal femoral nail (n = 3, 10.7%), dynamic condylar screw (n = 2, 7.1%), and Schanz Screw (n = 1, 3.6%). Causes of failure had included cut-out of screw (n = 14, 50.0%), avascular necrosis (n = 8, 28.6%), back-out of screw (n = 3, 10.7%), non-union (n = 2, 7.1%), and secondary osteoarthritis (n = 1, 3.6%). THA was carried out after mean 26.64 ± 9.01 months after index procedure. HHS improved significantly from 39.71 ± 10.89 preoperatively to 79.54 ± 4.22 at 1-year follow-up (mean difference 39.82, 95% confidence interval 43.66–35.98, $P < 0.001$). Perioperative complications occurred in two patients of Clavien-Dindo-Sink Grade III and another of Grade II, with no mortality occurring by 1 year. **Conclusions:** In resource-limited settings like LMICs, THA may be a safe and efficacious surgical modality for failed osteosynthesis of proximal femoral fractures.

Keywords: Clavien-Dindo-Sink, Harris hip score, implant failure, intertrochanteric fracture, neck femur fracture, total hip replacement

Introduction

Proximal femoral fractures are one of the most common causes of disability in the adult population, with femoral neck and intertrochanteric fractures accounting for the vast majority of these fractures.[1,2] Several implants are available for their treatment, including dynamic hip screws, cannulated cancellous screws, dynamic compression screws, intramedullary devices like proximal femoral nails, among others.[1-4] Extensive literature has demonstrated similar and equivocal outcomes for these techniques, with no implant being absolutely superior to the other.[3-8]

The use of internal fixation for proximal femoral fractures may fail due to multiple reasons, including nonunion, loss of fixation, femoral head osteonecrosis, posttraumatic arthritis, malunion, infection, or symptomatic hardware. Haentjens *et al*. reported failure rate with internal fixation for intertrochanteric fracture in the range of 3%–12% with device penetration (2%–12%), nonunion (2%–5%), and malunion causing varus

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jajs

DOI: 10.4103/jajs.jajs_17_22

Address for correspondence: Dr. Shailendra Singh, Department of Orthopaedic Surgery, King George's Medical University, Lucknow - 226 003, Uttar Pradesh, India. E-mail: shailendra81mamc@gmail.com

Submitted: 12-Feb-2022 **Revised:** 10-Mar-2022
Accepted: 13-Mar-2022 **Published:** 09-Jun-2022

How to cite this article: Rastogi D, Singh S, Ozair A, Waliullah S, Singh SK, Srivastava RN. Total hip arthroplasty for failed osteosynthesis of proximal femoral fractures: clinical outcomes from a low- and middle-income country. J Arthrosc Jt Surg 2022;9:22-7.

deformity (5%–11%).[9] Quite recently, a Cochrane Review published in 2022 reported high rates of reoperation after primary repair of extracapsular fracture of the hip in older adults.[5] The majority of these need to be performed due to cut-out by screw or blade due to progressive osteolysis of the cancellous bone, followed by the cortical bone, causing cephalad perforation of the device from the femoral head.[3]

For failed osteosynthesis of proximal femoral fractures, the procedure of choice in young patients is salvage with re-osteosynthesis and the conservation of the hip joint. In the elderly or in patients with femoral head injury, acetabular involvement, or significant lower limb shortening, it becomes necessary to utilize salvage with total hip arthroplasty (THA) for maintenance of joint mobility and stability. Conversion of failed hip surgeries to THA is indicated in cases where the bone quality is poor, the head is damaged due to previous internal fixation, the bone stock is poor, or the limb has undergone shortening. THA in these patients may be difficult because of the presence of a previous implant and poor bone stock.

While considerable data regarding the utility of THA in these individuals, has been published from high-income countries (HICs), little data exists regarding the clinical outcomes of such patients in low-and middle-income countries (LMICs). Given that resource-limited settings like LMICs often have higher rates of perioperative complications and mortality after routine surgical procedures, compared to HICs, therefore, determining the outcomes in LMICs is necessary since salvage THA is generally a more complex procedure than primary THA. Therefore, this work sought to determine the functional outcomes and technical difficulties associated with total hip replacement performed after failed osteosynthesis of proximal femoral fractures.

Methods

Study design

The present work was a retrospective cohort study conducted and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines. The study was performed at the Department of Orthopaedic Surgery in a tertiary-care, publicly funded institution of Northern India, in accordance with the ethical guidelines of the Declaration of Helsinki. Informed consent had been previously collected from the patients or their attendants at the time of presentation for future research activities. Patient data were collected through chart review and digitized, and confidentiality was strictly maintained through the use of an assigned identification number.

Study participants

All adult patients (>18 years) who had undergone a rescue THA, at our institution, for failed osteosynthesis of proximal femoral fractures, from January 2016 to June 2020 were included. The criteria to consider failed osteosynthesis were the presence of cut-out of the screw, back-out of the screw, nonunion, osteonecrosis of the femoral head, malposition, or breakage of osteosynthesis material. Patients <18 years of age and those presenting with concurrent infection with the implant *in situ* were excluded.

Study outcomes

Given the under-reporting of patient-reported outcomes (PROs) from LMICs, this work was focused on capturing PROs. Our primary outcomes were (1) Harris Hip Score (HHS), and (2) frequency of perioperative complications, with secondary outcomes being mortality at 1-year. HHS is a well-validated staff-administered tool for evaluating outcomes after various hip disabilities and treatment modalities. It awards 100 points across four domains, namely pain, function, deformity and range of motion.[10] Perioperative complications were graded using the Clavien-Dindo-Sink complication grading scale, which is Sink *et al*.'s modified complication classification schema for orthopedic surgery.[11] It has been validated widely, including in hip surgery and pediatric surgery,[11,12] and has been demonstrated to have high interobserver reliability.

Care pathway and surgical technique

These patients with failed osteosynthesis of proximal femoral fractures underwent a thorough clinical, biochemical and radiological examination preoperatively. Comorbidities were assessed and a complete preanesthetic workup was performed. THA was performed under epidural anesthesia, with the posterolateral approach being used in all cases. Despite resource limitations, a complete implant removal set had been arranged in all patients. In the case of united fracture, surgical dislocation of the head before implant removal was preferred. In cases of nonunion, head and neckpieces were extracted after implant removal. Hand-held reamers were used for femoral canal preparation under C-arm guidance to avoid perforation of the cortex. In the case of the cemented femoral stem, care was taken while cementing. Good cement pressurization was challenging because the cement could come out through the big hole in the lateral cortex and several small holes in either the lateral or medial cortices. The lag screw hole was closed using the assistant's thumb, firmly packed gauze, or fashioning a bone plug from the femoral head. For the screw holes, we applied direct finger pressure, used gauze or screws that were cut short to close the holes over the lateral cortex when cement was injected. Cemented arthroplasty was preferred in patients over 50 years of age with poor bone stock and a wide medullary canal. In younger patients, both cemented stem (standard metaphyseal stem or long stem) and uncemented stem (uncemented metaphyseal stem or a distal fixing stem) were used depending upon the location of the original fracture, a primary implant used, and the affordability of the patient. Metaphyseal fitting stem relies on the intact metaphyseal area and was not suitable when the fracture extended below the lesser trochanter. In such cases, a tapered, fluted, modular distally fixing stem was preferred. On the acetabular side, hydroxyapatite-coated cups were used in case of good bone stock. In osteoporotic individuals, cemented cups that are made of highly cross-linked polyethylene, were preferred.

Data collection and follow-up

Data was collected through paper charts. Functional assessment of included patients had been carried out both preoperatively and at 1-year follow-up. Patients had been reviewed regularly at 6 weeks, 12 weeks, 6 months, and 1 year. Radiographs of the hip were taken at follow-up and were compared with the baseline radiographs for signs of loosening, migration, wear, and implant failure. Radiological signs of loosening of the implant according to criteria laid down by Gruen *et al*. had also been noted at follow-up.[13]

Statistical analysis

Statistical analysis was carried out in Stata Base Edition V17.0 (StataCorp LLC, College Station, TX, USA). Normality of continuous variables was tested using the Shapiro-Wilk test, whose test statistics were nonsignificant indicating normality. Intergroup comparisons of categorical variables were performed using Chi-square, while preoperative and postoperative HHS scores were compared using paired *t*-test. Correlation between continuous variables was assessed using Pearson's correlation coefficient.

Results

A total of 28 patients were included, with the characteristics of included individuals having been described in Table 1. Eighteen males (64.3%) and 10 females (43.2%), were included having a mean (standard deviation) age of 43.2 (10.5) years. The most common technique used for femur fracture stabilization was dynamic hip screw (*n* = 16, 57.1%), followed by cannulated cancellous screw (*n* = 6, 21.5%), proximal femoral nail (*n* = 3, 10.7%), dynamic condylar screw (*n* = 2, 7.1%), and Schanz Screw (*n* = 1, 3.6%). Causes of failure included cut-out of screw (*n* = 14, 50.0%), avascular necrosis (*n* = 8, 28.6%), back-out of screw (*n* = 3, 10.7%), nonunion (n = 2, 7.1%) and secondary osteoarthritis (*n* = 1, 3.6%) [Table 2].

These patients had undergone revision surgery after a mean 26.64 ± 9.01 months after index operation. Uncemented THA had been carried out in 60.7% of cases as a salvage procedure while cemented THA had been performed in 39.3% of cases [Table 3]. HHS improved preoperatively from 39.71 ± 10.89 to 79.54 ± 4.22 at 1-year follow-up, with a statistically significant mean difference of 39.82 (95% confidence interval 43.66–35.98, paired *t*-test value 21.26, *P* < 0.001). The box-and-whisker plot for these results are demonstrated in Figure 1.

Three patients suffered perioperative complications [Table 4]. One complication was of Clavien-Dindo-Sink Grade II, wherein the patient suffered an avulsion of the tip of the greater trochanter occurred while broaching for the uncemented femoral stem, which was fixed while doing the THA, but the patient needed abduction bracing for 3 weeks and had prolonged hospitalization [Figure 2a-d]. Meanwhile, two complications were of Clavien-Dindo-Sink grade III. One patient developed Vancouver type C periprosthetic fracture while reducing the prosthesis due to the presence of a large femoral hole after implant removal [Figure 2e-g]. Another presented with acute infection 2 weeks after salvage THA and had to be treated with debridement and intravenous antibiotics based on culture sensitivity.

At latest follow up none of the cases showed radiological signs of loosening of the implant according to Gruen criteria.[13] No mortality had occurred by 1-year postoperatively. Difference of preoperative and 1-year postoperative HHS scores has

Table 1: Characteristics of the included patients in the present study

Variable	Value
Age (mean±SD)	43.25±10.5
Male/female	18/10
Side involved (left hip/right hip)	11/17
Fracture location, frequency (%)	
Neck of femur fracture	13 (46.4)
Intertrochanteric fracture	12 (42.9)
Subtrochanteric fracture	3 (10.7)

SD: Standard deviation

Table 2: Previous method of the treatment of the femoral fracture and the cause of the failure of osteosynthesis (*n*=28)

	Frequency (%)
Initial mode of osteosynthesis	
Cannulated cancellous screw	6 (21.5)
Dynamic condylar screw	2 (7.1)
Dynamic hip screw	16 (57.1)
Proximal femoral nail	3 (10.7)
Schanz screw	1 (3.6)
Cause of failure of osteosynthesis	
Avascular necrosis	8 (28.6)
Backout of prosthesis	3 (10.7)
Cut-out	14 (50.0)
Nonunion	2 (7.1)
Secondary osteoarthritis	1 (3.6)

Table 3: Procedural information and clinical outcomes of patients (*n*=28)

Variable	Value
Surgery performed, frequency (%)	
Cemented THA	11 (39.3)
Uncemented THA	17 (60.7)
Time between primary and revision surgery, mean±SD	26.64±9.01
Preoperative Harris Hip Score, mean±SD	39.71±10.89
Postoperative Harris Hip Score at 1 year, mean±SD	84.54±4.22
Patient distribution based on interpretation of 1 year postoperative Harris Hip, frequency (%)	
Score <70 (poor)	0
Score 70-79 (fair)	13 (46.4)
Score 80-89 (good)	15 (53.6)
Score 90-100 (excellent)	0

THA: Total hip arthroplasty, SD: Standard deviation

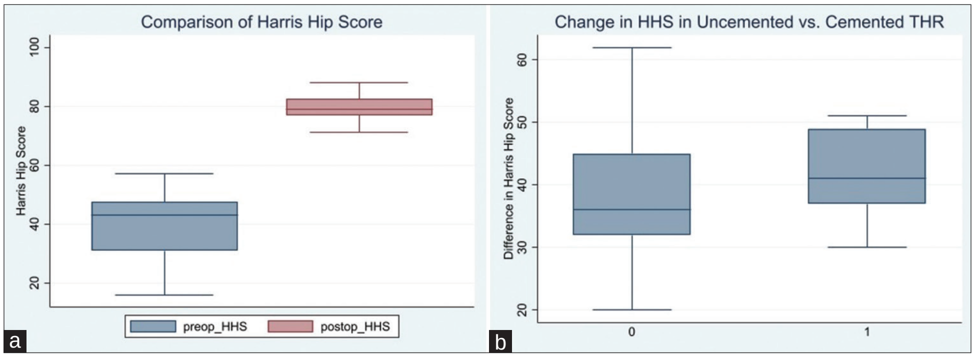


Figure 1: (a) Box plots of Harris Hip Score (HHS), preoperatively and 1-year postoperatively, and (b) Comparison of improvement in HHS in cemented versus uncemented total hip replacement

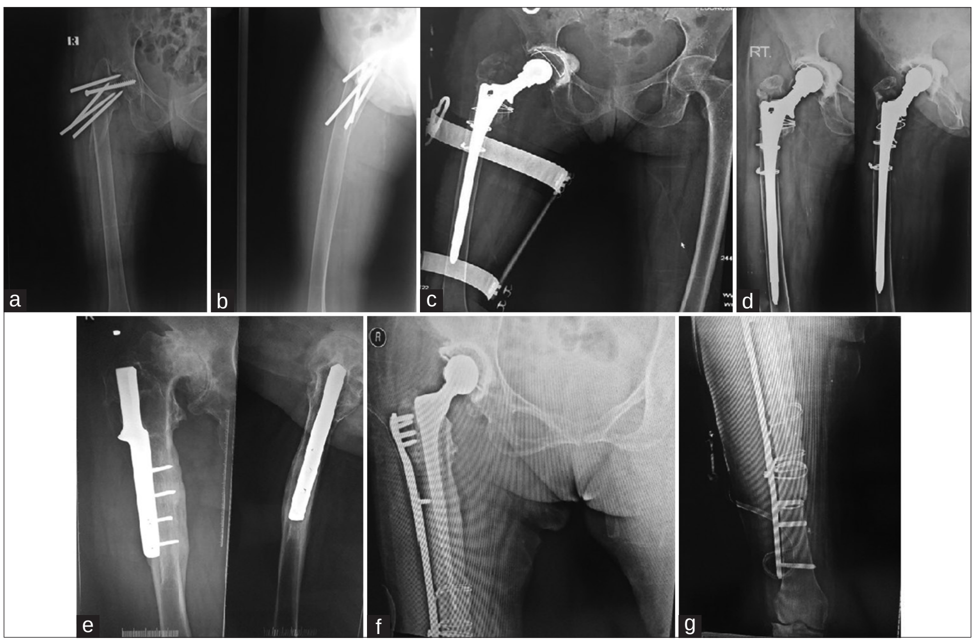


Figure 2: Radiographs of two patients who suffered complications. (a-d) Patient was a 36-years old female, elsewhere managed case of subtrochanteric fracture with implant *in situ* (a and b). During removal of implant, there occurred an avulsion of tip of greater trochanter, which was managed in the same setting by ethibond, followed by total hip arthroplasty (hybrid fixation). Patient was put in abduction braces (c) with 12-week radiograph demonstrating good outcome (d). (e-g) Patient was a 53-year-old female who was also an elsewhere managed case of intertrochanteric fracture with implant *in situ* (e). Implant was removed and THA was performed. Periprosthetic fracture (Vancouver Type C) occurred during reduction of hip, which had to be managed in a second surgery through the use of stainless-steel wiring and locking compression plate (f and g)

been demonstrated in Figure 1b, stratified by cemented and uncemented THA.

Discussion

This study finds that THA may be a safe and efficacious surgical modality for failed osteosynthesis of proximal femoral fractures, with good functional outcomes in resource-limited settings. Findings of the present work would be of value during the ascertainment of outcomes and complications reflective of actual effectiveness given that this was a nonindustry-supported work in a publicly-funded hospital from an LMIC, with the majority of the patients lacking resources for appropriate ancillary care. Such data also add to the limited body of literature published from LMICs in several surgical diseases.

Table 4: Frequency of complications in the patients (*n*=28)

Clavien-Dindo-Sink grade of perioperative complications	Frequency (%)
Grade I	0
Grade II	1 (3.6%)
Grade III	2 (7.1%)
Grade IV	0 (0%)
Grade V	0

The management of proximal femoral fractures has always remained a challenge for the treating surgeons especially in terms of fracture healing and post-operative functional outcome since most of these fractures are more prevalent in the geriatric age group.[14] With the availability of new generation osteosynthesis implants (cannulated cancellous screw, dynamic hip screw, proximal femoral nail), most of the intracapsular[15] and extracapsular fracture can be successfully treated with satisfactory postoperative pain relief and quick return to daily activities.[16,17]

When treatment fails, re-osteosynthesis seems to be a useful approach in young patients having high physical demand and good quality bone stock.[18,19] On the contrary, it is not recommended in the older population who have much lower demand, osteoporotic bones, and acetabular involvement. Here, arthroplasty, despite being an intimidating procedure after osteosynthesis failure, renders more satisfactory and predictable results.[20-22]

In our study, the mean age of patients was 43.25 ± 10.5 years. This was much less than the reported age (60.9 years) by Nambiar *et al*.[23] This difference is justifiable as we dealt with elsewhere managed cases of failed osteosynthesis cases who were relatively younger population.

Patients in our study had significant functional improvement as evident by their HHS. The mean HHS at 1-year follow-up was 79.54 ± 4.22 which was a significant improvement from the preoperative HHS 39.71 ± 10.89. Bidolegui *et al*. evaluated 80 patients in their study and reported similar results with a mean HHS of 84 (ranging from 67 to 93).[24] In 2010, D'Arrigo *et al*. reported a mean HHS score of 81 at last follow-up with improvement from mean preoperative HHS of 31.[25] The outcome of patients in our study [Table 3] was satisfactory with 15 patients (53.6%) recovered with good HHSs, while 13 patients (46.4%) had fair scores. Our studies like Berry *et al*. reported 89% of the patients did not suffer pain and 91% were able to walk at patient last check-up—59% of them with or without cane.[20] In 2015, Karampinas *et al*. evaluated 25 patients undergoing THA after failed osteosynthesis where he reported good or excellent results in 73% of patients at 2-year follow-up.[26]

These cases have a high incidence of intra-operative and post-operative complications compared to primary THA. To prevent complications, specific steps should be considered, including extensive preoperative planning, THA templating, evaluation of deformities and bone defects with the availability of specific tools for osteosynthesis implant removal, as well as preparedness for management of greater trochanter and abductors.

One of the frequently encountered complications during these surgeries is a periprosthetic fracture. We faced one such complication in a patient where the individual developed a Vancouver type C periprosthetic fracture while reducing the prosthesis since the bone was very weak due to the presence of a large femoral hole after implant removal [Figure 2]. We also encountered an acute infection in one patient that was treated with debridement and intravenous antibiotics based on culture and sensitivity. Similar results were also observed by Müller *et al*. who reported the postoperative infection developing in 6 out of 80 patients (7.5%).[27]

The presence of a femoral hole after implant removal with poor bone stock increases the likelihood of fracture development, especially during dislocation. Hence, it is important to dislocate the hip before the removal of osteosynthesis to decrease femoral stress and thus avoid intraoperative fracture. Along with this, the use of a femoral stem long enough to reach beyond the distal screw hole significantly reduces the risk of femoral fracture.

Limitations

Several limitations restrict the conclusions from this study. First, the sample size was small, and therefore did not allow for multivariate regression analysis, in order to identify for predictors of our key clinical outcomes. Second, the follow-up was limited, given the high rates of abandonment of regular in-person consultation by patients in LMICs and the logistical challenges in remote follow-up. Finally, we did not report data on patient-reported quality of life, since the current work was retrospective and this outcome had not been captured in routine clinical practice.

Conclusions

In resource limited settings like low-and middle-income countries, THA may be a safe and efficacious surgical modality for failed osteosynthesis of proximal femoral fractures. However, the procedure may be technically more demanding, given the training challenges encountered by LMIC surgeons, with a high rate of complications than those of primary hip arthroplasty.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Müller-Mai CM, Schulze Raestrup US, Kostuj T, Dahlhoff G, Günster C, Smektala R. One-year outcomes for proximal femoral fractures: Posthospital analysis of mortality and care levels based on health insurance data. Unfallchirurg 2015;118:780-94.
2. Müller F, Galler M, Zellner M, Bäuml C, Füchtmeier B. The fate of proximal femoral fractures in the 10th decade of life: An analysis of 117 consecutive patients. Injury 2015;46:1983-7.
3. Utrilla AL, Reig JS, Muñoz FM, Tufanisco CB. Trochanteric gamma nail and compression hip screw for trochanteric fractures: A randomized, prospective, comparative study in 210 elderly patients with a new design

of the gamma nail. J Orthop Trauma 2005;19:229-33.
4. Zehir S, Zehir R, Zehir S, Azboy İ, Haykir N. Proximal femoral nail antirotation against dynamic hip screw for unstable trochanteric fractures; a prospective randomized comparison. Eur J Trauma Emerg Surg 2015;41:393-400.
5. Lewis SR, Macey R, Gill JR, Parker MJ, Griffin XL. Cephalomedullary nails versus extramedullary implants for extracapsular hip fractures in older adults. Cochrane Database Syst Rev 2022;1:CD000093.
6. Bojan AJ, Beimel C, Taglang G, Collin D, Ekholm C, Jönsson A, *et al.* Critical factors in cutout complication after Gamma Nail treatment of proximal femoral fractures. BMC Musculoskelet Disord 2013;14:1.
7. Pajarinen J, Lindahl J, Michelsson O, Savolainen V, Hirvensalo E. Pertrochanteric femoral fractures treated with a dynamic hip screw or a proximal femoral nail. A randomised study comparing postoperative rehabilitation. J Bone Joint Surg 2005;87-B: 76-81.
8. Müller F, Galler M, Zellner M, Bäuml C, Marzouk A, Füchtmeier B. Peri-implant femoral fractures: The risk is more than three times higher within PFN compared with DHS. Injury 2016;47:2189-94.
9. Stoffelen D, Haentjens P, Reynders P, Casteleyn PP, Broos P, Opdecam P. Hip arthroplasty for failed internal fixation of intertrochanteric and subtrochanteric fractures in the elderly patient. Acta Orthop Belg 1994;60 Suppl 1:135-9.
10. Söderman P, Malchau H. Is the Harris hip score system useful to study the outcome of total hip replacement? Clin Orthop Relat Res 2001;???:189-97.
11. Sink EL, Leunig M, Zaltz I, Gilbert JC, Clohisy J; Academic Network for Conservational Hip Outcomes Research Group. Reliability of a complication classification system for orthopaedic surgery. Clin Orthop Relat Res 2012;470:2220-6.
12. Dodwell ER, Pathy R, Widmann RF, Green DW, Scher DM, Blanco JS, *et al.* Reliability of the modified Clavien-Dindo-sink complication classification system in pediatric orthopaedic surgery. JB JS Open Access 2018;3:e0020.
13. Gruen TA, McNeice GM, Amstutz HC. "Modes of failure" of cemented stem-type femoral components: A radiographic analysis of loosening. Clin Orthop Relat Res 1979;(141):17-27.
14. Innocenti M, Civinini R, Carulli C, Matassi F. Proximal femural fractures: Epidemiology. Clin Cases Miner Bone Metab 2009;6:117-9.
15. Gadegone WM, Chandak RM, Lokhande VR. DHS osteosynthesis with internal bone grafting in unstable delayed presented intracapsular neck femur fractures. Injury 2017;48 Suppl 2:S44-9.
16. Schipper IB, Steyerberg EW, Castelein RM, van der Heijden FH, den Hoed PT, Kerver AJ, *et al.* Treatment of unstable trochanteric fractures. Randomised comparison of the gamma nail and the proximal femoral nail. J Bone Joint Surg Br 2004;86:86-94.
17. Kumar R, Singh RN, Singh BN. Comparative prospective study of proximal femoral nail and dynamic hip screw in treatment of intertrochanteric fracture femur. J Clin Orthop Trauma 2012;3:28-36.
18. Haidukewych GJ, Berry DJ. Salvage of failed treatment of hip fractures. J Am Acad Orthop Surg 2005;13:101-9.
19. Enocson A, Mattisson L, Ottosson C, Lapidus LJ. Hip arthroplasty after failed fixation of trochanteric and sub-trochanteric fractures. A cohort study with 5-11 year follow-up of 88 consecutive patients. Acta Orthopaedica 2012;83:493-8.
20. Berry DJ. Salvage of failed hip fractures with hip replacement. Orthopedics 2002;25:949-50.
21. Haidukewych GJ, Berry DJ. Hip arthroplasty for salvage of failed treatment of intertrochanteric hip fractures. J Bone Joint Surg Am 2003;85:899-904.
22. Kim YH, Oh JH, Koh YG. Salvage of neglected unstable intertrochanteric fracture with cementless porous-coated hemiarthroplasty. Clin Orthop Relat Res 1992;(277):182-7.
23. Nambiar SM, Jagani NS, Sharoff L, D'souza JJ. Total hip replacement the ideal joint for failed osteosynthesis of hip fractures. Int J Orthop 2017;3:667-72.
24. Bidolegui F, Pereira S, Vindver G. Rescue of failed intertrochanteric and subtrochanteric osteosynthesis with joint replacement: Technique and results of a series of 61 cases. J Argent Assoc Orthop Traumatol 2018;83:85-93.
25. D'Arrigo C, Perugia D, Carcangiu A, Monaco E, Speranza A, Ferretti A. Hip arthroplasty for failed treatment of proximal femoral fractures. Int Orthop 2010;34:939-42.
26. Karampinas PK, Kollias G, Vlamis J, Papadelis EA, Pneumaticos SG. Salvage of failed hip osteosynthesis for fractures with modular hip prosthesis. Eur J Orthop Surg Traumatol 2015;25:1039-45.
27. Müller F, Galler M, Zellner M, Bäuml C, Füchtmeier B. Total hip arthroplasty after failed osteosynthesis of proximal femoral fractures: Revision and mortality of 80 patients. J Orthop Surg (Hong Kong) 2017;25:2309499017717869.

Original Article

The Effects of Intra-Articular Hyaluronate Injections in Young (<55 years) Patients with Glenohumeral Joint Osteoarthritis

Uche Oduoza, Michael Stoddart, Addie Majed, David Butt, Mark Falworth, William Rudge

Shoulder and Elbow Unit, Royal National Orthopaedic Hospital, Stanmore, England

Abstract

Purpose: Glenohumeral joint (GHJ) osteoarthritis (OA) in younger patients represents a challenging problem. This study assessed the efficacy of intra-articular hyaluronate injection in patients below the age of 55 years. **Methods:** We reviewed our patient database from August 2013 to December 2016 for patients who received a fluoroscopic-guided intra-articular injection of hyaluronate. Those who had received interventional procedures within the preceding 12 months were excluded. We evaluated the response to the injection using the Oxford Shoulder Score (OSS). These scores were recorded before injection and at 6 weeks, 12 weeks, and 26 weeks postinjection. Radiographs were reviewed independently by two evaluators, and the severity of GHJ OA was categorized (mild, moderate, or severe) using the Samilson–Prieto classification. **Results:** Fifty-five patients were identified, with a mean age of 43 years (18.6–54.6 years). These cases were classified as being mild in 11 (20%), moderate in 21 (38%), and severe in 23 (42%) using Samilson-Prieto classification. In the severe group, there was a statistically significant improvement in the OSS at all time points. In the moderate group, there were statistically significant improvements at 6 weeks and 12 weeks but not at 6 months. In the mild group, there were no statistically significant changes. **Conclusion:** In patients under the age of 55 years with moderate-to-severe GHJ OA, there is a significant improvement in the OSS up to 12 weeks after intra-articular injection of hyaluronate, with improvements lasting up to 26 weeks in more severe cases. Hyaluronate is, therefore, a useful treatment option in younger patients and may potentially delay the need for arthroplasty.

Keywords: Glenohumeral osteoarthritis, sodium hyaluronate, shoulder, non-operative, shoulder

Introduction

Osteoarthritis (OA) is the degenerative wear of hyaline cartilage from the joint surface leading to pain, reduced function, and disability.[1] When affecting the shoulder, this can reduce patients' ability to complete activities of daily living and have consequences for employment.[2] While primary OA of the joint is associated with increasing age, there is a significant population of younger patients (<55 years old) who develop secondary OA through trauma, instability, chronic rotator cuff tears, inflammation, and avascular necrosis.[3-5] Nonoperative treatment of glenohumeral OA in younger patients is preferred due to concerns regarding implant survivorship and morbidity associated with arthroplasty. A systematic review of patients under 65 receiving total shoulder arthroplasty reported a 17.4% revision rate and a 54% glenoid lucency rate at 9.4 years.[6] Further studies in the under 55's have reported 10-year survivorship of 62.5% when treated with total shoulder arthroplasty.[7] Nonoperative interventions may include intra-articular injections such as glucocorticoids, platelet-rich plasma, or hyaluronic acid (HA).[1] Intra-articular injections enable patients to manage pain and loss of function before definitive management with shoulder arthroplasty.

HA, a component of normal synovial fluid, is an acidic mucopolysaccharide which combines *in vivo* with protein to form

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jajs

DOI: 10.4103/jajs.jajs_4_22

Address for correspondence: Mr. Uche Oduoza, Royal National Orthopaedic Hospital, Brockley Hill, Stanmore HA7 4LP, England.
E-mail: u.oduoza@nhs.net

Submitted: 02-Feb-2022 **Revised:** 29-Mar-2022
Accepted: 20-Apr-2022 **Published:** 09-Jun-2022

How to cite this article: Oduoza U, Stoddart M, Majed A, Butt D, Falworth M, Rudge W. The effects of intra-articular hyaluronate injections in young (<55 years) patients with glenohumeral joint osteoarthritis. J Arthrosc Jt Surg 2022;9:28-33.

proteoglycan.[8] It is thought to have lubricant, shock-absorbing, and water homoeostatic properties.[9] High-molecular-weight HA has an immunosuppressive, anti-inflammatory, and antiangiogenic properties.[10] These actions led to it being considered in patients with OA. The use of HA in nonoperative treatment of OA has been studied primarily in the lower limb,[11,12] but there are also reports of reduced pain scores in the treatment of glenohumeral arthritis.[13] HA has a relatively low side effect profile[14] and is suggested as a nonoperative treatment for glenohumeral OA when surgery would need to be delayed.[1]

Many of the studies investigating the effects of HA on pain have an increased average age of the participant, 65 years.[15,16] Few studies selectively investigate younger patients with glenohumeral arthritis, where nonoperative management is the mainstay. In this retrospective single-arm intervention study, we investigate intra-articular viscosupplementation of the glenohumeral joint (GHJ), with high-molecular-weight sodium hyaluronate (Ostenil), in a younger population of arthritic patients (18–55 years old) to assess efficacy in improving pain and functional outcome scores.

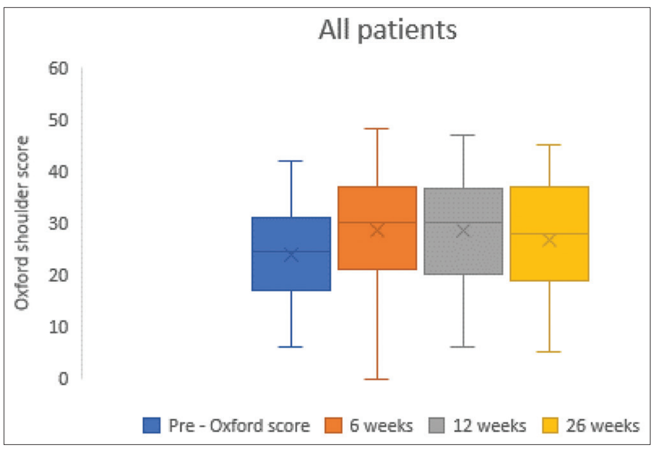


Figure 1: Box and whisker plot to show changes in Oxford shoulder score for all patients at 6, 12, and 26 weeks

Methods

This retrospective single-arm interventional study was performed at a single tertiary referral center for elective orthopedics.

Participants

All patients with a clinical and radiological diagnosis of glenohumeral OA were eligible for analysis. Patients gave informed consent to have their scores collected and used for research purposes. Radiographs were obtained in the radiology department using the Toshiba Ultimax fluoroscopy machine with the patient in the anteroposterior position. Glenohumeral OA was diagnosed and graded using the Samilson–Prieto classification with patients separated into mild (Grade I), moderate (Grade II), and severe (Grade III) OA [Table 1] by 2 independent shoulder and elbow consultants at the Royal National Orthopaedic Hospital.[17] Where there was a discrepancy in classification images, they were reviewed, and the consensus was agreed. Those under 18 and over 55 years old or those who underwent surgical

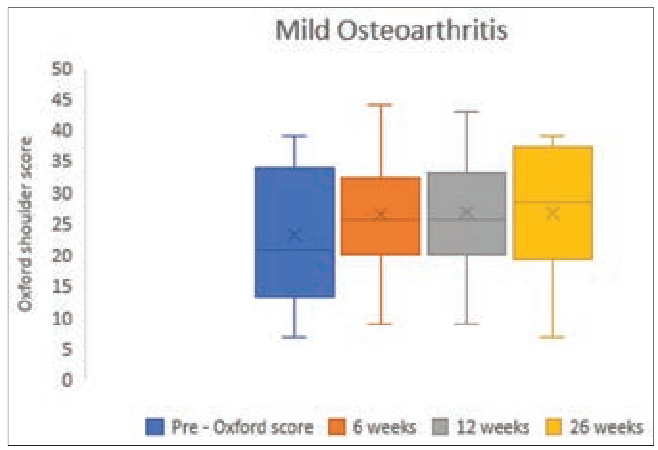


Figure 2: Box and whisker plot to show changes in Oxford shoulder score in patients with Samilson–Prieto mild (type 1) osteoarthritis at 6, 12 and 26 weeks

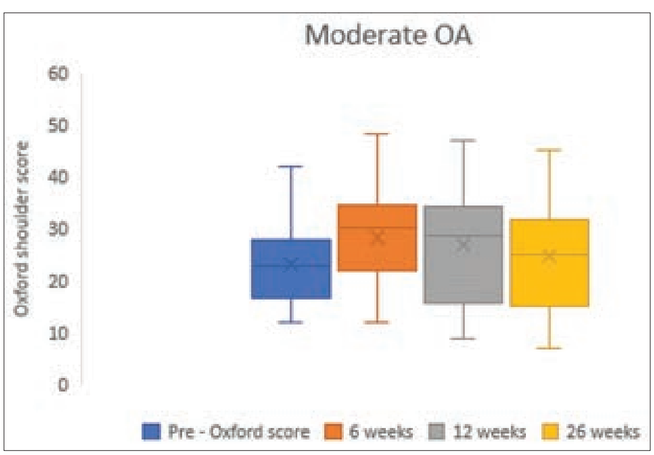


Figure 3: Box and whisker plot to show changes in Oxford shoulder score in patients with Samilson–Prieto moderate (type 2) osteoarthritis at 6, 12, and 26 weeks. OA; Osteoarthritis

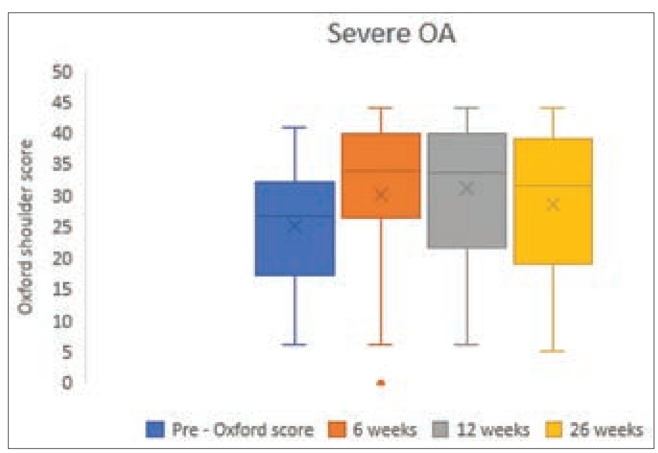


Figure 4: Box and whisker plot to show changes in Oxford shoulder score in patients with Samilson–Prieto severe (type 3) osteoarthritis at 6, 1,2 and 26 weeks. OA; Osteoarthritis

Table 1: Modified Samilson and Prieto classification according to Allain

Grade	Description
1	Inferior humeral exostosis between 1 and 3 mm in height
2	Inferior humeral exostosis between 4 and 7 mm in height
3	Inferior humeral exostosis more than 7 mm in height
4	Narrowing of the glenohumeral joint and sclerosis

intervention within the preceding 12 months were excluded from the study. Patients over 55 years were more likely to opt for surgical intervention in the form of arthroplasty and therefore were excluded. Surgical intervention was considered a confounder and was therefore excluded from the study along with brachial plexus injury and those with pain attributed to another cause. This project was approved by the Drugs and Therapeutic committee with local institutional review board approval (22.07.2013) for collection, processing and publication of this data.

Intervention

Eligible patients were offered a fluoroscopically guided intra-articular injection of sodium hyaluronate (OstenilPlus prefilled syringe (40mg/2ml)) into the GHJ space. Position of the needle in the joint space was confirmed using iodine contrast and local anaesthetic 0.25% bupivacaine. Injections were completed by a consultant radiologist at the Royal National Orthopaedic hospital.

Outcomes

The primary outcome was Oxford Shoulder Score (OSS) grading at 6, 12, and 26 weeks. OSS is a validated tool to assess function and pain in patients with shoulder pathology.[18,19] These scores were collected by the clinical nurse specialist in routine scheduled outpatient follow up.

Secondary Outcome Measures

The secondary outcome was Single Assessment Numeric Evaluation (SANE) scores,[20] pain scores using the Numeric Rating Pain Scale,[21] and the Western Ontario OA of the Shoulder (WOOS).[22] All scores were collected prospectively in clinic by the clinical nurse specialist from the patients before the injection and at 6-week, 12-week, and 26-week postinjection.

Statistical methods

Analysis was undertaken with IBM SPSS Statistics version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY, USA: IBM Corp). Descriptive statistics were used for categorical data and Shapiro–Wilk testing of normality for continuous data. Parametric data were expressed as mean and standard deviation, with nonparametric data as median and interquartile range (IQR). A repeated measures analysis of variance with a Greenhouse–Geisser correction was used to compare mean scores over successive time points, with *post hoc* analysis using Bonferroni adjustment to analyze differences between individual time points. For nonparametric data, the Friedman test was used with Wilcoxon signed-rank tests with a Bonferroni correction for *post hoc* analysis.

The study assumed that $P < 0.05$ was significant. All data were stored and processed in accordance with GDPR.

Results

Demographics

103 participants were recruited, following our exclusion criteria 55 shoulders (55 patients) were included, with a median age of 44.5 years (IQR, 13.6). These cases were classified as being mild in 11 (20%), moderate in 21 (38%), and severe in 23 (42%). There were no patients lost to follow up.

Table 2 demonstrates the change in scores following Ostenil injection from baseline at each time point. There was an improvement in all scores compared to preinjection score ($P < 0.05$).

Oxford scores

The overall mean Oxford scores differed statistically between time points ($P < 0.05$) [Figure 1].

After 6 weeks, the *post hoc* analysis revealed that changes in Oxford scores were not significant.

Subanalysis by Samilson–Prieto classification is shown in Table 3.

The difference between scores with mild OA was not significant ($P = 0.254$) [Figure 2].

In moderate OA, the improvement in Oxford scores differed statistically between time points ($P < 0.05$). After 6 weeks, the *post hoc* analysis revealed that changes in Oxford scores were not significant [Figure 3].

In severe OA, the mean Oxford scores differed statistically between time points ($P < 0.05$) [Figure 4]. After 6 weeks, the *post hoc* analysis revealed that changes in Oxford scores were not significant. There were no complications noted in the study population.

Single Assessment Numeric Evaluation scores

Overall, there was a statistically significant difference in median SANE scores ($P < 0.05$). After 6 weeks, this revealed that changes in SANE scores were not significant.

Subanalysis by Samilson–Prieto classification is shown in Table 4.

The difference between scores with mild OA was not significant ($P = 0.582$).

In moderate OA, the improvement in SANE scores was significant ($P < 0.05$). After 6 weeks, *post hoc* analysis revealed that changes in SANE scores were not significant.

In severe OA, the mean SANE scores differed statistically between time points ($P < 0.05$). After 6 weeks, *post hoc*

Table 2: Baseline and changes in Oxford Shoulder Score, Single Assessment Numeric Evaluation, pain and Western Ontario Osteoarthritis Score at 6, 12 and 26 weeks

Oxford Score				SANE				Pain				WOOS			
Pre	6 weeks	12 weeks	6 months	Pre	6 weeks	12 weeks	6 months	Pre	6 weeks	12 weeks	6 months	Pre	6 weeks	12 weeks	6 months
23.9	28.8	28.6	27.2	38.3	47.2	46.8	44.8	6.4	4.6	5.1	5.5	36.8	45.7	45.9	43.9

SANE: Single Assessment Numeric Evaluation, WOOS: Western Ontario Osteoarthritis Score

analysis revealed that changes in SANE scores were not significant.

Pain scores

Overall, the mean pain scores differed statistically between time points ($P < 0.05$). After 6 weeks, *post hoc* analysis revealed that changes in pain scores were not significant.

Subanalysis by Samilson–Prieto classification is shown in Table 5.

The difference between scores with mild OA was not significant ($P = 0.584$).

In moderate OA, the improvement in pain scores was $P < 0.05$. After 6 weeks, *post hoc* analysis revealed that changes in pain scores were not significant.

In both moderate and severe OA, a statistically significant improvement ($P < 0.05$) in pain scores was observed at 6 weeks. After 6 weeks, post hoc analysis revealed that changes in pain scores were no longer significant.

Western Ontario Osteoarthritis Scores

Overall, the mean WOOS scores differed statistically between time points ($P < 0.05$). After 6 weeks, *post hoc* analysis revealed that changes in WOOS scores were not significant.

Subanalysis by Samilson–Prieto classification is shown in Table 6.

Difference between scores with mild OA was not significant ($P = 0.770$).

In moderate OA, the improvements in WOOS scores were significant ($P < 0.05$). After 6 weeks, *post hoc* analysis revealed that changes in WOOS scores were not significant.

In severe OA, mean WOOS scores differed statistically between time points ($P < 0.05$). After 6 weeks, *post hoc* analysis revealed that changes in WOOS scores were not significant, apart from the decrease in scores between 12 weeks and 6 months (4.17 [95% CI, 0.815–7.208]).

There were no complications noted in the study population.

Table 3: Baseline and changes in Oxford Shoulder Score sub catergorised by modified Samilson–Prieto classification at 6, 12 and 26 weeks

Grade	Oxford Score			
	Pre	6 weeks (*P*)	12 weeks (*P*)	6 months (*P*)
All (55)	23.9	28.8 (<0.05)	28.6 (<0.05)	27.2 (<0.05)
Mild (11)	20	21.1 (0.254)	22.1 (0.254)	22.7 (0.254)
Moderate (21)	24	29.5 (<0.05)	28.3 (>0.05)	26.6 (>0.05)
Severe (23)	25.7	31.9 (<0.05)	32.0 (>0.05)	30.0 (>0.05)

Table 4: Baseline and changes in Single Assessment Numeric Evaluation Score sub catergorised by modified Samilson–Prieto classification at 6, 12 and 26 weeks

Grade	SANE Score			
	Pre	6 weeks (*P*)	12 weeks (*P*)	6 months (*P*)
All (55)	38.3	47.2 (<0.05)	46.8 (>0.05)	44.8 (>0.05)
Mild (11)	31.4	34.4 (0.582)	33.9 (>0.05)	37.7 (>0.05)
Moderate (21)	38.1	47.9 (<0.05)	47.6 (>0.05)	26.6 (>0.05)
Severe (23)	41.8	52.7 (<0.05)	52.3 (>0.05)	47.7 (>0.05)

SANE: Single Assessment Numeric Evaluation

Table 5: Baseline and changes in pain score sub catergorised by modified Samilson–Prieto classification at 6, 12 and 26 weeks

Grade	Pain score			
	Pre	6 weeks (*P*)	12 weeks (*P*)	6 months (*P*)
All (55)	6.4	4.6 (<0.05)	5.1 (>0.05)	5.5 (>0.05)
Mild (11)	6.2	5.9 (0.584)	5.8 (>0.05)	5.7 (>0.05)
Moderate (21)	6.9	4.7 (<0.05)	5.4 (>0.05)	5.8 (>0.05)
Severe (23)	6.0	3.9 (<0.05)	4.4 (>0.05)	5.2 (>0.05)

Discussion

This retrospective single-arm interventional trial has shown a statistically significant improvement in OSS in patients over 18 and under 55 with severe (Grade III) GHJ OA who had a single dose of sodium hyaluronate injected. There was also a statistically significant reduction in visual analogue scale (VAS) pain scores in this population.

The development of effective nonoperative interventions for the treatment of GHJ OA in younger patients is crucial in delaying the need for arthroplasty. While arthroplasty surgical techniques and prostheses are improving rapidly, there are still concerns regarding the long-term morbidity associated with revision surgery in patients requiring arthroplasty at a relatively young age.[6,23,24]

While there are numerous studies reporting positive outcomes following intra-articular HA injection, none have

Table 6: Baseline and changes in Western Ontario Osteoarthritis Score sub catergorised by modified Samilson–Prieto classification at 6, 12 and 26 weeks

Grade	WOOS score			
	Pre	6 weeks (*P*)	12 weeks (*P*)	6 months (*P*)
All (55)	36.8	45.7 (<0.05)	45.9 (>0.05)	43.9 (>0.05)
Mild (11)	32.5	33.5 (0.770)	34.7 (>0.05)	33.9 (>0.05)
Moderate (21)	36.7	46.8 (<0.05)	45.8 (>0.05)	45.8 (>0.05)
Severe (23)	38.9	50.5 (<0.05)	51.3 (>0.05)	47.1 (>0.05)

WOOS: Western Ontario Osteoarthritis Score

a study population with an average age as young as this study (44 years). We feel this provides evidence base that the usage of intra-articular HA injections for the younger population is beneficial. While there are other nonarthroplasty treatments, including operative interventions such as comprehensive arthroscopic management, there are risks and morbidity associated with all operative interventions, and effective nonoperative treatments are therefore preferable.

Intra-articular sodium hyaluronate improved the OSS in all groups of patients but had a longer duration of effect in those with severe OA. This could potentially be due to the fact that patients in the radiologically mild group had a lower average OSS than patient with moderate and severe radiologically graded OA. In a recent article, the reported minimal clinically important difference in OSS and WOOS scores when treated with anatomic total shoulder arthroplasty were 4.3 and 12.3.[25] In the 23 patients graded as severe OA, the improvement at 6 and 12 weeks met the minimally clinically important difference (MCID) threshold reported in studies. Similarly, improvements were noted in the moderate group also reaching the threshold for a clinically meaningful difference (preinjection OSS 24 postinjection OSS 29.5).

When assessing pain specifically, studies have quoted approximately a 1.4 reduction in VAS pain score as the MCID after shoulder arthroplasty.[26] In this study, that threshold was reached for all patients classified as moderate and severe OA radiographically at both 6-week and 12-week postinjection but not at 26 weeks. The current literature states that the mean VAS pain score reduction, following intraarticular HA, is approximately 2.0[15,16,27] with effects lasting longer than the 12-week period. One systematic review reported a mean improvement in VAS pain scores of 26.2 m at 3 months and 29.5 mm at 6 months.[13] While they did report an increased improvement in scores, it is also noted that in this systematic review, there were differences in the number of doses and the amount of HA administered.

The safety profile of repeated HA injections has not been studied in the shoulder, but there is ample evidence of its safety in the knee.[28] In a recent study, the 3-year effects of repeated HA injections were proven to be safe over this particular period. Over 36 000 patients were followed up with the most common adverse effect being arthralgia in patients who have had five or more doses (45%). There were no serious adverse events with no safety concerns throughout the 3-year period. Added to this it, the authors report an inability to determine if the injections caused the adverse events.[29]

Limitations

The main limitation of this study is the lack of control group. Numerous studies have reported the placebo effect of intra-articular injections, making it difficult to attribute the improvements in function and pain to HA alone.[17,30,31] However, the placebo effect alone would not explain why those in the severe group had a longer duration of benefit compared to those with mild OA. The aim of the study was to assess the efficacy of sodium hyaluronate in younger patients attending a tertiary center with GHJ OA, and it has shown that all participants reported improvement.

Conclusion

Nonoperative treatments are the mainstay of intervention for younger patients due to the risks associated with shoulder arthroplasty and concerns regarding survivorship of the prosthesis and the need for further revision surgery. This study found an improvement in OSS outcomes in patients treated with sodium hyaluronate. We believe that HA injections are effective at treating both pain and function in those with OA under the age of 55 for 3-6 months. Further large-scale prospective randomized control trials with appropriate power calculations would strengthen the evidence base on the utility of intra-articular HA injections.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Thomas M, Bidwai A, Rangan A, Rees J, Brownson P, Tennent D, *et al.* BESS/BOA patient care pathways glenohumeral osteoarthritis. Shoulder Elbow 2016;8:203-14.
2. Lo IK, Litchfield RB, Griffin S, Faber K, Patterson SD, Kirkley A. Quality-of-life outcome following hemiarthroplasty or total shoulder arthroplasty in patients with osteoarthritis. A prospective, randomized trial. J Bone Joint Surg Am 2005;87:2178-85.
3. Goud A, Segal D, Hedayati P, Pan JJ, Weissman BN. Radiographic evaluation of the shoulder. Eur J Radiol 2008;68:2-15.
4. Ibounig T, Simons T, Launonen A, Paavola M. Glenohumeral osteoarthritis: An overview of etiology and diagnostics. Scand J Surg 2021;110:441-51.
5. Kruckeberg BM, Leland DP, Bernard CD, Krych AJ, Dahm DL, Sanchez-Sotelo J, *et al.* Incidence of and risk factors for glenohumeral osteoarthritis after anterior shoulder instability: A US population-based study with average 15-year follow-up. Orthop J Sports Med 2020;8:2325967120962515.
6. Roberson TA, Bentley JC, Griscom JT, Kissenberth MJ, Tolan SJ, Hawkins RJ, *et al.* Outcomes of total shoulder arthroplasty in patients younger than 65 years: A systematic review. J Shoulder Elbow Surg 2017;26:1298-306.
7. Denard PJ, Raiss P, Sowa B, Walch G. Mid- to long-term follow-up of total shoulder arthroplasty using a keeled glenoid in young adults with primary glenohumeral arthritis. J Shoulder Elbow Surg

2013;22:894-900.
8. Itokazu M, Matsunaga T. Clinical evaluation of high-molecular-weight sodium hyaluronate for the treatment of patients with periarthritis of the shoulder. Clin Ther 1995;17:946-55.
9. Fraser JR, Laurent TC, Laurent UB. Hyaluronan: Its nature, distribution, functions and turnover. J Intern Med 1997;242:27-33.
10. Valachová K, Šoltés L. Hyaluronan as a prominent biomolecule with numerous applications in medicine. Int J Mol Sci 2021;22:7077.
11. Huang TL, Chang CC, Lee CH, Chen SC, Lai CH, Tsai CL. Intra-articular injections of sodium hyaluronate (Hyalgan®) in osteoarthritis of the knee. A randomized, controlled, double-blind, multicenter trial in the Asian population. BMC Musculoskelet Disord 2011;12:221.
12. Bannuru RR, Natov NS, Obadan IE, Price LL, Schmid CH, McAlindon TE. Therapeutic trajectory of hyaluronic acid versus corticosteroids in the treatment of knee osteoarthritis: A systematic review and meta-analysis. Arthritis Rheum 2009;61:1704-11.
13. Zhang B, Thayaparan A, Horner N, Bedi A, Alolabi B, Khan M. Outcomes of hyaluronic acid injections for glenohumeral osteoarthritis: A systematic review and meta-analysis. J Shoulder Elbow Surg 2019;28:596-606.
14. Honvo G, Reginster JY, Rannou F, Rygaert X, Geerinck A, Rabenda V, *et al.* Safety of intra-articular hyaluronic acid injections in osteoarthritis: Outcomes of a systematic review and meta-analysis. Drugs Aging 2019;36:101-27.
15. McKee MD, Litchfield R, Hall JA, Wester T, Jones J, Harrison AJ. NASHA hyaluronic acid for the treatment of shoulder osteoarthritis: A prospective, single-arm clinical trial. Med Devices (Auckl) 2019;12:227-34.
16. Blaine T, Moskowitz R, Udell J, Skyhar M, Levin R, Friedlander J, *et al.* Treatment of persistent shoulder pain with sodium hyaluronate: A randomized, controlled trial. A multicenter study. J Bone Joint Surg Am 2008;90:970-9.
17. Samilson RL, Prieto V. Dislocation arthropathy of the shoulder. J Bone Joint Surg Am 1983;65:456-60.
18. Roller AS, Mounts RA, DeLong JM, Hanypsiak BT. Outcome instruments for the shoulder. Arthroscopy 2013;29:955-64.
19. van der Linde JA, van Kampen DA, van Beers LW, van Deurzen DF, Terwee CB, Willems WJ. The Oxford Shoulder Instability Score; validation in dutch and first-time assessment of its smallest detectable change. J Orthop Surg Res 2015;10:146.
20. Gowd AK, Charles MD, Liu JN, Lalehzarian SP, Cabarcas BC, Manderle BJ, *et al.* Single Assessment Numeric Evaluation (SANE) is a reliable metric to measure clinically significant improvements following shoulder arthroplasty. J Shoulder Elbow Surg 2019;28:2238-46.
21. Haefeli M, Elfering A. Pain assessment. Eur Spine J 2006;15 Suppl 1:S17-24.
22. Kirkley A, Griffin S, Dainty K. Scoring systems for the functional assessment of the shoulder. Arthroscopy 2003;19:1109-20.
23. Kusnezov N, Dunn JC, Parada SA, Kilcoyne K, Waterman BR. Clinical outcomes of anatomical total shoulder arthroplasty in a young, active population. Am J Orthop (Belle Mead NJ) 2016;45:E273-82.
24. Sayegh ET, Mascarenhas R, Chalmers PN, Cole BJ, Romeo AA, Verma NN. Surgical treatment options for glenohumeral arthritis in young patients: A systematic review and meta-analysis. Arthroscopy 2015;31:1156-66.e8.
25. Nyring MRK, Olsen BS, Amundsen A, Rasmussen JV. Minimal clinically important differences (MCID) for the Western Ontario Osteoarthritis of the Shoulder Index (WOOS) and the Oxford Shoulder Score (OSS). Patient Relat Outcome Meas 2021;12:299-306.
26. Tashjian RZ, Hung M, Keener JD, Bowen RC, McAllister J, Chen W, *et al.* Determining the minimal clinically important difference for the American Shoulder and Elbow Surgeons score, Simple Shoulder Test, and visual analog scale (VAS) measuring pain after shoulder arthroplasty. J Shoulder Elbow Surg 2017;26:144-8.
27. Colen S, Geervliet P, Haverkamp D, Van Den Bekerom MP. Intra-articular infiltration therapy for patients with glenohumeral osteoarthritis: A systematic review of the literature. Int J Shoulder Surg 2014;8:114-21.
28. Pagnano M, Westrich G. Successful nonoperative management of chronic osteoarthritis pain of the knee: Safety and efficacy of retreatment with intra-articular hyaluronans. Osteoarthritis Cartilage 2005;13:751-61.
29. Dasa V, Lim S, Heeckt P. Real-world evidence for safety and effectiveness of repeated courses of hyaluronic acid injections on the time to knee replacement surgery. Am J Orthop (Belle Mead NJ) 2018;47.
30. Kwon YW, Eisenberg G, Zuckerman JD. Sodium hyaluronate for the treatment of chronic shoulder pain associated with glenohumeral osteoarthritis: A multicenter, randomized, double-blind, placebo-controlled trial. J Shoulder Elbow Surg 2013;22:584-94.
31. Merolla G, Sperling JW, Paladini P, Porcellini G. Efficacy of Hylan G-F 20 versus 6-methylprednisolone acetate in painful shoulder osteoarthritis: A retrospective controlled trial. Musculoskelet Surg 2011;95:215-24.

The Cinch Knot Technique of Anatomical Fibular Collateral Ligament Reconstruction

K. Santosh Sahanand, Prashanth Pandian, David V. Rajan

Ortho One Orthopaedic Speciality Centre, Coimbatore, Tamil Nadu, India

Abstract

Reconstructing the lateral collateral ligament (LCL) has started gaining importance with better appreciation of the knee anatomy and biomechanics. Over the years, a multitude of reconstructive techniques have been described. Among these, the anatomical reconstructions closely reproduce the native anatomy with better functional outcomes. In this technical note, we have described the cinch knot technique of anatomical LCL reconstruction, an implant free technique at the fibular end which satisfactorily recreates the native footprint of the LCL.

Keywords: Cinch knot technique, fibular collateral ligament reconstruction, lateral collateral ligament reconstruction, lateral collateral ligament tear

Introduction

The fibular lateral collateral ligament (LCL) is an important component of posterolateral corner (PLC) of the knee and is the primary varus stabilizer.[1-3] The PLC, alluded as the dark side of knee, was poorly understood. Injuries to this region notoriously had poor results due to the gap in understanding anatomy and possible treatment options. However, extensive researches done during the last few decades have led to better comprehension and innovative reconstruction techniques.

Isolated LCL injuries are a rarity and usually occur in association with other ligamentous injuries like the cruciate ligaments and other PLC ligaments. The mechanism of injury is usually direct varus impact, hyperextension, or twisting injuries of the knee.[4] Good healing rates are observed in conservatively treated grade 1 and grade 2 tears, but grade 3 tears heal poorly resulting in instability.[5] In the acute setting, these injuries cause significant disability and eventually patients develop a varus thrust gait with increased medial compartment loading. LCL deficiency increases the stress on the anterior or posterior cruciate ligament reconstruction leading to high failure rates. Hence, it is important to diagnose and treat these tears appropriately to avoid these setbacks.

The possibility of repairing and reconstructing these tears have been explored with the reconstructions clearly doing better than the repairs.[6] Various reconstruction techniques with a multitude of graft options have been described and validated.[7-10] The anatomic reconstructions have shown to restore near normal knee biomechanics and are now the preferred treatment of choice. In this article, we have described our technique to reconstruct the LCL anatomically with an implant free fixation at the fibular head.

Surgical Technique

Patient positioning

Under spinal anesthesia, the patient is made to lie supine on the operating table and examined for concomitant other injuries like the Anterior cruciate ligament (ACL) or PCL. A high pneumatic tourniquet along with lateral thigh support and foot post is applied with the knee in 60° of flexion.

Surgical approach

A lateral incision extending from the lateral epicondyle and to a point between the fibular head and Gerdy's tubercle is made [Figure 1]. Sharp dissection is continued, raising thick

Address for correspondence: Dr. Prashanth Pandian,
Ortho One Orthopaedic Speciality Centre, Coimbatore - 641 005,
Tamil Nadu, India.
E-mail: drprashanth.sayee@gmail.com

Submitted: 18-Feb-2022 **Revised:** 29-Mar-2022
Accepted: 20-Apr-2022 **Published:** 09-Jun-2022

How to cite this article: Sahanand KS, Pandian P, Rajan DV. The cinch knot technique of anatomical fibular collateral ligament reconstruction. J Arthrosc Jt Surg 2022;9:34-7.

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jajs

DOI: 10.4103/jajs.jajs_26_22

anterior and posterior flaps with subcutaneous tissue to avoid risk of flap necrosis. The next crucial step is identifying the common peroneal nerve lying posterior to biceps femoris tendon [Figure 2]. The nerve is then is tagged and protected to avoid any iatrogenic injury.

The gracilis graft harvested using the standard technique is whip-stitched with No. 2 polyethylene/polyester suture at both ends. FCL attachment has been described as 8.2 mm posterior to anterior margin of fibular head and 28.4 mm distal to the tip of the fibular styloid process.[11] Proximally, it inserts just higher and posterior to the lateral epicondyle.[11] Recreating this, the bony fibular tunnel is made by drilling a guide pin from the anterolateral to posteromedial aspect at an angle of 45° in the sagittal plane. A 4.5 mm reamer is drilled over to create the final tunnel. Care is taken not to drill the tunnel too proximal to avoid iatrogenic popliteofibular ligament injury.

The doubled graft is then passed from the anterolateral to posteromedial end [Figure 3]. The posteromedial graft loop is then brought anterior and deep to the remnant FCL attachment. The whip-stitched free ends of the graft is passed through the loop to form a cinch around the tip of fibula recreating the native anatomical footprint [Figure 4]. The lateral epicondyle of distal femur is identified and a longitudinal split made in the overlying iliotibial band. An eyelet tipped guide is then drilled anteromedially from the identified isometric point on lateral femoral epicondyle. This is subsequently over-drilled using a 6 mm reamer and a passing suture is shuttled through the tunnel. The anterolateral ligament attachment, which lies just proximal and posterior to FCL, is damaged if proper care is not taken during dissection. The direction of the tunnel is ensured to be anteromedial, so that it does not collide with femoral tunnel of ACL reconstruction. Femoral tunnel of concomitant injuries like ACL is dealt with at this stage.

The graft is then passed under the iliotibial band [Figure 5] and fixed at the femoral end with interference screw with the knee in 20° of flexion, gentle valgus and neutral rotation ensuring there in no residual varus instability [Figure 6]. This is followed by fixing the concomitant ACL graft at the tibial side.

Figure 1: Skin incision extending from lateral epicondyle to the fibular head

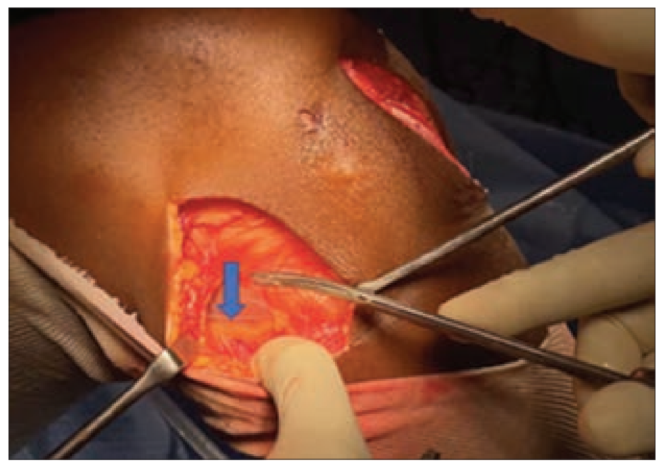


Figure 2: Identifying and isolating the common peroneal nerve (arrow mark)

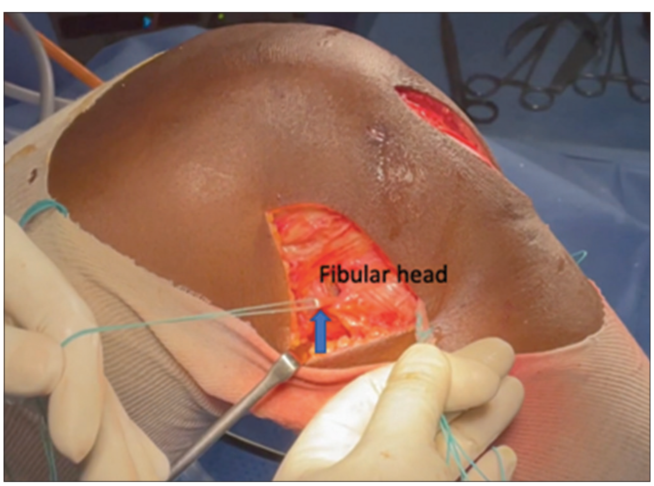


Figure 3: Doubled graft being passed through the head of fibula. Note the graft loop at the posteromedial end (arrow mark)

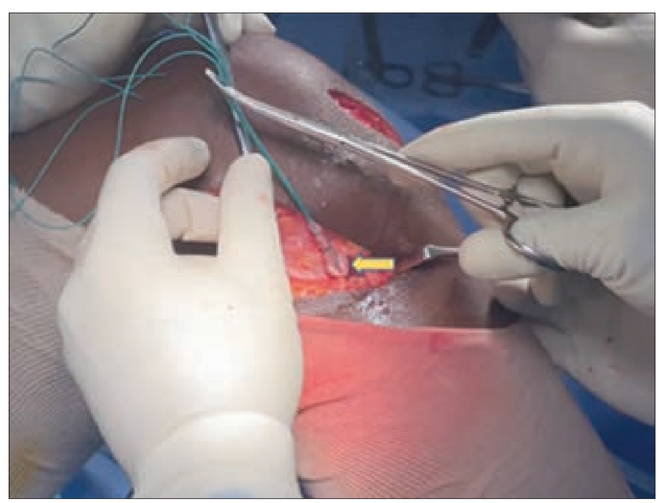


Figure 4: Cinch knot being created at the anterior fibular head

Rehabilitation

Postoperatively, patients are made to nonweight bear with knee brace for the first 6 weeks. Quadriceps strengthening and range of movement exercises are initiated in the immediate postoperative period. Patients are encouraged to achieve 90° of knee range of movement by 2 weeks. Subsequent weight bearing and range of movement exercises are initiated as tolerated. Patients with isolated FCL reconstructions are allowed return to normal activity by 6 months and in patients with associated ligament injuries, this is delayed till 9 months.

Discussion

The LCL injuries usually occur along with other ligamentous injuries like the ACL, PCL or other PLC structures. These previously missed injuries are now gaining importance due to improved imaging techniques along with better understanding of the knee anatomy and biomechanics.[12] An adroit clinical examination including detailed history, varus stress test, dial test, reverse pivot test and external rotation recurvatum test should be done and compared to the other side to not miss these subtle injuries. Cooper *et al*.[13] reported common peroneal nerve injuries in almost one third of PLC injuries and hence must not be missed. The varus stress X-ray along with magnetic resonance imaging have greatly improved the diagnostic sensitivity of imaging techniques. A side-to-side difference of 2.7 to 4 mm in the stress X-ray is indicative of isolated LCL tear, whereas a difference of more than 4 mm points to an associated PLC injury.

The reconstructive procedures have greatly evolved over time with deeper understanding of the anatomy. Hughston and Jacobson[14] in their series described advancement osteotomy of the lateral epicondyle to restore normal lateral opening of the knee. Although their technique showed promising long-term results, it came under criticism for the fact that it alters the natural insertion of lateral epicondyle and can be done only in knees which have healed with interstitial elongation of the lateral structures. Biceps tenodesis was then proposed as a treatment option but did not gain traction because it over constrained external rotation.[9,15] After years of research, anatomic reconstruction is now accepted as the ideal reconstructive method as they closely reproduce the native knee biomechanics. Several studies have also validated this with significant improvement in the preoperative knee scores after anatomical LCL reconstruction.[16,17]

In our technique, we have attempted to reproduce the LCL anatomy by using a cinch knot around the fibular head [Figure 7]. This replicates the natural LCL footprint with the added advantage of being implant free at the fibular end. In a setting where there is no availability of allografts, the choice of gracilis tendon as the graft choice proves convenient. Studies have shown the doubled gracilis graft to satisfactorily substitute the LCL with adequate tensile strength and minimal donor site morbidity.[18] Harvesting it seems hassle free as most surgeons are familiar with the hamstring harvesting technique used for other reconstructions. This leaves the semitendinosus free for use in other concomitant ligament reconstructions. Despite all these advantages, a potential limitation of this technique

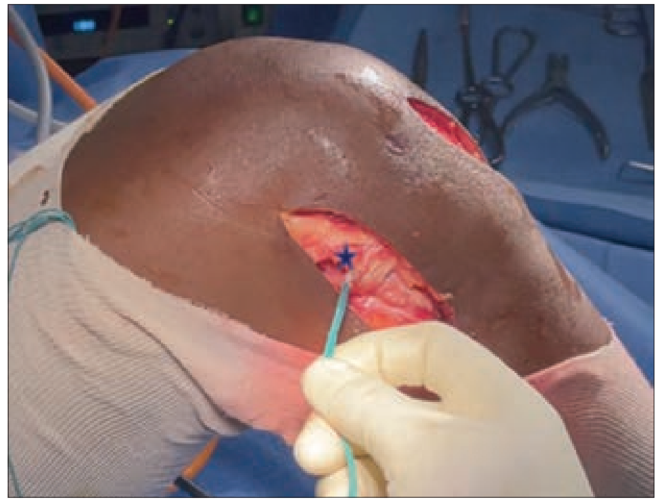


Figure 5: Whip-stitched free ends of the graft being shuttled through the iliotibial band split (blue star). Note the graft passing beneath IT band

Figure 6: Graft being fixed at the femoral tunnel with the knee in 200 of flexion, gentle valgus and neutral rotation

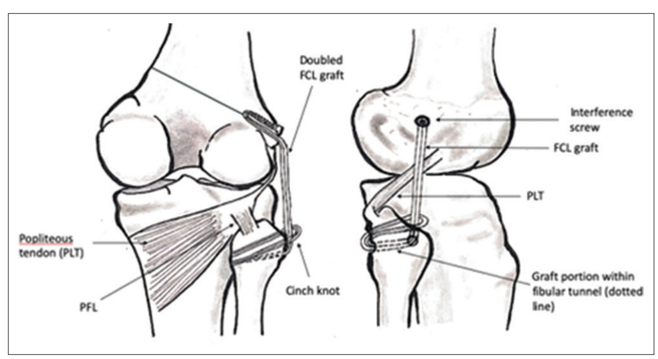


Figure 7: Schematic diagram of anatomical LCL reconstruction using cinch knot technique. LCL: Lateral collateral ligament, PFL: Popliteofibular ligament, PLT: Popliteus tendon, FCL: Fibular collateral ligament

Table 1: Pearls and pitfalls of the cinch knot technique

Pearls	Pitfalls
Closely reproduces the native anatomy of FCL	Incorrect technique may injure the PFL at the fibular end and ALL at the femoral end
Graft of choice is gracilis, this gives us the option of using ST for other concomitant reconstructions	Length of the gracilis graft might not be sufficient when doubled. In such case, an alternative graft like the ST or a different reconstruction technique might be needed
Avoids the need for screw fixation at the fibular head which might not be possible in a small bone	Improper femoral tunnel positioning can cause collision with an eventual ACLR
Implant free fixation at the fibular end	Needs long-term validation

ST: Semitendinosus, FCL: Fibular collateral ligament, PFL: Popliteofibular ligament, ALL: Anterolateral ligament, ACLR: Anterior cruciate ligament reconstruction

is that it lacks long term data to prove its efficacy. The pearls and pitfalls of the technique are enlisted in Table 1.

Conclusion

The LCL being the primary varus stabilizer of knee and is imperative for maintaining the native biomechanics. Failure to reconstruct the concomitant LCL tear during an ACL or PCL reconstruction leads to increased chance of graft failure. Furthermore, LCL deficient knees have higher medial compartment loading leading to early arthritis. Our cinch knot technique of LCL reconstruction closely reproduces the native anatomy and is easily reproducible. We urge researchers to use our technique and come out with additional studies to confirm the effectiveness.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Gollehon DL, Torzilli PA, Warren RF. The role of the posterolateral and cruciate ligaments in the stability of the human knee. A biomechanical study. J Bone Joint Surg Am 1987;69:233-42.
2. Grood ES, Stowers SF, Noyes FR. Limits of movement in the human knee. Effect of sectioning the posterior cruciate ligament and posterolateral structures. J Bone Joint Surg Am 1988;70:88-97.
3. Gwathmey FW Jr., Tompkins MA, Gaskin CM, Miller MD. Can stress radiography of the knee help characterize posterolateral corner injury? Clin Orthop Relat Res 2012;470:768-73.
4. LaPrade RF, Terry GC. Injuries to the posterolateral aspect of the knee. Association of anatomic injury patterns with clinical instability. Am J Sports Med 1997;25:433-8.
5. Griffith CJ, Wijdicks CA, Goerke U, Michaeli S, Ellermann J, LaPrade RF. Outcomes of untreated posterolateral knee injuries: An *in vivo* canine model. Knee Surg Sports Traumatol Arthrosc 2011;19:1192-7.
6. Black BS, Stannard JP. Repair versus reconstruction in acute posterolateral instability of the knee. Sports Med Arthrosc Rev 2015;23:22-6.
7. Noyes FR, Barber-Westin SD. Surgical restoration to treat chronic deficiency of the posterolateral complex and cruciate ligaments of the knee joint. Am J Sports Med 1996;24:415-26.
8. Veltri DM, Warren RF. Operative treatment of posterolateral instability of the knee. Clin Sports Med 1994;13:615-27.
9. Fanelli GC, Giannotti BF, Edson CJ. Arthroscopically assisted combined posterior cruciate ligament/posterior lateral complex reconstruction. Arthroscopy 1996;12:521-30.
10. Chen CH, Chen WJ, Shih CH. Lateral collateral ligament reconstruction using quadriceps tendon-patellar bone autograft with bioscrew fixation. Arthroscopy 2001;17:551-4.
11. LaPrade RF, Ly TV, Wentorf FA, Engebretsen L. The posterolateral attachments of the knee: A qualitative and quantitative morphologic analysis of the fibular collateral ligament, popliteus tendon, popliteofibular ligament, and lateral gastrocnemius tendon. Am J Sports Med 2003;31:854-60.
12. Coobs BR, LaPrade RF, Griffith CJ, Nelson BJ. Biomechanical analysis of an isolated fibular (lateral) collateral ligament reconstruction using an autogenous semitendinosus graft. Am J Sports Med 2007;35:1521-7.
13. Cooper JM, McAndrews PT, LaPrade RF. Posterolateral corner injuries of the knee: Anatomy, diagnosis, and treatment. Sports Med Arthrosc Rev 2006;14:213-20.
14. Hughston JC, Jacobson KE. Chronic posterolateral rotatory instability of the knee. J Bone Joint Surg Am 1985;67:351-9.
15. Clancy WG, Martin SD. Posterolateral instability of the knee: Treatment using the Clancy biceps femoris tenodesis. Operative techniques in sports medicine. Oper Tech Sports Med 1996;4:182-91.
16. LaPrade RF, Spiridonov SI, Coobs BR, Ruckert PR, Griffith CJ. Fibular collateral ligament anatomical reconstructions: A prospective outcomes study. Am J Sports Med 2010;38:2005-11.
17. Moulton SG, Matheny LM, James EW, LaPrade RF. Outcomes following anatomic fibular (lateral) collateral ligament reconstruction. Knee Surg Sports Traumatol Arthrosc 2015;23:2960-6.
18. Nordin JS, Olsson O, Lunsjö K. The gracilis tendon autograft is a safe choice for orthopedic reconstructive procedures: A consecutive case series studying the effects of tendon harvesting. BMC Musculoskelet Disord 2019;20:138.

Endoscopic Marginal Excision of Extraarticular Osteochondroma around the Knee

I Gede Eka Wiratnaya, Hans Kristian Nugraha, I Ketut Siki Kawiyana, Putu Astawa

Department of Orthopaedic and Traumatology, Faculty of Medicine, University of Udayana/Sanglah General Hospital, Denpasar, Bali, Indonesia

Abstract

We present three patients with pedunculated and sessile osteochondromas of distal femur and proximal tibia, ranging from a 15-year-old to a 30-year-old patient. All were removed due to esthetic concerns; therefore, we utilized a novel marginal excision using minimally invasive endoscopic tools. All patients had excellent functional and esthetic outcomes up until 1-year postoperative evaluation. Although technically challenging, endoscopic marginal excision is a viable alternative for the surgical management of osteochondroma of the knee and should be considered when esthetic is the primary concern of the patients.

Keywords: Endoscopic resection, knee, osteochondroma

Introduction

Osteochondroma, or osteocartilaginous exostosis, is a benign bone tumor composed of trabecular bone covered by cartilage covering, as the result of malformations from the formation of the periosteum from cartilage nodules.[1] As children with osteochondroma get older, there are chances of these tumors getting bigger and stopping when they reach the growth limit in the child's bones. Long bones in the lower extremities, especially the distal femur and proximal tibia, are the predilection sites for osteochondroma.[2,3] These tumors are usually located outside the joints, and in rare cases, osteochondromas can occur in the pelvis and ankles. These tumors are usually asymptomatic and show clinical symptoms as a result of trauma and compression of the surrounding organs. It could occur as a solitary or as multiple hereditary exostoses with or without systemic anomalies.[1,4]

Operative treatment is one of the options for symptomatic osteochondroma. Possible symptoms are pain due to impingement at surrounding blood vessels and nerves, bursitis, fracture at the vessels, or even a sign of a change toward malignancy if accompanied by a sudden change in size. In addition to relieve pain, operative action is also able to improve the limitations of joint motion, cosmetic abnormalities that arise due to osteochondroma and prevent changes toward malignancy, where osteochondroma has a tendency to change by 0.5%–5%.[5] The standard surgical option for a symptomatic osteochondroma is open marginal extraperiosteal excision.[6]

This case report aims at increasing awareness of the fact that endoscopic resection is a safe novel choice to eliminate extraarticular osteochondroma at the knee region, with the main advantage of faster recovery and better cosmetic results.

Case Presentation

Case 1

Case 1 was a 17-year-old male with a lump on his left proximal tibia who came to our hospital after his parents has considerable concern with the growth of the lump which they felt was considerably faster in the past 1 year and localized pain due to repeated accidental bumps on the lump. He had no history of trauma. On physical examination, there was a

Access this article online	
Quick Response Code:	**Website:** https://journals.lww.com/jajs
	DOI: 10.4103/jajs.jajs_5_22

Address for correspondence: Dr. Hans Kristian Nugraha,
Department of Orthopaedic and Traumatology, Faculty of Medicine,
University of Udayana / Sanglah General Hospital, Denpasar, Bali, Indonesia.
E-mail: hans.nugraha@yahoo.com

Submitted: 02-Feb-2022 **Accepted:** 11-Apr-2022
Published: 09-Jun-2022

How to cite this article: Wiratnaya IG, Nugraha HK, Kawiyana IK, Astawa P. Endoscopic marginal excision of extraarticular osteochondroma around the knee. J Arthrosc Jt Surg 2022;9:38-42.

palpable, nontender 4 cm × 4 cm mass at the medial side of the left proximal tibia, with well-defined and smooth edge. The lump was immobile and has solid consistency with no sign of inflammation. On a plain radiograph, there was a solitary, pedunculated exophytic cortical mass protruding from the metaphyseal-diaphyseal junction of the medial side of the left proximal tibia [Figure 1]. These features were consistent with a pedunculated osteochondroma.

After comprehensive discussion and obtaining informed consent from his parents, therefore, we proceed with a novel, minimally invasive technique for this patient. Under general anesthesia and 350 mmHg tourniquet around the thigh, a stab incision was made first made above the lesion to clearly visualize the tumor. Next, similar nick-and-spread technique was used below the lesion for the instrumentation [Figure 2]. With an osteotome, the osteochondroma was resected using fragmentation with a fine osteotome and removed with a grasper through the working portals, and the remaining bony surface was abraded by a motorized shaver. Both portals were used interchangeably to ensure complete visualization and removal of the lesion [Figure 3]. Histopathological examination confirmed the diagnosis of osteochondroma.

Figure 1: Preoperative X-ray of a 17-year-old boy

Case 2

Case 2 was a 15-year-old male with a painless lump on his right distal femur. He personally noted that it grew larger in the last year, and his parents preferred to have it removed rather just treated conservatively. Sometimes, he complained of pain in his knee when he ran, sat, and climbed stairs. Physical examination revealed a palpable, nontender 3 cm × 5 cm mass at the medial side of the right distal femur, with a smooth and well-defined edge. It has solid consistency, immobile, and without any sign of inflammation. On a plain radiograph, there was a solitary, pedunculated exophytic cortical mass protruding from the metaphyseal-diaphyseal junction of the medial side of the right distal femur [Figure 4]. These features were consistent with a pedunculated osteochondroma; therefore, similar techniques were used in the previous patient. Tumor [Figure 5] was then excised using working portals at the superior and inferior aspects of the tumor, and the postoperative histopathological investigation also confirmed the diagnosis of osteochondroma.

Case 3

Case 3 was a 38-year-old male with a chief complaint of nongrowing lump on his left distal femur in the past 20 years and concerned over esthetic aspects in his daily social gatherings. On physical examination, there was a palpable hard mass, nontender, size 5 cm × 4 cm at the anterior side of the left distal femur, well-defined and smooth edge. It was immobile with solid consistency. There was also no sign of inflammation. On a plain radiograph, there was a solitary, sessile exophytic cortical mass protruding from the metaphyseal-diaphyseal junction of the anterior side of the left distal femur [Figure 6]. These features were consistent with a sessile osteochondroma. Similar techniques were used, and the patient could immediately weight bear 1 day after surgery with minimal pain. Twelve-month postoperative evaluation showed that all patients have excellent functional and esthetic outcomes.

Discussion

Osteochondromas are the most common bone tumors, approximately about 20%–50% of all benign bone tumors,

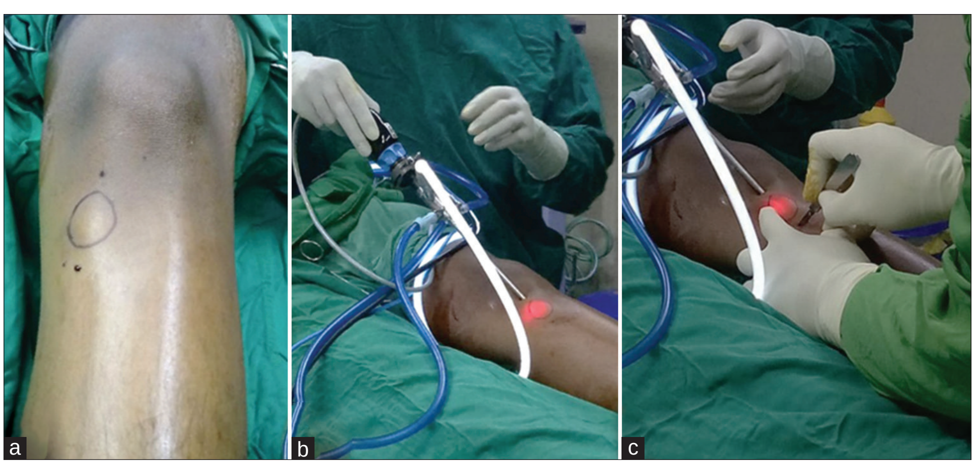


Figure 2: (a) Site marking of the osteochondroma and the planned portal entry, (b) placement of the first portal, (c) incision of the second portal

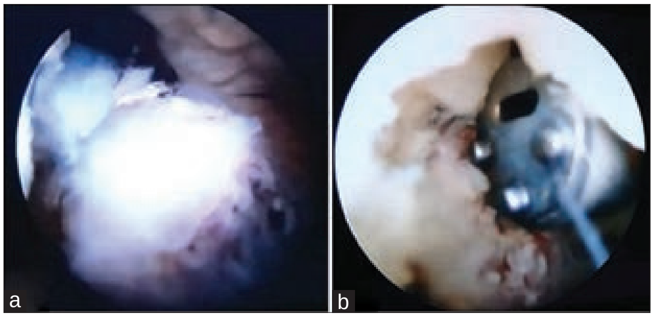


Figure 3: (a) Visualization of the tumor, (b) resection of the tumor with electric shaver

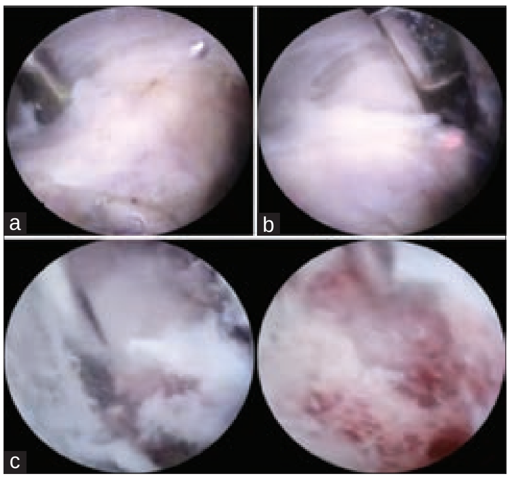


Figure 5: (a) Visualization of the tumor, (b) resection of the tumor, (c) visualization of the tumor after removal

Figure 4: Preoperative X-ray of a 14-year-old boy

Figure 6: (a) Clinical appearance of a 38-year-old male (b) preoperative X-ray of the patient

although true incidence is unknown because most lesions are asymptomatic.[1-3] Accordingly, all of our patients only have painless lumps. They are thought to arise during the first two decades of life from trapped growth-plate cartilage and defect in the perichondrial node of Ranvier, allowing physeal growth herniation through the cortical surface and grows through endochondral ossification beneath the periosteum.[4] Similar to our cases, all are identified at the first two decades of life with metaphyseal long bone as the most affected region, especially around the knee, proximal humerus, and pelvis.[1,5,6]

Osteochondromas bring clinical attention due pain associated with its interference with surrounding structures (bursa, muscle, nerve, and vessel), mechanical disturbance related to the surrounding joint, esthetic reasons, or rarely a pathological fracture and malignant changes.[6] The clinical findings must be corroborated with radiographic examination to establish the diagnosis of an osteochondroma. Mostly, a plain X-ray is sufficient.[5,7] Magnetic resonance imaging (MRI) was not done in our cases because there was no sign nor symptom of malignant degeneration, which was confirmed by postoperative routine histopathological assessment [Figure 7]. Besides, routine use of advanced examination such as MRI is discouraged in our country due to cost control in the universal health-care system. In case of dubious appearance in the preoperative radiographic investigation, a biopsy could also be done preoperatively.[8]

Although osteochondroma may regress spontaneously,[4] conservative management is not usually not preferred by patients or their parents, mainly due to esthetic concerns as in our cases. First reported by Schmoyer,[9] arthroscopic resection has been reported to be used to treat osteochondroma in the scapula,[10-12] clavicle,[13] as well as femoral neck,[14,15] intraarticularly at the knee,[16-21] fibular head,[22] and ankle.[23] To our knowledge, there is only 1 patient in the literature in which his extraarticular osteochondroma at the distal femur was endoscopically removed.[24] Our patients in this series have concern over postoperative scar; therefore, the option of minimally invasive procedure with consequent smaller surgical scar after stab incisions used for endoscopic portals is the preferable option by our patients, compared to the standard open incisions, although technically more demanding than the conventional open surgery.

Instead of deploying standard knee arthroscopy portals for extraarticular osteochondroma,[21] each of the working portals in our cases was placed in the superior and inferior aspects of the tumor with careful consideration regarding the important anatomic structures around the planned portals. The advantage

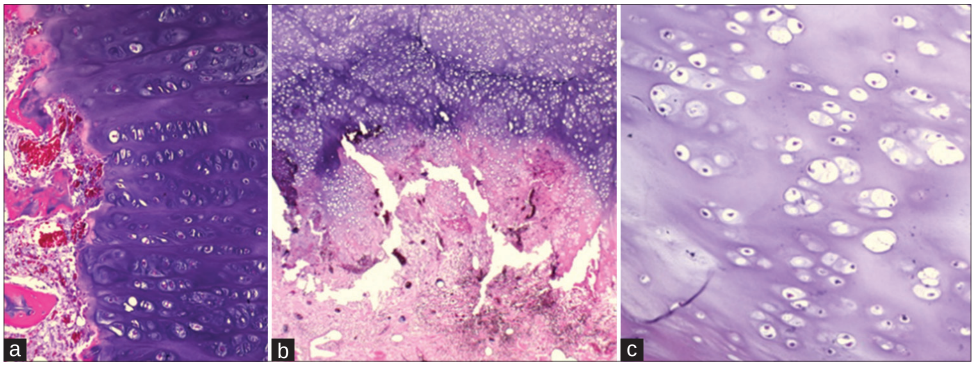


Figure 7: Microscopic view of the histopathological samples (a) Patient 1 (b) Patient 2 (c) Patient 3 – showing uniform, typically benign chondrocytes alongside endochondral bones

of such portals is to minimize the trauma to the joint, while also to avoid the subsequent complication such as arthrofibrosis. It could also be used to navigate through a cortical window if a curettage is needed.[25] In our cases, we avoid the posterior placement of the working portals due to the risk to injure the neurovascular bundle. If a tumor is located in the posterior part, a conventional open approach is preferred in regard to better visualization of adjacent critical structures. Irrigation should be judiciously used to avoid the spread of the fragmented debris to surrounding normal tissue, leading to rare complication of heterotopic ossification or recurrence.

Recurrence after surgical excision is rare but may develop when a portion of the cartilage cap or attached perichondrium is left *in situ*.[1] The magnification through the arthroscope in this novel technique, therefore, allows more thorough cleanup of both the cartilage cap and perichondrium.

Immediately after the surgery, all of our patients could return to normal activity and no recurrence was found on 6 months' postoperative follow-up. Furthermore, this technique has better esthetic results as compared to the traditional open approach. In our experiences, there was no other drawback of this novel technique other than the steep learning curve for the surgeon as well as the availability of the equipment, with much faster return to normal activity compared to the conventional open surgery.

Conclusion

Osteochondromas represent one of the most common bone tumors, with physical examination and plain X-ray played essential roles in establishing the diagnosis. Endoscopic resection was proven to be a safe, novel choice and has the potential to be more widely used to treat such lesion around the knee region, with the main advantage of faster recovery and better cosmetic results.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the journal. The patient understands that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Dorfman HD, Czerniak B. Bone Tumors. 2nd ed. St. Louis: Mosby; 2015.
2. de Souza AM, Bispo Júnior RZ. Osteochondroma: Ignore or investigate? Rev Bras Ortop 2014;49:555-64.
3. Hakim DN, Pelly T, Kulendran M, Caris JA. Benign tumours of the bone: A review. J Bone Oncol 2015;4:37-41.
4. Aiba H, Yamada S, Yamamoto N, Hayashi K, Miwa S, Tsuchiya H, *et al.* Spontaneous shrinkage of solitary osteochondromas. Skeletal Radiol 2018;47:61-8.
5. Motamedi K, Seeger LL. Benign bone tumors. Radiol Clin North Am 2011;49:1115-34, v.
6. Khare GN. An analysis of indications for surgical excision and complications in 116 consecutive cases of osteochondroma. Musculoskelet Surg 2011;95:121-5.
7. Ostensen H, Pettersson H, Davies AM, Arredondo F, Meligi MR, Guenther R, *et al*. The WHO Manual of Diagnostic Imaging: Radiographic Anatomy and Interpretation of the Musculoskeletal System. Geneva: World Health Organization; 2012.
8. Ayerza MA, Abalo E, Aponte-Tinao L, Muscolo DL. Endoscopic resection of symptomatic osteochondroma of the distal femur. Clin Orthop Relat Res 2007;459:150-3.
9. Schmoyer S, Ciullo JV. Arthroscopic resection of an osteochondroma of the knee. Arthroscopy 2001;17:765-7.
10. Aalderink K, Wolf B. Scapular osteochondroma treated with arthroscopic excision using prone positioning. Am J Orthop (Belle Mead NJ) 2010;39:E11-4.
11. Nascimento AT, Claudio GK. Snapping scapula. Arthroscopic resection of osteochondroma of the subscapularis superomedial angle. Case report and literature review. Rev Bras Ortop 2017;52:220-3.
12. Alshayhan FA, Alahaidib A, Alsowaigh M, Alahaideb A. Bilateral scapular osteochondroma in Multiple Hereditary Exostosis patient presented with bilateral shoulder pain treated with arthroscopic and open excision: Case report. Ann Med Surg (Lond) 2021;67:102481.
13. Lopez-Ovenza JM, San Roque M, Olvi LG. Arthroscopic Resection of Distal Clavicular Osteochondroma: A Case Report. JBJS Case Connect. 2021;11(2).
14. Aguiar T, Dantas P. Arthroscopic resection of intra-articular osteochondromas of the hip. Arthrosc Tech 2014;3:e347-50.
15. Alter T, Okoroha KR, Kunze KN, Beck EC, Nho SJ. Arthroscopic femoral osteochondroplasty with capsular plication for osteochondroma

of the femoral neck. Arthrosc Tech 2019;8:e1353-9.
16. Rizzello G, Franceschi F, Meloni MC, Cristi E, Barnaba SA, Rabitti C, *et al.* Para-articular osteochondroma of the knee. Arthroscopy 2007;23:910.e1-4.
17. Kim JI, Kwon JH, Park YJ, D'Almeida VR, Soni SM, Nha KW. Arthroscopic excision of solitary intra-articular osteochondroma of the knee. Knee Surg Relat Res 2013;25:36-9.
18. Kesgin E, Çelik C, Karaoğlu S. Arthroscopic resection of osteochondroma of the knee: Two case reports. Eklem Hastalik Cerrahisi 2013;24:112-6.
19. Kong M, Cao LI, Zhang Q, Fang Y, Zhao C, Gu H, *et al.* Identification of a rare case of intra-articular osteochondroma manifesting as three loose bodies in a patient with hereditary multiple osteochondromas: A case report. Oncol Lett 2015;10:798-804.
20. Mahardika IMY, Suhendra H, Wonggokusuma E. Arthroscopic Excision of an Intraarticular Osteochondroma of Knee: A Rare Case Report. Orthop J Sports Med. 2019;7:2325967119S00471.
21. Tsakotos G, Tokis A, Vlasis K, Demesticha T, Skandalakis P, Filippou D, *et al.* Arthroscopic resection of extra-articular knee osteochondroma: Report of two cases. J Surg Case Rep 2019;2019:rjz167.
22. Gudas R, Pocius A. Endoscopic removal of the osteochondroma of the fibular head. Medicina (Kaunas) 2013;49:191-4.
23. Tonogai I, Sairyo K. Posterior ankle arthroscopy for osteochondromatosis of the posterior ankle extra-articular space with a longitudinal tear of flexor hallucis longus. Case Rep Orthop 2020;2020:6580472.
24. Díaz AA, Miguel A. Endoscopic resection of a distal femoral osteochondroma: Description of the technique and case report. Arthroscopy 2002;18:23E.
25. Wiratnaya IGE, Subawa IW, Astawa P, Nugraha HK. Arthroscopic Management of Giant Cell Tumor of the Calcaneus. Foot Ankle Spec. 2021:19386400211029120.

Total Hip Arthroplasty in Ochronotic Arthropathy

R. Ponnaian Prabhakar, Parikshat Gopal[1], Rupesh Prasad[1], Kunjan Pathania[2]

Department of Orthopedics and Joint Replacement, Care Group of Hospitals, Hyderabad, Telangana, [1]Department of Orthopedic Surgery, ACMS and Base Hospital, Delhi Cantt, [2]Department of Pathology, Military Hospital, Jodhpur, Rajasthan, India

Abstract

Ochronotic arthropathy is a rare amino acid metabolic disorder that causes arthritis knee and hip in the 4th and 5th decades of life. There are only a few documented cases in the literature. We report one such case of a 46-year-old washer man, its clinical presentation, imaging findings, intraoperative findings, and treatment by uncemented total hip replacement.

Keywords: Alkaptonuria, hip, ochronotic arthropathy, total hip replacement, uncemented

Introduction

Ochronotic arthropathy is a musculoskeletal manifestation of alkaptonuria. Alkaptonuria is a disorder of amino acid metabolism, resulting from incomplete breakdown of aromatic amino acids, namely tyrosine and phenylalanine, due to deficiency of the enzyme homogentisate 1,2-dioxygenase (HGO). Homogentisic acid is a breakdown product of tyrosine and phenylalanine which requires the enzyme HGO for further degradation.[1,2]

Ochronotic arthropathy is an autosomal recessive disorder often occurring as a consequence of consanguineous marriages. There is a mutation of the *HGO* gene on chromosome 3q.[3-5] Prevalence of ochronotic arthropathy is 1 in 1,000,000–1 in 250,000 population.[6]

Urine turns black on prolonged standing. Black pigmentation develops in conchae and antihelix of the pinna first and then involves sclera but remains asymptomatic till the 3rd and 4th decades of life. Low backache and stiffness of back are generally a constant finding. Degenerative arthritis of the knee, hip, and shoulder is also common.[3]

The pathogenesis of ochronotic arthropathy is due to abnormal accumulation of homogentisic acid, which is a strong reducing agent. On oxidation, it is converted into a dark pigment. Blue-black pigmentation of the tissues in which it gets deposited takes place because of this reason. It gets deposited in the sclera of the eye, cartilage of pinna, tendons, ligaments, capsule, and articular cartilage of peripheral joints.[3,4] Deposition of these pigments result in loss of elasticity of cartilage (increased brittleness) which in turn leads to poor resistance to mechanical strain.

There is no definitive treatment. Dietary restriction of tyrosine and phenylalanine along with Vitamin C is being used routinely. Nitisinone, a reversible inhibitor of 4-hydroxyphenylpyruvate, is an FDA-approved drug for tyrosinemia type 1 and is under investigation for the treatment of ochronotic arthropathy.

In this article, we present a case of ochronotic arthritis hip of a 46-years-old male who was managed by total hip replacement.

Case Report

A 46-year-old male washer man reported to the department of orthopedics of a tertiary care hospital with complaints of pain on the right hip for 3 years' duration. Pain was dull aching in nature and localized to the right hip. Initially, he was able to perform his daily activities with mild underlying pain, but it increased to such an extent that he could not walk even 500 m in one stretch or climb stairs. There was no

Access this article online	
Quick Response Code:	**Website:** https://journals.lww.com/jajs
	DOI: 10.4103/jajs.jajs_61_22

Address for correspondence: Dr. R. Ponnaian Prabhakar, Department of Orthopedics and Joint Replacement, Care Group of Hospitals, Nampally, Hyderabad, Telangana, India. E-mail: drprabhakar1@gmail.com

Submitted: 08-Mar-2022 **Accepted:** 11-Mar-2022 **Published:** 09-Jun-2022

How to cite this article: Prabhakar RP, Gopal P, Prasad R, Pathania K. Total hip arthroplasty in ochronotic arthropathy. J Arthrosc Jt Surg 2022;9:43-6.

radiation of pain. There was no diurnal or seasonal variation of pain. There was no history of chronic pulmonary or renal illness, steroid intake, or blood dyscrasia. No positive history of such illness in family was noted. There was no history of loss of appetite, weight loss, chronic cough, or evening rise of temperature. However, he complained of low backache for 1 year duration which was insidious in onset, gradually progressive, and localized [Figure 1]. He was not able to squat or sit cross-legged. He had difficulty in using toilet and public transport.

On examination, vital parameters were within normal limits with a body mass index of 23.6. General physical examination and systemic examination were grossly normal. The patient was dark complexioned, and we were not able to appreciate any pigmentation of pinna or skin. On local examination, there was 1 cm shortening of the right lower limb. There was fixed flexion deformity of 15°, with further flexion to 100°. There was 10° of adduction deformity.

Radiograph showed concentric joint space reduction and osteophytes with subchondral cysts. Subchondral fracture can be appreciated in weight-bearing area [Figure 2].

Preoperative templating was done for uncemented total hip arthroplasty.

After obtaining informed written consent from the patient, he was taken up for surgery under combined spinal–epidural anesthesia. Left lateral decubitus positioning was done. Moore's posterior approach was used. After skin incision, short external rotator muscles were lifted. Capsule was found to be pigmented black, hard in consistency, and contracted, and hence excised [Figure 3]. In spite of excision of entire posterior capsule, there was no evidence of dislocation at the end of surgery. Acetabular bone was soft to ream. We succeeded in obtaining press-fitting acetabular component. In addition, screws in the superolateral quadrant were used to secure the acetabular component. Neck cut was done with all precautions because of sclerotic bone [Figure 4]. Press-fit femoral component was achieved after standard reaming and broaching [Figure 5].

Postoperative period remained uneventful. The patient was mobilized the next day of surgery and discharged on day 3. Surgical wound healed well, and sutures were removed on day 14.

Histopathological specimen showed characteristic banana-shaped ochronotic bodies and interspersed foreign body giant cells [Figure 6].

No implant-related complications were observed till 4 years of follow-up [Figure 7].

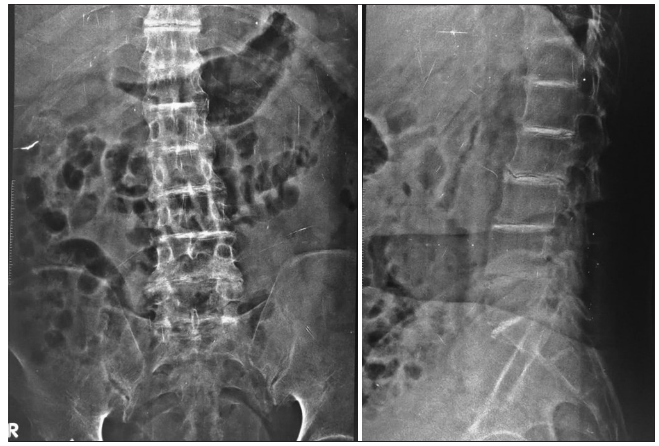


Figure 1: Radiograph of lumbosacral spine in anteroposterior and lateral view showing ossified intervertebral disc with slight erosion of adjacent vertebral margins

Figure 2: Radiograph of the right hip anteroposterior and cross table lateral view showing concentric joint space reduction and marginal osteophytes. Subchondral cysts and subchondral fracture can be seen in weight bearing area

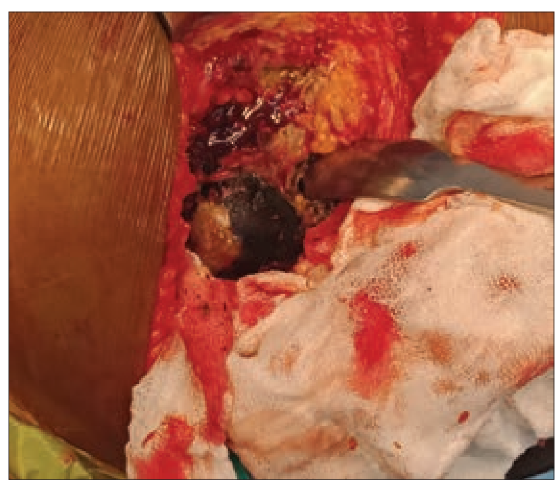


Figure 3: Peroperative photograph showing hyperpigmented head of femur *in situ*

Discussion

The patient was taken up for surgery as a case of osteoarthritis right hip because he was symptomatic. The diagnosis of ochronotic arthritis in this case was intraoperative. This case report teaches us that we should consider ochronotic arthropathy as one of the differential diagnoses whenever arthritic changes of hip are seen in the 4th and 5th decades.

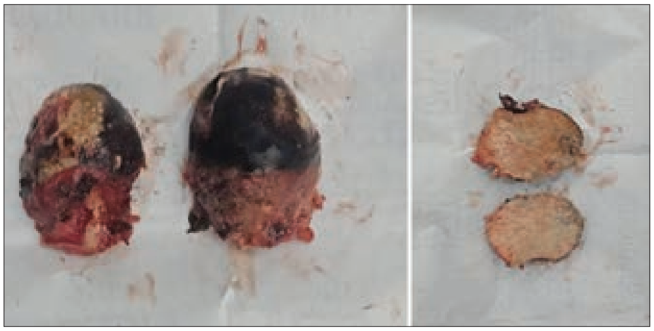


Figure 4: Intraoperative specimen of excised head of the femur (2 cut halves) showing black pigmentation of articular cartilage and sclerotic bone

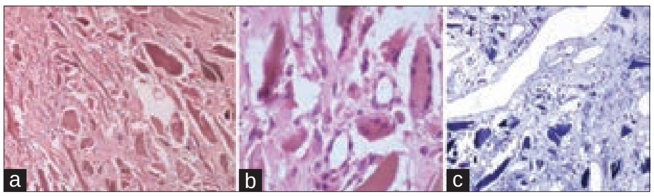


Figure 6: Hematoxylin and eosin-stained sections showing bony tissue with spread out "banana-shaped" ochronotic bodies (a). These crystals are surrounded and at places engulfed by foreign body type giant cells (b). Ochronotic bodies are highlighted by methylene blue which stains them blackish-blue coloration (c)

Awareness of ochronosis as one of the differential diagnoses will lead to careful evaluation by an anesthetist for associated cardiac and respiratory ailments for unforeseen intraoperative complications.[7]

In view of no medical treatment available for this ailment, hip arthritis is the inevitable outcome. There is no standard treatment protocol for ochronotic hip arthritis. Arthroplasty can be effective in the treatment for pain relief and joint mobility in ochronotic arthropathy.[5] Careful reaming of soft acetabulum and neck cut of the sclerotic femur is required. There are no clear guidelines regarding advantages of cemented versus uncemented prosthesis in this ailment. We have used uncemented total hip replacement in this case,[4,8] and there were no complications in 4 years of follow-up.

A few case reports have used cemented implant on the basis of sclerotic bone.[6,8] Even after excision of hard and sclerotic capsule, there was no incidence of dislocation in this case.

We have found that there is simultaneous involvement of spine and hip in this case. Early involvement of the spine than hip is a common finding in ochronotic arthritis.[5] Even though there is no incidence of dislocation in 4 years of follow-up in this case, dynamic spinopelvic parameters should be taken into consideration to prevent this complication. Desired inclination and anteversion of the cup should be based on dynamic pelvic tilt in supine, sitting, and standing posture due to spine stiffness.[9,10]

Figure 5: Plain anteroposterior radiograph of pelvis with both hip showing uncemented acetabular and femoral components postoperative

Figure 7: Plain radiograph of the pelvis with both hip anteroposterior and cross-table lateral view right hip 4 years of follow-up

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Gil JA, Wawrzynski J, Waryasz GR. Orthopedic manifestations of ochronosis: Pathophysiology, presentation, diagnosis, and management. Am J Med 2016;129:6.e1-6.

2. Lee WC, Tan TL, Chan YH. Total knee arthroplasty in ochronosis arthropathy: A case report and systematic review. Case Rep Orthop 2019;2019:1871856.
3. Jain AK, Jajodia N. Metabolic bone diseases and related dysfunction of parathyroid glands. In: Jain AK, editor. Turek's Orthopaedics Principles and their Applications. New Delhi: Wolters Kluwer (India) Pvt Ltd; 2016. p. 249-82.
4. Siavashi B, Zehtab MJ, Pendar E. Ochronosis of hip joint; a case report. Cases J 2009;2:9337.
5. Yetis M, Unveren Z, Uzun E, Ozcamdalli M, Kizkapan TB, Misir A. Alkaptonuric ochronosis; hip arthroplasty – A rare case treated with total hip replacement. Firat Tip Derg/Firat Med J 2018;23:100-2.
6. Cebesoy O, Isik M, Subasi M, Kaya A, Bilgin F, Kaya O. Total hip replacement for an ochronotic patient: A technical trick. Am J Case Rep 2014;15:27-30.
7. Mazoochy H, Razi M. Knee and hip joint replacement surgery in a patient with ochronotic arthropathy: Surgical tips. Arch Bone Jt Surg 2018;6:577-81.
8. Pachore JA, Shah VI, Upadhyay S, Shah K, Sheth A, Kshatriya A. Primary hip arthroplasty for the treatment of alkaptonuric hip arthritis: 3- to 24-year follow-ups. Arthroplasty 2019;1:8.
9. Heckmann N, McKnight B, Stefl M, Trasolini NA, Ike H, Dorr LD. Late dislocation following total hip arthroplasty: Spinopelvic imbalance as a causative factor. J Bone Joint Surg Am 2018;100:1845-53.
10. Ike H, Dorr LD, Trasolini N, Stefl M, McKnight B, Heckmann N. Spine-pelvis-hip relationship in the functioning of a total hip replacement. J Bone Joint Surg Am 2018;100:1606-15.

ISKSAA International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

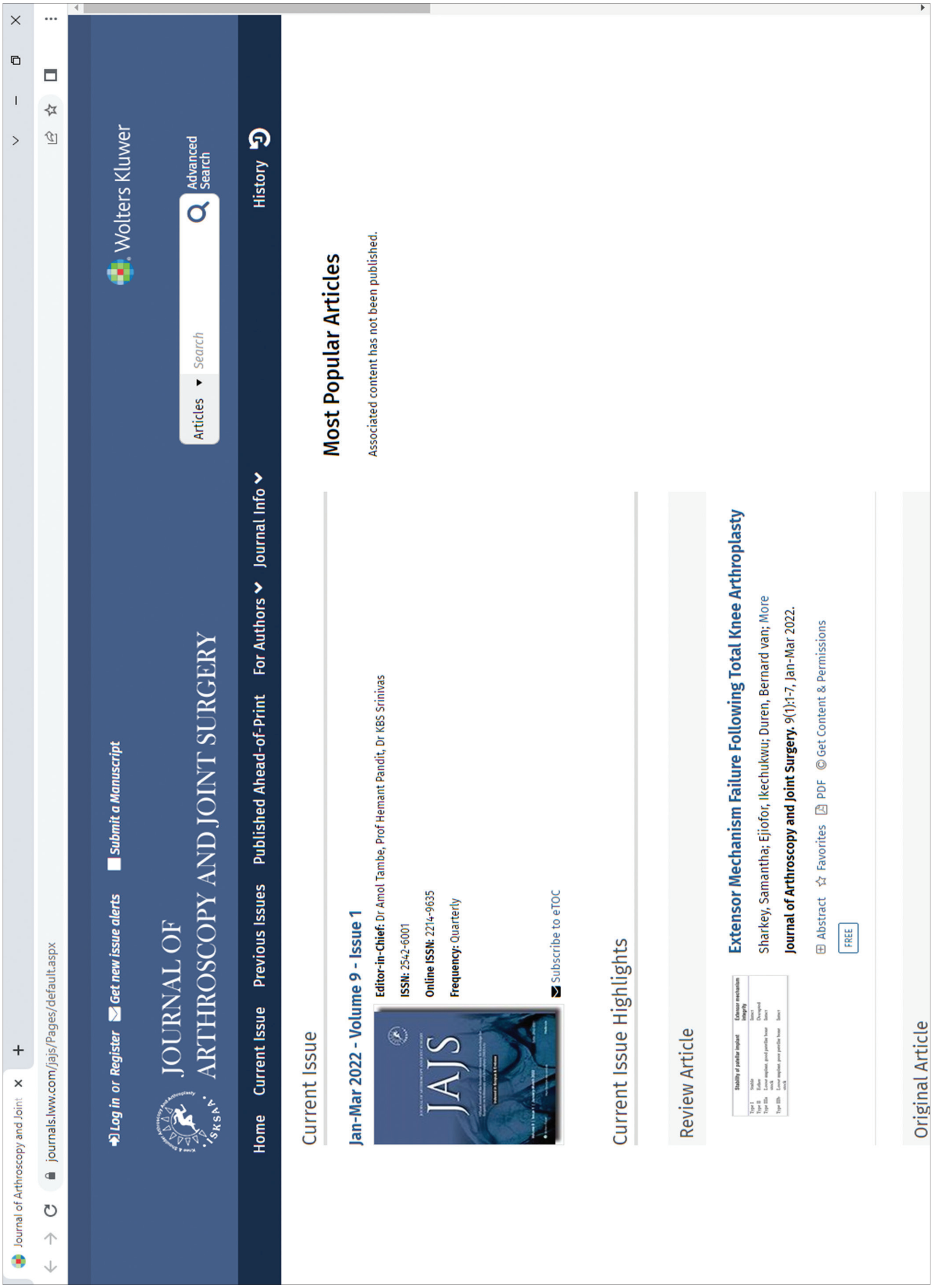
Wrightington, Wigan and Leigh NHS Foundation Trust

Edge Hill University

ISKSAA – Wrightington International Training Fellowships leading to MCh degree (2023).

Interested candidates are invited to apply for a unique opportunity for post-graduate education and subspecialist training in the UK

1. The interested candidates are encouraged to look at the University website link. The programme is aimed at motivated candidates who wish to come to UK to obtain 2-3 years of clinical experience, specialist surgical training and an MCh degree from Wrightington Hospital and Edge Hill University.
2. The interviews are slated for 19th and 20th of November 2022 in New Delhi when the recruitment team will be visiting India. The exact venue will be confirmed in due course.
3. **Having cleared the IELTS exam** before the interviews will be of advantage for final selections.
4. The Clinical posts would start in August 2023 although if candidates were to be interested for August 2024 start, they could still apply.
5. The MCh course is at the Edge Hill University and although most of the payment for the course can be made along the way in installments over the 2 years, there would be an initial Commitment of £8,000 to be made to secure the place before the formalities with Royal colleges and GMC are commenced at this End. The salary scales are detailed with the information sheet as well.
6. There will be two posts per year as the "Wrightington - ISKSAA MCh Fellowship". There would be an **assured Wrightington placement** during the 2-year UK rotation via this stream. **Only ISKSAA Life Members can apply for these posts** .
7. **THE EMAIL SHOULD MENTION ISKSAA MEMBERSHIP NUMBER VERY CLEARLY**
8. THESE ARE SALARIED JOBS IN THE NHS AND SO ARE FULLY FUNDED.



Printed and published by Wolters Kluwer India Pvt. Ltd. on behalf of International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty and printed at Balaji Art, Bhandup (W), Mumbai, India. and published at A-202, 2nd Floor, The Qube, C.T.S. No. 1498A/2 Village Marol, Andheri (East), Mumbai - 400 059, India