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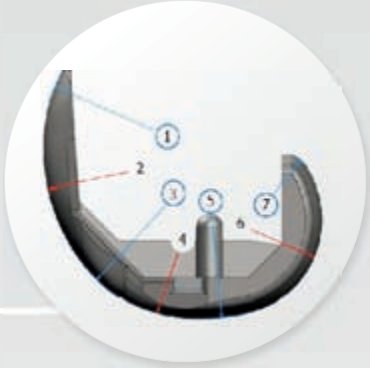

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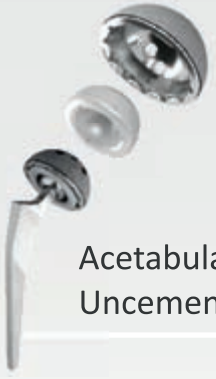

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Aims and Scope

Journal of Arthroscopy and Joint Surgery (JAJS) is committed to bring forth scientific manuscripts in the form of original research articles, current concept reviews, meta-analyses, case reports and letters to the editor. The focus of the Journal is to present wide-ranging, multi-disciplinary perspectives on the problems of the joints that are amenable with Arthroscopy and Arthroplasty. Though Arthroscopy and Arthroplasty entail surgical procedures, the Journal shall not restrict itself to these purely surgical procedures and will also encompass pharmacological, rehabilitative and physical measures that can prevent or postpone the execution of a surgical procedure. The Journal will also publish scientific research related to tissues other than joints that would ultimately have an effect on the joint function.

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Editorial

The current issue of JAJS contains two original papers reporting the outcome of surgical management of acromio-clavicular (A.C) joint injuries by arthroscopic tight rope stabilization. Both the studies are prospective studies and have 10 and 11 patients, respectively. Both the papers have included Rockwood grade III to grade V A.C joint injuries. The similar surgical technique used by both the authors, however, has not produced similar outcomes. The first series of Gupta et al. has reported seven excellent, two good and one fair result. While Gangary et al. in their series have reported one good, seven satisfactory and two poor outcomes. The second study has reported six failures of a total number of 11 shoulders. Two shoulders required revision surgery. Of the six failed cases, four belonged to grade III injury.

Arthroscopic assisted reconstruction with non-rigid coraco-clavicular (CC) lacing is a relatively new method of surgical stabilization of the A.C joint. The main advantages of this method include better cosmetic result, shorter time of surgery, no intra-operative fluoroscopy and reduced post-surgical morbidity due to minimal invasive nature of the surgery.[1,2] However, the method involves a higher cost of the implant and requires a surgeon well versed with the procedure of arthroscopy.[3]

Some of the recent studies have shown successful outcome with coraco-clavicular lacing procedures including tight rope.[1,2,4–6] On the contrary, there are studies which have reported unfavorable results with these surgical procedures. Clavert et al. in a prospective multi-centric study of 116 patients have reported 50% significant persistent dislocations after arthroscopic endobutton coraco-clavicular procedures with a complication rate of 22.4%.[7] Similarly, Barth et al. in a multicenteric study have concluded that coracoclavicular stabilization alone is not sufficient irrespective of the implant used.[8]

Loriaut et al. have also reported 7% patients requiring revision surgery because of persistence of dislocation after arthroscopic assisted reconstruction of A.C. joint.[9]

Thus the results of arthroscopic non-rigid CC fixation, in the current literature are mixed. Whether the diagonally opposite outcomes are related to variations in patient selection or execution of the surgical technique is still unknown.

But a universal similarity in all the studies emanating from single centers is that the series are small with less number of patients thus reducing the power of study. Reporting of larger case series from individual centers will certainly take out the factor of the learning curve of the surgeon, in addition to enhancing the power of the study thus eliminating the chance factor.

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Original Article

Humeral avulsion of glenohumeral ligaments – Detection on magnetic resonance arthrography

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ABSTRACT

Background: Humeral avulsion of the glenohumeral ligaments (HAGL) is an important cause of shoulder instability, with magnetic resonance arthrography (MRA) routinely being used for diagnosis. Our aim was to compare the diagnostic value of MRA to shoulder arthroscopy for the detection of HAGL lesions and to calculate its prevalence.

Methods: Patients who underwent a shoulder arthroscopy with a single surgeon and pre-operative MRA between February 2011 and March 2012 for instability were identified. MRAs were reported by experienced musculoskeletal radiologists and compared to arthroscopy findings for the presence of HAGL lesions. Sensitivity, specificity, positive and negative predictive values, prevalence and positive and negative likelihood ratios were calculated.

Results: A total of 194 patients were identified with a HAGL lesion prevalence of 4.64% on arthroscopy. The sensitivity of MRA in detecting HAGL was 0.44 (CI: 0.14–0.79) and the specificity was 0.97 (CI: 0.94–0.99). The positive predictive value was 0.44 (CI: 0.14–0.79) and negative predictive value was 0.97 (CI: 0.94–0.99). The positive likelihood ratio was 16.44 (CI: 5.30–51.00) and negative likelihood ratio was 0.57 (CI: 0.32–1.02).

Conclusions: MRA appears to be specific and accurate in excluding HAGL lesions, but not sensitive. HAGLs were associated with numerous other injuries such as bankart, SLAP and Hill–Sach lesions. The prevalence of 4.64% is comparable to previous studies.

1. Introduction

Humeral avulsion of glenohumeral ligaments (HAGL) is an important cause of shoulder instability.[1] Instability usually arises as a result of acute trauma from glenohumeral subluxation or dislocation, with a combination of hyperabduction and external rotation.[2] MRA is well established in assessing glenohumeral pathology but its role in identifying HAGL lesions is under-reported in literature.[3] Jana et al. and Carlson described the J-sign referring to the conversion of the U-shaped axillary pouch to a J-shape as the inferior glenohumeral ligament (IGHL) complex drops inferiorly.[3,4] Other characteristics include increased intensity, thickening of the inferior capsule, a

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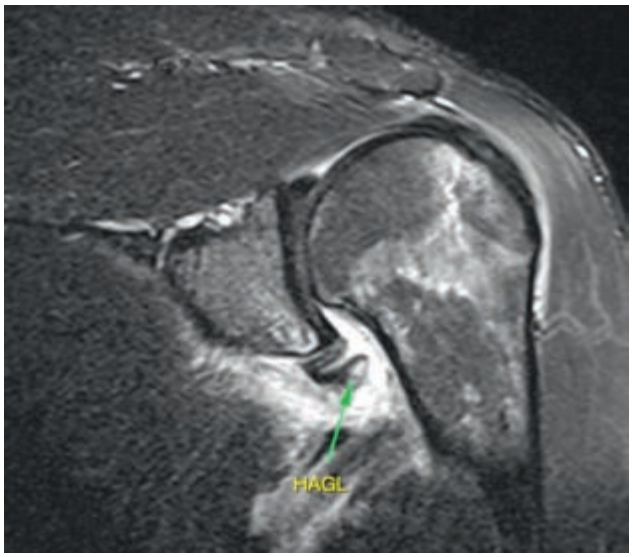

Fig. 1 – A MRA demonstrating a HAGL lesion.

thickened wavy contour and higher intensity within the ligament itself, and extravasation of contrast material along the humeral neck (Fig. 1).[3,4]

Shoulder arthroscopy is the gold standard in detecting HAGL lesions through direct visualisation.[5] The distinguishing sign is visualisation of fibres of the subscapularis through the avulsed inferior joint capsule.[6] Bokor et al. described a disruption of the 'wave' between the reflection of the inferior capsule onto the humeral neck to be a reliable sign of HAGL lesions.[7]

The aim of our study is to assess the diagnostic value of MRA in detecting HAGL lesions compared with arthroscopy and to calculate the prevalence within our study group (Fig. 2).

2. Materials and methods

Shoulder arthroscopies performed by a single Consultant Orthopaedic Surgeon between February 2011 and March 2012 for instability were identified using the surgeon's operative records. All patients attended an initial outpatient clinic and were found to have clinical instability on examination, with suspicion of glenohumeral pathology including the possibility of a HAGL lesion. Of these patients, only those who had a pre-operative MRA were included and identified through PACS (Centricity PACS, GE Healthcare), Bluespier (Bluespier International, Droitwich, UK) and clinic letters. Patients were included regardless of demographics, background, side of operation or indication. The MRAs were requested by the Orthopaedic Surgeon to ensure that radiologists were made aware of the positive clinical findings on the request forms. The investigations and procedures were conducted over three hospital sites. 1.5T MRI scanners with gadolinium as contrast were used throughout with a routine standard protocol of T1 and T1 fat–sat axial, T1 fat–sat coronal and sagittal obliques, T2 fat–sat coronal oblique. All MRAs were reported by experienced specialist musculoskeletal radiologists. Findings were only included as positive when the radiologists or arthroscopist were definitive in their diagnosis.

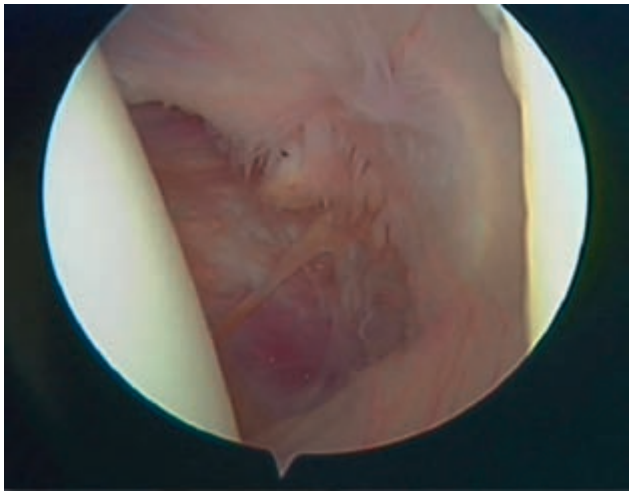

Fig. 2 – A HAGL lesion on shoulder arthroscopy.

2.1. *Statistics*

Sensitivities, specificities, positive and negative predictive values (PPV/NPV), positive and negative likelihood ratios (PLR/NLR) were calculated using Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS Inc. Chicago, IL, USA, 2014).

3. Results

A total of 744 patients underwent shoulder arthroscopic procedures for instability, of which 194 patients had a pre-operative MRA. Patients whose pathology was easily identifiable, or not related to a HAGL, on clinical examination or simpler radiological investigations such as ultrasound and X-rays did not have an MRA. The mean age was 29.9 years with a range between 13 and 69 years. 73%/27% of patients were males/females. Right to left ratio was nearly equal (52%:48%).

The prevalence of HAGL lesions on arthroscopy was 4.64% (9/194 cases). There were 4 true positives, 180 true negatives, 5 false positives and 5 false negatives. The sensitivity and specificity was 0.44 (CI: 0.14–0.79) and 0.97 (CI: 0.94–0. 99) respectively. The PPV was 0.44 (CI: 0.14–0.79) and NPV was 0.97 (CI: 0.94–0. 99). The PLR was 16.44 (CI: 5.30–51.00) and NLR was 0.57 (CI: 0.32–1.02). Table 1 summarises the statistical analysis.

Table 1 – A table to show the sensitivity, specificity, positive likelihood ratios (PLR), negative likelihood ratios (NLR), positive predictive value (PPV) and negative predictive value (NPV) with 95% confidence intervals.

Statistical test	Value	95% confidence intervals
Sensitivity	0.44	0.14–0.79
Specificity	0.97	0.94–0.99
Positive likelihood ratio	16.44	5.30–51.00
Negative likelihood ratio	0.57	0.32–1.02
Positive predictive value	0.44	0.14–0.79
Negative predictive value	0.97	0.94–0.99

Of the 9 confirmed cases of HAGLS on arthroscopy, 8/9 had an associated bankart lesion, 1/9 had an anterior labral periosteal sleeve avulsion (ALPSA), 3/9 had a superior labral tear from anterior to posterior (SLAP), 4/9 had a Hill–Sach's lesion and 2/9 had a rotator cuff tear.

4. Discussion

The diagnostic value of MRA in identifying HAGL lesions has been largely under-reported.[5] Acid et al. compared MRA and multidetector computed tomography (MDCT) to arthroscopy and found that MRA had a sensitivity/specificity of 1.00/0.97 for humeral avulsion of IGHL lesion and 0.58/0.95 for middle glenohumeral ligament tear.[5] Our study showed a lower sensitivity and specificity of 0.44 (CI: 0.14–0.79) and 0.97 (CI: 0.94–0.99) for HAGL lesions. In our study, the presence of any glenohumeral ligament avulsion was considered as a HAGL lesion regardless of position which may account for the differences in statistics. Furthermore, our series was much larger with 194 patients in comparison to 40 patients, which may account for further differences.

Bigliani et al. suggested that avulsion of the IGHL would occur in up to 25% of cases with anterior dislocation in biomechanical cadeveric studies.[8] However, the actual prevalence has been reported to be much less in patients among literature. Wolf et al. were first to demonstrate a prevalence of 9.3% in 64 patients with shoulder instability, of which 73.5% also had a bankart lesion.[6] Yiannakopoulos et al. found that HAGL lesions had a prevalence of 1.57% in 127 patients with anterior shoulder instability.[9] Magee analysed 1000 magnetic resonance imaging (MRI) reports and found a prevalence of 1.6% on MRI and 2.1% in those who proceeded to surgery.[10] Liavaag et al. showed a prevalence of 21.4% of HAGL lesions on MRI in patients with traumatic shoulder dislocation and 7.1% on MRA at follow-up.[11] Bokor et al. found an incidence of 7.5% of HAGL lesions in 514 patients with primary instability on arthroscopy.[7] The incidence of HAGLs rose to 39% in patients who did not have a bankart lesion and violent injury was the cause of the initial dislocation.[7] Bhatia et al. found 11% of patients with bony instability had a HAGL lesion in a 64 patient series.[12] Bui-Mansfield et al. found an incidence of 2% for HAGL lesions in 307 patients who had a diagnostic arthroscopy for glenohumeral instability.[13] Mizuno et al. found a total incidence of 4.6% (14 patients) for HAGLs in 303 shoulders with recurrent dislocations and 4% (12 patients) had an isolated HAGL.[14] The prevalence and population age in our study of 4.64% and mean age 29.9 years is comparable to these studies.

There are several limitations of our study: firstly, a 100% commitment to the diagnosis with terms such as 'possible' and 'cannot exclude' being identified as a negative finding. Time elapsed between the MRA and shoulder arthroscopy could account for worsening or improving pathology and possibly subsequent additional injury leading to the development of a HAGL lesion. MRA reports were available to the arthroscopist prior to the procedure, which may have added an element of bias. However, we tried to minimise this by standardising the method of the procedure to assess the presence of specific glenohumeral pathology regardless of the MRA. Nevertheless, clinical findings were available to both the radiologist and arthroscopist prior to their assessments. Furthermore, arthroscopy, although gold standard, is imperfect due to its operator-dependant nature and may result in overlooked pathology as well.

5. Conclusion

In our study, we found large 95% confidence interval for PPV, PLR/NLR and sensitivity. It is therefore difficult to ascertain definitive conclusions upon diagnostic value with these statistics. Nevertheless, we are able to conclude that MRA is specific and able to predict a negative result with smaller 95% confidence intervals, but it is limited as a diagnostic tool for HAGLs due to its poor ability to produce a definitive positive result. However, by performing a MRA, the shoulder can be examined for concurring pathologies, which may provide an alternative or concurrent diagnosis. A much larger scale study with greater number of cases assessing the diagnostic value of MRA for HAGL lesions is necessary to explore the true potential of MRA. An additional study comparing MRA and MRI would help establish any further benefit, if any, for the more invasive MRA.

Conflicts of interest

All authors have none to declare.

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Original Article

Arthroscopic fixation using TightRope device for acute acromioclavicular joint disruptions

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ABSTRACT

Background: Acromioclavicular (AC) joint dislocation is a common shoulder injury that affects young adults. The treatment of these injuries depends on dislocation grade, the patient's complaints and time since injury.

Materials: Patients with acute AC joint injuries (Rockwood grades III–V) of less than 4 weeks duration were included in the study. We had 10 cases of AC joint injuries, which fulfilled the inclusion criteria. All patients were diagnosed based on history, examination and plain radiographs. Grading was done based on plain radiographs. Patients with grades III–V were selected for TightRope fixation. All 10 patients with AC joint injury underwent arthroscopic AC joint fixation using TightRope. Functional outcome of patients was done using constant shoulder score preoperatively and postoperatively. All patients were followed up for at least one year. We were able to achieve satisfactory reduction in all the patients.

Results: Mean constant score at the final follow-up was 92.2 (range 76–97). The mean difference in constant score between operated and normal shoulder was 9.8. On the basis of difference of constant score, 7 patients had excellent results, 2 had good results and 1 had fair result.

Conclusion: Arthroscopic fixation of acute AC joint dislocation using the TightRope device is a simple, reproducible, minimal invasive technique that enables a rapid return to activity for the acute injury.

1. Introduction

Acromioclavicular (AC) joint dislocation is a common shoulder injury that typically affects young adults.[1,2] The treatment of these injuries depends on dislocation grade, the patient's complaints and time since injury. For Rockwood I and II dislocations, non-operative management shows very satisfying results. Acute Rockwood IV and V dislocations are a clear indication for surgery.[3] The treatment guidelines for Rockwood III dislocations are not uniform.[4] While some publications postulate conservative treatment to be superior, others report better outcome with operative treatment of Rockwood type III dislocations.[5,6]

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Conventionally open procedures have been considered as preferred modality of treatment in AC dislocations. However, recent years have seen an upsurge in the use of arthroscopic techniques for management of acute AC joint injuries.[7] A gold standard for the reconstruction of coracoclavicular (CC) complex is yet to emerge. Most techniques not only fail to recreate the original anatomy, but often involve the use of materials that are not strong enough to maintain the reduction during healing process.[7] A new option is offered by the TightRope™ system (Arthrex, Naples, USA), which consists of 2 metal buttons (1 circular and 1 oblong), joined by a continuous loop of Fibrewire suture.[8] The device can be used to fix the AC joint using an arthroscopic technique. This technique has been described as a simple, reproducible, minimal invasive procedure for acute AC joint fixation that enables a rapid return to activity for the acute injury. It also leaves minimal scarring and does not require any metalwork removal. We describe our experience of treating 10 patients with acute AC joint dislocation with arthroscopic TightRope™ fixation.

2. Materials and methods

This was a prospective study where the patients with AC joint injuries treated arthroscopically with TightRope™ fixation between January 2013 and September 2014 were assessed. The patients with acute AC joint injuries of Rockwood grades III, IV & V and less than 4 weeks duration were included in the study. Exclusion criteria were AC joint injury of more than 4 weeks duration, open injuries and injuries of Rockwood grade I, II and VI. A total of 10 cases aged between 18 and 40 years fulfilled the inclusion criteria. The patients were diagnosed based on history, examination and radiographs. Grading was done based on plain radiographs done in two planes. Arthroscopic TightRope™ fixation was done in all the cases.

2.1. *Surgical technique*

The patient was positioned in the lateral decubitus position under a general anaesthesia. Preoperative antibiotics were administered. A 30° arthroscope was introduced into the glenohumeral joint via a standard posterior portal. An anteroinferior portal was created near the tip of the coracoid with an outside/in technique, using the spinal needle to ensure that the base of the coracoid could be reached. An 8.25-mm twist-in cannula (Arthrex) was inserted through this portal, and the debridement of the rotator interval was done. A 4.5-mm full-radius shaver blade was introduced through the anteroinferior cannula and into the rotator interval and debrided until the tip of the coracoid could be visualized (Fig. 1).

A radiofrequency device and a 4.5-mm shaver were then used to expose the base of the coracoid and strip the bursa and periosteum to obtain a full view of the undersurface. The AC TightRope™ Constant Drill Guide with coracoid drill stop attachment (Arthrex) was prepared with the guide set at 80 and was inserted through the anteroinferior portal. We made certain that a sufficient bone bridge existed around the 4-mm reamed tunnel (Fig. 2).

The top of the guide was positioned over the distal clavicle directly over the coracoid and a 1.5-cm incision made and continued down to the clavicle. The guide was then positioned 3 cm from the AC joint on the superior surface of the clavicle.

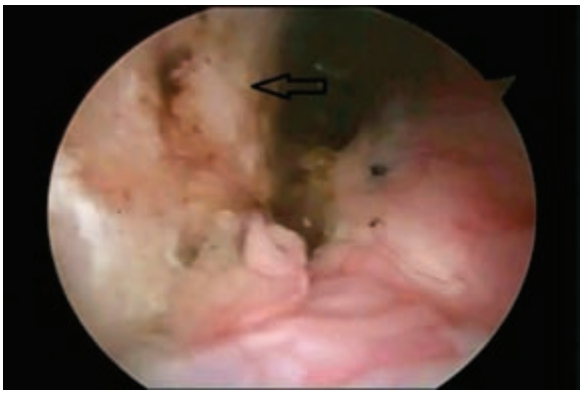

Fig. 1 – Arthroscopic view of base of coracoid after clearance of rotator interval.

Using a power drill, a 2.4-mm Drill Tip Guide Pin (Arthrex) was inserted into the guide pin sleeve and was advanced through the clavicle and coracoid. The drilling was stopped at the base of the coracoid. The position of the pin was checked in relation to the coracoid and, if incorrect, the guide pin was redrilled. The drill guide was removed, and the guide pin was left in situ. The drill guide was repositioned under the pin to keep it from advancing while reaming. The 4-mm cannulated drill was then passed over the pin and through the coracoid, again under direct vision. The pin was then removed, leaving the drill in situ.

A Nitinol Suture Passing Wire (Arthrex) was passed down through the drill and taken out through the anteroinferior portal using an arthroscopic grasper, leaving the suture loop superiorly. The drill was then carefully removed, leaving the wire in position. The 2 white traction sutures from the oblong button of the TightRope™ system passed through the wire loop of the Nitinol Suture Passing Wire, which was then drawn out of the anteroinferior portal under direct vision. Once the oval button was seen under the coracoid (Fig. 3), the trailing suture was used to flip it, locking it under the bone. Once the security of the button was confirmed, the clavicle was then reduced by the surgical assistant and was confirmed by fluoroscopy. When a satisfactory reduction was achieved, the

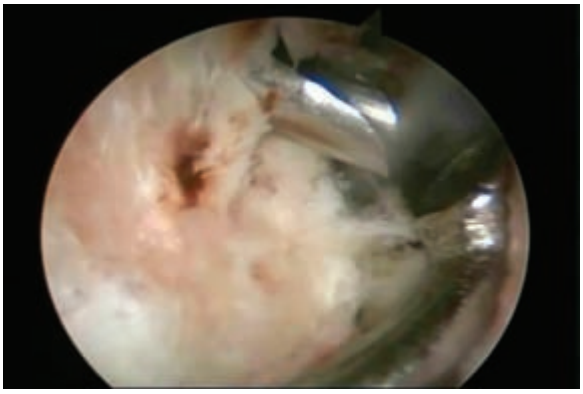

Fig. 2 – Drill guide passing through base of coracoid.

Fig. 3 – Oblong button at base of coracoid, arthroscopic view.

sutures were tied over the top of the superior button. The wounds were then closed and aseptic dressing done.

All patients had a standard postoperative rehabilitation. Patients were followed up at regular intervals till at least one year. Post-operatively, sling or shoulder immobilizer was used for 4–6 weeks to allow the reconstruction to heal. Passive and active assisted range of motion exercises was initiated as early as 7–10 days postoperatively. Strengthening exercises were typically avoided for 6 weeks. Patient was advised to avoid non-contact sports for 3 months and contact athletic activities for 6 months. Radiographs were obtained to ascertain the quality of reduction and maintenance of reduction in the post-operative period. Functional assessment of all the patients was done using constant shoulder score.

3. Results

The mean age of the patients was 32 years (range 24–40 years). There were eight male and two female patients. Average duration between injury and surgery was 16 days (range 6–28 days). Three patients had Rockwood type III AC dislocation while seven patients had type V dislocation. In seven patients, dominant extremity was involved while the remaining three had injured the non-dominant shoulder. Mode of injury was road traffic accident in 8 cases and direct fall on shoulder in 2 cases. All the patients were treated by arthroscopic TightRope™ fixation. Satisfactory reduction was achieved in all the cases. The mean duration of follow-up was 12.7 months (range 11–16 months). Mean constant score at the final follow-up was 92.2 (range 76–97). The mean difference in constant score between operated and normal shoulder was 9.8. On the basis of the difference in constant score between normal and operated sides, seven patients had excellent results, two had good results and one had fair result. There was one case of coracoid fracture at 4 weeks post-surgery in a 34-year-old male patient, which resulted in some loss of reduction. There was no case of implant loosening or osteolysis of clavicle. The details of the patients are provided in Table 1 and Fig. 4 shows pre- and post-operative clinical and radiological images.

4. Discussion

AC dislocation is one of the most common shoulder injuries seen in general orthopaedic practice. These are commonly seen in second and third decade of life. The average incidence is 9–12% of all injuries to the shoulder.[9] Males are more commonly affected, with male to female ratio of 5:1. The most common mechanism of injury is a fall with direct force to the lateral aspect of shoulder with the arm in adduction. Depending on the magnitude of trauma, this injury can be classified into 6 types.[10] Typically, Rockwood types I and II are treated conservatively, with most patients returning to pre-injury levels of activity.[11] Although the treatment of type III injuries is controversial, various methods have been described, such as an augmented suture with absorbable material, stabilization with k-wires in combination with or without additional wire loop, hook plate, or the Bosworth screw.[4,12–15,17] In low demand patients, satisfactory results can be obtained with conservative treatment. However, in younger patients and athletes with high physical demands, early operative stabilization is favoured by many surgeons to achieve good anatomic, functional and clinical results.

Acute surgical intervention is recommended for the more severe grades of AC joint dislocation (types IV–VI).[3] If the joint

Table 1 – Descriptives for the cases.

	Age	Sex	Mode of injury	Type of injury	Interval between injury and surgery (days)	Final follow-up (months)	Final CSS	Result	Complications
1	29	M	RTA	III	10	12	88	Good	Nil
2	24	M	RTA	V	6	14	94	Excellent	Nil
3	34	M	RTA	V	18	12	76	Fair	Coracoid fracture
4	29	M	RTA	III	17	12	95	Excellent	Nil
5	36	M	Fall	V	28	11	96	Excellent	Nil
6	34	F	RTA	V	24	14	89	Good	Nil
7	28	M	RTA	III	15	12	96	Excellent	Nil
8	40	M	RTA	V	10	12	95	Excellent	Nil
9	27	F	Fall	V	20	16	97	Excellent	Nil
10	39	M	RTA	V	12	12	96	Excellent	Nil

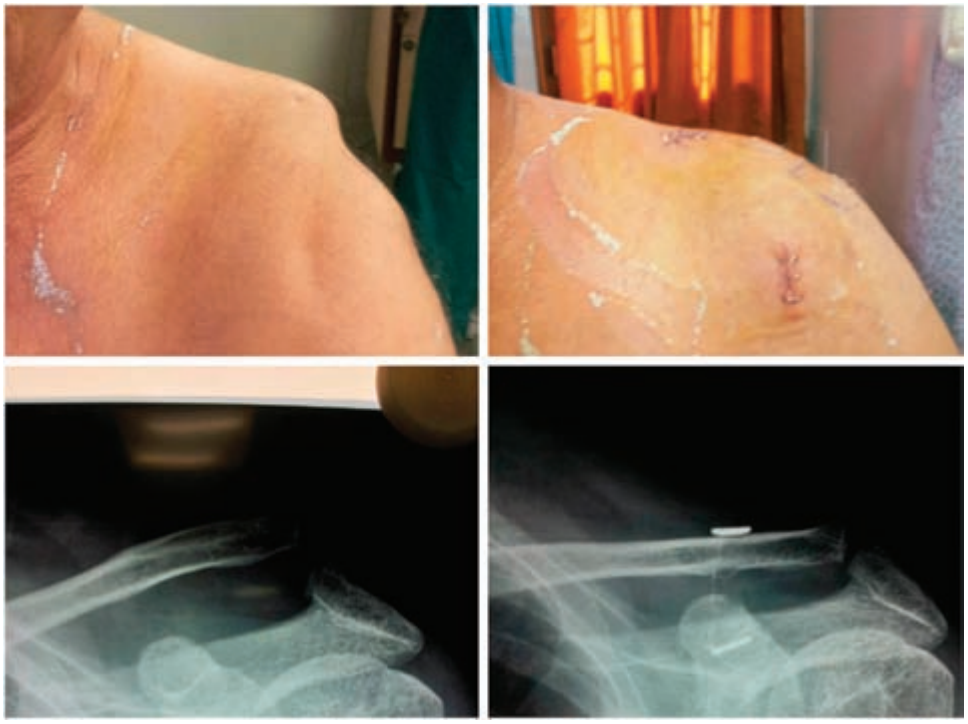

Fig. 4 – Pre-operative and post-operative, clinical and radiological pictures of type III acromioclavicular dislocation showing good reduction after fixation with TightRope™.

is reduced acutely and held reduced during the healing phase, the native ligaments can heal, thus restoring the stability of the joint. Currently, there are 4 main surgical treatment options for the dislocated ACJ: (1) primary fixation of AC joint (with pins, screws, suture wires, plates, hook plates) with or without ligament repair or reconstruction,[16] (2) primary CC interval fixation (with Bosworth screw, wire, fascia, conjoint tendon, or synthetic sutures) with or without incorporation of AC ligament repair/reconstruction,[7,17,18] (3) Excision of distal clavicle with or without CC ligament transfer[19,20] and (4) Dynamic muscle transfer with or without excision of the distal clavicle.[21]

Traditional open techniques leave a large scar and often require the removal of metalwork. Recently, a number of arthroscopic techniques have been described, but most are complex or necessitate passing material around the coracoids, with the subsequent risk of cutting through the bone and of damage to the brachial plexus as it passes medial to the coracoid.[7] Arthroscopic surgery causes less injury to the soft tissue envelope; however, it is limited by a steeper learning curve. Scheibel et al. and Walz et al. have published results following two bundle anatomic reduction of AC joint using a TightRope™.[22,23] They attempted at the replacement of both conoid and trapezoid part of ac joint using two separate tunnels and TightRope™ devices. Walz et al. have reported satisfactory clinical results at the end of 58 months. However, a biomechanical study done by Mazzocca et al. comparing single clavicular tunnel, double clavicular tunnel and Weaver Dunn procedure concluded that single and double clavicular tunnel has a higher load to failure for superior translation as compared to Weaver Dunn procedure.[24] The use of two clavicular tunnels did not have a significant advantage over single tunnel. Since the technique is relatively new, the literature on this technique is scarce. However, short-term results are available. A study conducted by Sameh A. El Sallakh with 10 patients with acute AC joint injuries stabilized with TightRope™ technique.[25] The mean follow-up period was 26.5 months. Average Constant score was 96.3 (range, 94–99) at last follow-up. The 10 patients were satisfied with their functional results and cosmetic appearance. Another study conducted by Thiel et al.,[26] for AC joint dislocations using TightRope™. Eleven patients had either Rockwood grade IV or V disruption. The majority of patients obtained satisfactory functional results according to the Simple Shoulder Test with 11 of 12 questions being answered positively and 11 of 12 patients were satisfied with the procedure. The rate of fixation failure was 16.6%. This case series revealed a high rate of fixation failure with the TightRope™ system. Still, most patients were satisfied with the procedure and achieved high functional shoulder results. Our results are comparable to those in the literature.[27,28] There was one case of coracoid fracture in our study. The fracture occurred at 4 weeks post-op resulting in shoulder stiffness and was managed conservatively. The failure was due to non-compliance of patient in post-operative period as he started strenuous manual work two weeks after surgery. He regained satisfactory range of motion gradually with physiotherapy and his constant shoulder score at one year was 76.

In acute injury, the AC joint can be reduced easily and held with strong AC TightRope™ fixation allowing the CC

ligaments to heal. As it is an elastic fixation, its removal is not required. Caution should be observed while drilling the tunnel in coracoids. It should be centred at the base or else may cause coracoid fracture. As it is a minimal invasive technique, recovery is relatively fast and the scars are cosmetically acceptable. Most patients scored high on functional scoring and were happy with both the functional and cosmetic results. The main drawbacks of our study were smaller sample size and relatively shorter follow-up. However, the early results with this small group were quite encouraging. Studies with larger number of cases, longer follow-up and control groups are needed to assess the long-term outcome and efficacy of this procedure.

5. Conclusion

Arthroscopic fixation of acute AC joint dislocation using the TightRope™ Device is a simple, reproducible, minimal invasive technique for acute AC joint fixation that enable a rapid return to activity for the acute injury.

Disclaimer

None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of an aspect of this work. In addition, none of the authors, or his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. Also, none of the authors has a patent or patents, planned, pending, or issued, that is broadly relevant to the work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work.

Conflict of interest

All authors have none to declare.

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Original Article

Arthroscopic stabilization of acute acromioclavicular joint dislocation with tightrope AC system: A tale of failures

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ABSTRACT

Background: Stabilization of acromioclavicular joint is a challenging technique with several methods described in literature from non-biological methods to biological fixation of AC joint. Arthroscopic fixation of AC joint is a newer technique with limited literature available. The aim of our study is to evaluate the results of arthroscopic stabilization of acute acromioclavicular joint with tightrope.

Methods: From February 2013 till August 2013, arthroscopic stabilization of acute ACJ dislocation was performed in 11 patients. The group consisted of eight men and three women with an average age of 34.2 years. The Rockwood type III to type V ACJ dislocations (III, 6; IV, 2; V, 3) were indicated for surgery. The average interval between injury and surgery was 5.4 days. In all cases, a second-generation tightrope implant was inserted by the Endobutton technique joining the distal end of the clavicle and the coracoid process. The results were evaluated using the UCLA Shoulder Scale at 10 months after surgery.

Results: All 11 patients returned to their preoperative activities without any restriction of shoulder motion within 5 months of surgery. The average postoperative UCLA score was 30.3 points (range 27–34). Radiographic evidence of the loss of partial reduction, with no effect on the clinical outcome, was recorded in 5 patients (45%) and loss of full reduction noted in 5 (45%) patients during postoperative rehabilitation. One patient was lost in follow-up.

Conclusion: Arthroscopic stabilization of acute ACJ dislocations using a single tightrope implant is a minimally invasive surgical technique, but less satisfactory result may be because of non-biological nature of fixation. Non-biological AC joint fixation is not a good method of fixation of a biological AC joint.

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Table 1 – Patient demographics and coracoclavicular distance measurements.

Patient	Age/sex	Occupation	Rockwood type	Coracoclavicular distance				Time of failure (months)	Reason of failure
				Preop	Normal/ Contralateral side	Postop	At one year		
1	30 y/M	Labourer	III	17	10	9	12	–	–
2	43 y/F	Labourer	III	19	9	9	15	3	Coracoid through
3	36 y/M	Labourer	V	20	9	9	11	–	–
4	31 y/M	Shop assistant	III	17	11	10	15	5	Coracoid through
5	33 y/F	Housewife	V	19	9	9	12	–	–
6	33 y/M	Labourer	III	18	10	9	12	–	–
7	48 y/M	Labourer	III	18	10	10	18	6	Coracoid through
8	38 y/M	Labourer	V	22	11	9	20	6	Clavicular erosion
9	25 y/M	Labourer	III	18	9	10	17	3	Coracoid through
10	49 y/M	Shop assistant	IV	20	11	10	16	2	Clavicular through
11	35 y/M	Housewife	IV	20	10	9	12	–	–

1. Introduction

Acromioclavicular joint (AC jt) injuries are one of the most common injuries of the shoulder joint in the young and active patient population.[1] The incidence of traumatic AC joint separation varies from 3 to 4 per 100,000 people with 25–52% of these occurring during sporting activities.[2] Most acromioclavicular (AC) joint injuries can be successfully treated non-operatively; surgery is usually needed for Rockwood grade IV–VI dislocations.[3,4] Treatment strategies to treat Rockwood grade III dislocations remain controversial and can be either conservative or surgery.[2] The principle is to reduce and temporarily fix the joint in place to allow healing of torn ligaments. Stabilization of acromioclavicular joint is a challenging technique with several methods described in literature from non-biological methods to biological methods.[5] The latter is a newer technique with limited literature available The metallic fixation materials often loosen and will usually impair shoulder joint function; therefore, pins, screws or plates must be removed 6 weeks to 12 weeks after surgery, which occasionally leads to recurrence of dislocation or subluxation.[6] Some studies have suggested that sutures may be used to permanently replace coracoclavicular ligaments.[7,8] Arthroscopic fixation of acromioclavicular joint is a relatively new technique with conflicting results.

The present study aimed to assess the radiological and functional results of using arthroscopy-assisted coracoclavicular flip button device (tightrope) repair for Rockwood grade III to V AC dislocations.

2. Materials and methods

A series of 15 consecutive patients were treated prospectively for acute acromioclavicular joint dislocation from February 2013 to August 2013. In all cases, a second-generation tightrope implant was inserted by the Endobutton technique joining the distal end of the clavicle and the coracoid process. Inclusion criteria were a completely acute traumatic AC jt dislocation (Rockwood grade III to V), age between 18 and 45 years and a minimum of one-year follow-up. Exclusion criteria were associated lesions, low functional demand patients and surgery delay more than one week. We excluded 4 patients: 1 patient had associated greater tuberosity fracture, 1 patient was operated after 7 days and two patients were low demand patients. This left us with 11 patients. Data were collected and include gender, age at the time of surgery, injury mechanism, Rockwood classification and complications. Coracoclavicular distance was measured and compared to the other side (Table 1). Patients with at least one-year follow-up were included in this study.

All patients were evaluated clinically and radiologically using Constant–Murley score (Table 2). Anteroposterior radiographs were obtained for both clavicles and AC joints at preop, postop, 6 weeks and 6-month interval. Coracoclavicular distance was measured and compared to normal side. All analyses were performed using SAS statistical software (SAS 9.2, Cary, NC). Reduction of AC joint was assessed using coracoclavicular distance.

2.1. *Surgical technique*

The arthroscopic procedure was performed in lateral position under general anaesthesia. Three portals were used: a posterior portal, an anterolateral portal for the optical device and an operative anterosuperior portal. The glenohumeral joint was explored using posterior portal. The anterolateral portal was used to explore the lateral and upper surfaces of the coracoid, whereas the anterosuperior portal was used to introduce a radiofrequency device to clean the lateral and inferior coracoid side. A 4-mm dedicated C-ring drill guide was introduced into the anterosuperior portal and under the coracoid. A small incision of 2 cmm was made to expose the distal clavicle. The guidewire was directed from the posterior site of the clavicle to the coracoid base as close as possible to the coracoid centre under arthroscopic visualization. Then, a

Table 2 – Summary of Constant–Murley score.

Constant and Murley score	No of patients (%)
Excellent	0 (0%)
Good	1 (9%)
Satisfying	8 (72%)
Poor	2 (18%)

Fig. 1 – Six months postoperative AP radiograph of the tightrope.

4.5 mm cannulated drill pin was introduced through the clavicle and the coracoid. A tightrope (Arthrex, Naples, FL, USA) was pulled under the coracoid base using nitinol wire loop. It was then flipped under arthroscopic control. Reduction was confirmed fluoroscopically and the sutures tightened on the circular clavicular button (Fig. 1). Wound was then closed in layers.

Postoperatively, all patients were placed in a sling immobilizer for 4–6 weeks. Gentle pendulums and Codman's were begun postop day 1. Passive shoulder motion was started at 4 weeks (elevation <90), with full active motion at 6 weeks. Patients were allowed to return to manual work or sports at 4–5 months depending on the rehabilitation.

3. Results

There were eight men and three women. Average age of the patients was 34.2 years. According to Rockwood classification, there were 6 type III, 2 type IV and three type V. The mechanism of injury was bicycle accident in two, motor vehicle accident in seven and fall from height in two. The average interval between injury and surgery was 5.4 days. Mean coracoclavicular distance preoperatively was 18.9 (1.4) mm. Postoperative radiographs showed that reduction was good in all patients. Postoperative coracoclavicular distance was 11(0.5) mm.

The overall mean follow-up time was 12 months. The mean constant score was 82 ± 0.84. One (9%) patient rated the outcome as good, 8 (72%) rated it as satisfactory and 2 (18%) rated it as poor (Table 1). Mechanism of injury and modes of failure are summarized in Table 2. Two patients showed loss of full reduction and they were reoperated with double suture button (Dog Bone Button, Arthrex). All patients except one, who underwent resurgery, returned to their previous occupation.

4. Discussion

The management of acromioclavicular joint disruptions is continuously evolving. Various surgical options have been described for this injury. Traditionally done open techniques are being replaced by arthroscopic fixation. Arthroscopic stabilization of acute AC joint dislocation is a minimally invasive procedure providing the coracoclavicular ligament complex with dynamic stability. The tightrope is a device originally described for reduction and fixation of tibiofibular syndesmosis. However, few studies have described the results of arthroscopic fixation of AC jt injury using tightrope.[9–11]

In our study, although initial reduction was good in all of the patients, however, radiologically failure occurred in 54% of patients. This cannot be attributed to technical failure since technical failure occurs within one month of surgery. Therefore, the reasons for failure of reduction were considered most probably due to non-distribution of stress forces onto a single suture button (AC tightrope) leading to clavicular or coracoid side pull through.

Similar to our study, other authors have also reported high failure rate. In a study by Lim et al., eight patients with an acute acromioclavicular joint injury were managed with implantation of one tightrope device. The patients were followed for a minimum of 6 months. They noted a 50% fixation failure rate, with loss of reduction occurring between the second and sixth postoperative weeks. Retrieved specimens revealed suture abrasion that was postulated to be the mechanism of failure. At final follow-up, 4 of the 8 patients had uneventful recovery with no pain and resumption of full duties.[13] Thiel et al. reported a failure rate of 16.6% in their series.[11] El Sallakh studied 10 patients and reported only one failure of fixation, which was the result of a technical error.[10]

Despite high rate of failure/loss of reduction, as observed on follow-up radiographs, this was not accompanied by any clinical problems and functional results, as measured by Constant–Murley score. The score was satisfactory in most but not excellent. This is consistent with the observations of other authors. Biomechanical studies have shown that tightrope has comparable biomechanical properties to the native coracoclavicular ligaments. Still tightrope has a high failure rate.[14,15]

The use of double tightrope may decrease the failure rate as shown by recent studies. However, loss of reduction has also been observed with the use of two tightropes. The double tightrope reconstruction technique more closely recreates the anatomy of acromioclavicular joint and the coracoclavicular complex. Salzmann et al. reported results of 23 patients of AC jt injury treated with 2 tightrope devices. At a mean follow-up of 30 months, they noted significant improvement in visual analogue scale and Constant–Murley scores. Postoperative radiographs showed unsatisfactory alignment in 8 cases. However, they noted no difference in clinical outcome compared to the patient who maintained reduction.[16] Scheibel et al. in their series of 28 patients of AC jt injuries managed with double tightrope showed good to excellent early results in all patients without any case of implant failure. However, 43% of their patients had posterior instability. To avoid this, they recommended addition of a percutaneous image intensifier controlled acromioclavicular cerclage in addition to the coracoclavicular stabilization.[12] The use of double tightrope has certain disadvantages, such as higher risks of coracoid fracture, extension of operative time and higher costs.

The principal limitation of this study is the small sample size and lack of control.

5. Conclusion

Arthroscopic stabilization of acute ACJ dislocations using a single tightrope implant is a minimally invasive surgical technique but with less satisfactory result, and may be because of non-biological nature, technical failure or implant failure.

Conflicts of interest

All authors have none to declare.

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Original Article

Comparison of CT-based patient-specific templating and digital radiography templating in total knee arthroplasty

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ABSTRACT

Aim: The aim of the prospective study is to evaluate and compare the accuracy of digital templating and CT-based templating in preoperative planning, in determining the size of the femoral and tibial component in total knee arthroplasty.

Materials and methods: A prospective study was conducted to compare the accuracy in predicting the size of the prosthetic components in total knee replacement in 81 patients. Preoperatively, all the patients underwent the same standard protocol including digital radiographs with calibration and a CT scan. A dedicated IMPAX digital software was used to template the radiographs. The CT-based planning was performed on 3D reconstruction of CT scans as per standardized protocol for patient-specific instrumentation.

Result: The planning of digital radiography indicates the correct size in 71% of the cases for the femoral component and 47% for the tibial component. CT-based planning reached an accuracy of 93% for the femur and 54% for the tibia in predicting the exact size. The accuracy reaches 100% for both components if considered the maximum error of one size in CT-based planning. There were no surgical complications in any of the cases.

Discussion: The improvement in the ability to predict the size of the prosthetic components obtained by the CT images is statistically significant compared to that obtained by the radiographic study to predict the size of the tibial and femoral component. CT can indicate the number of size within the maximum error of measurement of one size in 100% of cases and this can be helpful to the surgeon and the organization in terms of trays to be sterilized, OR turnover, and cost savings. It appears that CT-based patient-specific templating is relatively easy to use, less invasive, saves time, and improves the accuracy in the positioning of the prosthetic components.

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1. Introduction

Accurate alignment and positioning of implants in total knee arthroplasty (TKA) is an important goal of the procedure.[1–7] Numerous studies have demonstrated a high frequency of implant malalignment in TKA, regardless of the surgical techniques utilized.[8–10] The innovation cycle of TKA has mirrored this fundamental concept. Initially, free-hand surgical cuts were performed prior to the placement of implant components. Subsequently, mechanical alignment guides were devised based on bony or external landmarks, and predetermined angular or measured resections were performed. More recently, imageless computer navigation systems have been developed to guide the surgical procedure and ultimate component alignment. The most recent innovation in TKA is patient-specific instrumentation (PSI), which has been introduced as a next generation technology in an effort to further improve the accuracy and precision of surgical technique, implant placement, and alignment. The advantages of PSI include normal realignment of the mechanical axis, minimized resection of the patient's bony tissue, reduced perioperative and postoperative blood loss, and reduced thromboembolic complications.[11–13]

An anticipated advantage of the PSI technology is the decrease in the number of trays to be sterilized for every TKA and hence the related cost benefit. But this depends on the accuracy of the technology to predict the exact size of the implant to be used. PSI may potentially achieve more reliable alignment parameters, decrease operative time and blood loss, and increase efficiency when compared with conventionally instrumented TKA.[1,14–18] However, a previous report[18] suggested that frequent intraoperative surgeon-directed changes may still be required. Thus, there is a need for more evidence-based data that evaluate and quantify the accuracy and reliability of CT-based templating in PSI.

Aim of this prospective study is to evaluate and compare the accuracy of two different types of preoperative planning, in determining the size of the femoral and tibial component in TKA. The two compared techniques were digital radiography and CT-based PSI (Fig. 1). Specifically, we asked the following questions:

(1) What percentage of times was the preoperative plan able to accurately predict the actual size of the implanted femoral or tibial components?
(2) What percentage of knees was implanted without any changes?

2. Materials and methods

A prospective study was conducted to compare the accuracy in predicting the size of the prosthetic components in total knee replacement in 81 patients diagnosed with primary and symptomatic osteoarthritis of the knee. Inclusion criteria were ''Easy Knee'': BMI ≤35, varus/valgus deviation ≤15°, and residual flexion of the knee ≥90°.

Out of 81 patients, 37 were women and 44 were men; mean age was 68.5 years, the range extended from 53 to 79 years. In 48 cases, right side was involved, while in other 33 cases, left side was involved.

The mean hip–knee–ankle (HKA) angle is 177.4° and range was from 172 to 184°. Preoperatively, all the patients underwent the same standard protocol including digital radiographs with calibration and a CT scan. A dedicated IMPAX digital software (Agfa-Gevaert, NV, USA) was used to template the radiographs. On these radiographs, a sphere, 25 mm in diameter (size suggested by the manufacturer of the software), was included, which is necessary in order to properly calibrate the images and avoid systematic errors due to radiographic magnification, that is variable between the different radiographs. The best position of the sphere is medial or lateral to the knee, as close as possible to the bone level. After drawing all the axes for femur and tibia, the best fitting component is selected according to the make, model, and size of the implant.

The CT-based planning was performed on 3D reconstruction of CT scans of three joints: hip, knee, and ankle, as established in standardized protocol to build up patient-specific cutting mask (MyKnee, Medacta, Castel S. Pietro, Switzerland). All the surgeries were performed by two senior authors (M.A. and N.C.) using the same implant, and the definitive component sizes implanted were registered and

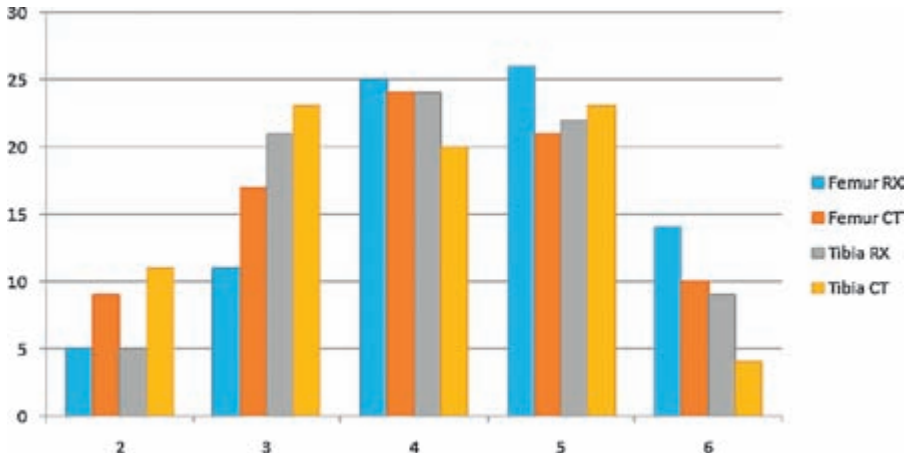

Fig. 1 – Comparison of the size of the femoral and tibial component predicted by X-ray and CT templating.

compared with the sizes suggested by both planning techniques considering also the range of error. Results' analysis was carried out using nonparametric tests.

3. Result

The planning of digital radiography indicates the correct size in 71% of the cases for the femoral component and 47% for the tibial component. The accuracy reaches 92–95% for both components if we consider the maximum error of one size. By evaluating the correlation of the two components together, it appears that in 65% of cases the planning digital X-ray shows exactly the prosthetic components to be implanted; this percentage becomes 93% when considering a margin of error of up to one size (Table 1).

CT-based planning reached an accuracy of 93% for the femur and 67% for the tibia considering the exact size. The accuracy reaches 100% for both components if considered the maximum error of one size. By evaluating the correlation of the two components together, it appears that in 80% of cases, the CT-based planning predicts exactly the prosthetic components to be implanted; this percentage becomes 100% as a margin of error of up to one size (Table 1).

The mean postoperative HKA angle was 177.53° (range: 173–183).

There is a statistically significant difference in X-ray-based planning and CT-based planning for predicting femur size ($p < 0.01$), while there was no statistical significance as far as tibia was concerned. When comparing both femur and tibia, CT-based planning showed statistically significant accurate results compared to X-ray planning ($p < 0.01$).

There were no surgical complications, including bleeding, wound complications, arterial or venous thromboembolic disease, vascular injury, neural deficit, ligament injury, instability, stiffness, fracture, infection, osteolysis, or implant loosening during any of the cases.

4. Discussion

The digital templating is a technique of preoperative study used to try to predict in advance the size of the prosthesis to be implanted. This method is spreading in orthopedic surgery and has largely replaced the study of analog X-rays and acetate templating.

Several studies have shown a good ability to predict, through planning of digital radiography, the size of the tibial and femoral components of the prosthesis to be implanted.[19–21] In addition, the planning can provide an estimate of the angle of the bone cuts to be performed in the operating room, which can help in making a decision on how to proceed during surgery. It also allows for prevention of possible errors or technical difficulties at the time of surgery.[20]

However, previous studies have suggested that templating with regard to implant size selection may provide inaccurate results and the findings are not reproducible (Table 2).[22–26]

Trickett et al.[22] showed accuracy to the exact size by 50%, rising to 98% if we considered a maximum error of one size. The femoral component was generally scheduled with higher accuracy compared to that of the tibial component.

Heal and Blewitt[23] found preoperative radiological templating to be accurate in just 57% of cases and thus questioned its usefulness in preoperative management.

Hsu et al.,[26] studying 48 patients undergoing total knee replacement, as well as confirming that 54% of the size of the prosthesis was correctly predicted by the digital templating, also stated that there were no statistically significant differences when digital planning was done by an experienced surgeon in prosthetic surgery of the knee than one with less experience.

Kobayashi et al.[27] have finally compared the accuracy of traditional two-dimensional X-ray and three-dimensional CT scan, while getting superior results with CT, and showed that the improvement was not statistically significant and this would seem to indicate the non-necessity of preoperative CT scan in TKA.

It is therefore unclear whether these emerging technologies offer a real cost benefit or result in an improved outcome. Hence, the present study tried to evaluate the usefulness and reliability of the preoperative CT-based templating to predict the component size compared to the digital templating.

In our study, the improvement in the ability to predict the size of the prosthetic components obtained by the CT images is statistically significant compared to that obtained by the radiographic study to predict the size of the tibial and femoral component.

In fact, it was possible to predict the size of the prosthetic implant with digital radiograph in 72% of cases for the femoral

Table 1 – Correlation between the X-ray and CT-based template size and final implant size used.

Planning error (no. planned size vs installed size)	Femur and tibia		Femur		Tibia	
	Rx	CT-based	Rx	CT-based	Rx	CT-based
−2	0	0	0	0	0	0
−1	18 (11.2%)	26 (16.0%)	1 (1.2%)	2 (2.5%)	17 (21.0%)	24 (29.6%)
0	105 (64.8%)	130 (80.2%)	58 (71.7%)	76 (93.8%)	47 (58.0%)	54 (66.7%)
+1	28 (17.2%)	6 (3.8%)	15 (18.5%)	3 (3.7%)	13 (16.0%)	3 (3.7%)
+2	11 (6.8%)	0	7 (8.6%)	0	4 (5.0%)	0
Overall	162	162	81	81	81	81
Within ±1	151 (93%)	162 (100%)	73 (90%)	81 (100%)	77 (95%)	81 (100%)
Over ±1	11 (6.7%)	0	7 (8.6%)	0	4 (4.9%)	0

Table 2 – Literature review of studies related to accuracy of digital templating in TKA.

References	Patients (N)	Exact femur (%)	±1 femur (%)	Exact tibia (%)	±1 tibia (%)
Miller and Putill[28]	25	52	100	48	96
The et al.[29]	65	55	92	52	94
Trickett et al.[22]	40	48	98	55	100
Kniesel et al.[30]	46	43	97	71	98
Hsu et al.[26]	82	83	100	90	100
Hsu et al.[26]	48	58	96	50	88
Levine et al.[31]	176	69	100	63	97
Peek et al.[25]	92	71	100	60	100
Specht et al.[19]	50	48	92	52	94
Del Gaizo et al.[20]	76	66	99	66	97
Overall	700	63	98	63	97

component and 58% for the tibial component, the accuracy reached 94% and 67%, respectively as predicted by the CT. It can be concluded from the study that the data obtained by CT provide the surgeon with greater safety in deciding the size of the prosthetic components.

Another conclusion obtainable from the study is that CT can indicate the number of size within the maximum error of measurement of one size in 100% of cases, and this can certainly be helpful to the surgeon in planning the prosthesis to be implanted, also at organizational level, it ensures access to the necessary size and can save time and cost in the preparation of the operating room and sterilization of necessary trays and also reduces the risk of infection.[26]

Regarding costs, they are definitely smaller than the computer-assisted surgery, while, compared with the traditional. It is difficult to evaluate, since, if on the one hand, the technology PSI has increased spending for the CT or MRI and for the creation of templates cutting, on the other hand, there is a saving linked to the lesser quantity of material to be sterilized and especially the reduction of the surgical time and risk of infection.[26]

However, all the obtained information is subject to various limitations.

First, the relative narrowness of the sample is definitely the basis of this lack of significance.

Also our study only concerns the accuracy of the implant size selection in preoperative templating and does not refer to the overall planning of the TKA procedure regarding component placement and alignment.

Another limitation in the data analysis is the significant difference between the accuracy that the CT demonstrates in determining the size of the femoral component, which reaches 94%, when compared to the 67% achieved for the tibial component. This remarkable difference is hard to justify. Perhaps, it is due to the different reference taken by the surgeon during preoperative planning and intraoperatively to determine the rotational alignment of the tibial component. Another possible explanation is searchable in the fact that the surgical saw used to perform the bone cutting has a margin of movement which, although minimal, is still present and can vary its inclination, thus making the surface of bone also different from cover with the prosthetic component.

A further explanation that tries to explain the difference described is represented by the possibility that during the intervention, the surgeon might have needed to refine the tibial cut to lower the joint line, to allow better alignment with the femoral component or to improve the ligament balancing. Finally, the manufacturer of the masks and cutting of the prosthesis states that the software is designed in such a way that, if the size of prosthetic seems to fall in the middle between two measurements, the lower size is selected by default.

Overall, therefore, with the first data available in the literature, it appears that technology-based patient-specific templating is relatively easy to use, less invasive, saves time, and improves the accuracy in the positioning of the prosthetic components.

The sample of patients present in the literature studies is limited, and for now, although the results appear better than the conventional method, it is necessary to extend such studies both with regard to the number of subjects and with regard to the period of follow-up. In our study the accuracy of the X-ray planning using dedicated software confirms the results obtained by other studies in the literature. Likewise the CT-based planning does provide significant more accurate data and the error is never more than one size. Further studies are needed to evaluate potential economical advantages in term of reducing hardware and sterilization costs in the operating theater despite more expensive exams.

Conflicts of interest

All authors have none to declare.

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Original Article

A radiological comparative study between transtibial & anteromedial portal drilling of femoral tunnel in single bundle anterior cruciate ligament reconstruction: A comparison of four angles

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ABSTRACT

Femoral tunnel drilling for graft insertion is performed by transtibial or transportal technique.

Aim: Main objective of this study was to compare the postoperative anteroposterior and lateral radiographs after arthroscopic ACL reconstruction by transtibial and transportal techniques by measuring four angles.

Materials and methods: A retrospective study of 60 patients was conducted, who were further subdivided into two groups containing 30 each. The first group had patients who had undergone arthroscopic ACL reconstruction by transtibial technique and the second group had patients who had undergone ACL reconstruction by transportal technique. Post-operative anteroposterior radiographs (AP) and lateral radiographs of the operated knees were compared. Condylar tunnel (CT) and tunnel screw (TS) angles were measured in AP radiographs and compared. In lateral radiographs, shaft tunnel (ST) and TS angles were measured and compared. 'Student *t*-test' was used in calculating the results.

Results: Mean of the angles measured were tabulated and compared. CT angle was noted to be more acute in transportal group ($38.4 \pm 8.756^{\circ}$) as compared to transtibial group ($46.97 \pm 12.754^{\circ}$) with a significant '*p*-value' (0.004). ST angle was noted to be more obtuse in the transportal group ($119.57 \pm 11.212^{\circ}$) as compared to transtibial group ($113.17 \pm 12.793^{\circ}$) with a significant '*p*-value' (0.044).

This infers that transportal technique oriented the graft more horizontal as compared to transtibial technique.

Tunnel screw angles when compared in AP radiographs showed that transportal technique ($5.5 \pm 4.644^{\circ}$) had more acute angulation as compared to transtibial group ($12.57 \pm 8.287^{\circ}$) with a significant '*p*-value' (<0.001). Same results were obtained when the lateral

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views were compared between transportal (9.27 ± 8.25°) and transtibial technique (23.73 ± 12.174°) with a significant '*p*-value' (<0.001). This indicated reduced screw tunnel divergence in transportal technique as compared to transtibial technique.

Conclusion: Transportal technique results in a more anatomical femoral tunnel placement as compared to transtibial technique.

1. Introduction

There has been evolution over the ages for techniques and methods of anterior cruciate ligament reconstruction. The prime concern has been to bring about anatomical placement of the graft in the knee. The anatomical placement improves the anteroposterior translation and reduces the pivot shifting, thereby providing better rotational stability and reducing posterior cruciate ligament impingement.[1–7] The transtibial technique employs drilling of the femoral tunnel through a pre-drilled tibial tunnel. Whereas the transportal technique is independent of any pre-drilled tunnel.[8] The angulation of the femoral tunnel in the transtibial technique depends on the angulation of the pre-drilled tibial tunnel.[9–11] Several anatomical studies have reported that the ACL lies deep and low on the medial wall of the lateral femoral condyle in its femoral attachment.[12,13] Musahl and colleagues reported that a tunnel position inside the anatomical footprint of ACL brings about knee kinematics almost similar to that of the intact knee.[4]

The length of the graft changes when the knee flexes and extends. This has more effect on the femoral attachment than the tibial attachment, even minimal displacement along the Blumensaat's line is particularly significant.[5,14,15] Graft healing is affected as there can be abnormal tensile and compressive loads in a non-anatomically placed graft.[16]

2. Aims and objectives

(a) To radiographically compare femoral tunnel position by use of transportal versus transtibial technique in primary single bundle ACL reconstruction.
(b) To test the hypothesis that transportal technique could afford a better femoral tunnel position than the transtibal technique.

3. Materials and methods

A retrospective study was conducted in our centre of a total of 60 patients who had undergone arthroscopic ACL reconstruction by transtibial and transportal technique from January 2012 to January 2015. All the cases had undergone femoral graft fixation by titanium interference screws. The details and post-operative X-rays of these patients were collected. The inclusion criteria of the study included skeletally mature patients with normal bony anatomy, with no associated joint pathology or associated bony injuries. The 60 patients were subdivided into two groups of 30 patients each. The first group included patients who underwent ACL reconstruction by transtibial technique and the other group who underwent ACL reconstruction by transportal technique.

Four angles were calculated in these patients in the post-operative anteroposterior and lateral radiographs.

In the anteroposterior (AP) radiograph:

(a) The condylar tunnel (CT) angle
(b) The tunnel screw (TS) angle

In the lateral radiograph:

(a) The shaft tunnel (ST) angle
(b) The TS angle

CT angle: This angle was measured in the post-operative anteroposterior radiographs. A straight line was drawn joining

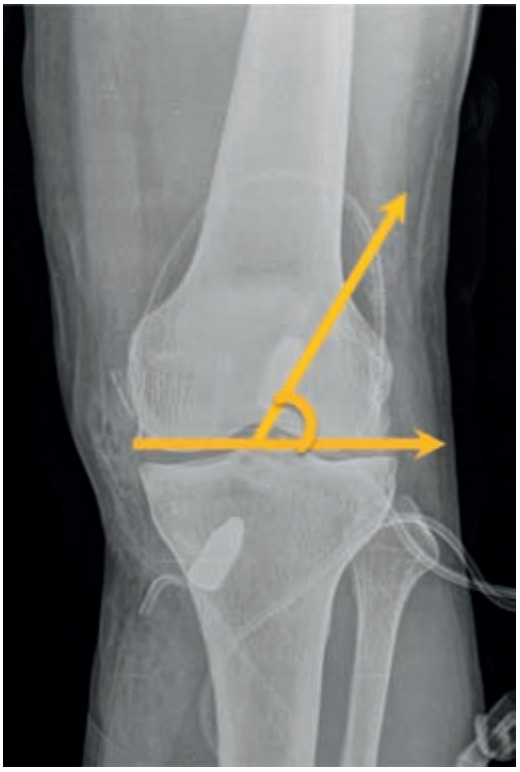

Fig. 1 – Anteroposterior radiograph of left knee indicating the measurement of the condylar-tunnel angle. This is formed by a line drawn across the condyles of the femur and one line across the long axis of the femoral tunnel and the acute angle formed is measured.

Fig. 2 – Lateral radiograph of left knee indicating the measurement of the shaft-tunnel angle. This is formed by a line drawn across the long axis of the femoral shaft and one line across the long axis of the femoral tunnel and the obtuse angle formed is measured.

Fig. 3 – Anteroposterior radiograph of left knee indicating the measurement of the tunnel screw angle (divergence angle). This is formed by a line drawn across the long axis of the femoral tunnel and one line across the long axis of the interference screw and the acute angle formed is measured.

both the femoral condyles. A second line straight line was drawn across the long axis of the femoral tunnel. The acute angle subtended by the intersection of these two lines formed the CT angle (Fig. 1).

The ST angle: This angle was measured in the post-operative lateral radiographs. A straight line was drawn along the long axis of the femoral shaft in the lateral view. A second line was drawn along the long axis of the femoral tunnel. The obtuse angle subtended by the intersection of these two lines formed the ST angle (Fig. 2).

The TS angle: This angle was measured in both anteroposterior and lateral radiographs. A straight line was drawn along the long axis of the femoral tunnel. The second line extended along the long axis of the screw. The angle subtended by the intersection of these two lines formed the TS angle (Figs. 3 and 4). It is also termed as the 'divergence angle'.

All the results were tabulated and the mean was compared statistically using the 'Student *t*-test'.

4. Results

All the results were tabulated and compared using the 'Student *t*-test' (Table 1).

On comparing the CT angles in anteroposterior radiographs, a mean of 46.97 ± 12.754° was noted for the transtibial

Table 1 – Table indicating the mean and '*p*-values' calculated for all the four angles measured in anteroposterior and lateral radiographs.

	Group	*N*	Mean	Std. deviation	*t*	df	*p* value
Condylar-tunnel angle	Transportal	30	38.4	8.756	−3.033	58	0.004
	Transtibial	30	46.97	12.754			
Anteroposterior tunnel-screw angle	Transportal	30	5.5	4.644	−4.075	45.582	<0.001
	Transtibial	30	12.57	8.287			
Lateral tunnel-screw angle	Transportal	30	9.27	8.25	−5.388	58	<0.001
	Transtibial	30	23.73	12.174			
Shaft-tunnel angle	Transportal	30	119.57	11.212	2.061	58	0.044
	Transtibial	30	113.17	12.793			

Fig. 4 – Lateral radiograph of left knee indicating the measurement of the tunnel screw angle (divergence angle). This is formed by a line drawn across the long axis of the femoral tunnel and one line across the long axis of the interference screw and the acute angle formed is measured.

group and 38.4 ± 8.756° for the transportal group. This indicated that the CT angle was more acute and horizontal for the transportal technique than transtibial technique (Fig. 5). When the mean of ST angle was compared between transtibial and transportal techniques in the lateral radiographs, it was noted that the ST angle in the transportal technique had a mean of 113.17 ± 12.793° in the transtibial technique and 119.57 ± 11.212° for the transportal technique. This showed that the angle was more obtuse in the transportal

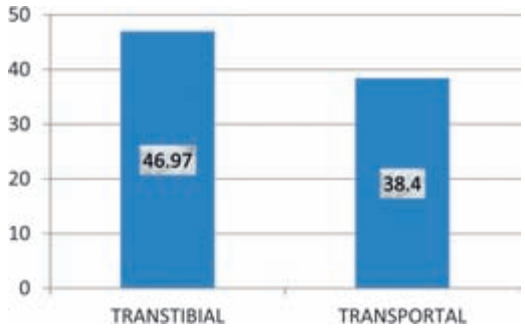

Fig. 5 – Bar graph showing the comparison of the condylar tunnel angles of the two techniques. The *x*-axis represents the technique employed and the *y*-axis represents the mean calculated. It can be noted that the transportal technique brought about a more acute and horizontal femoral tunnel angulation.

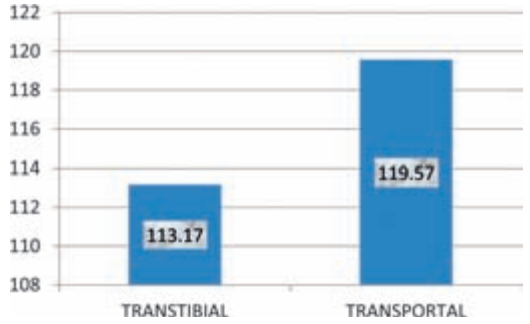

Fig. 6 – Bar graph showing the comparison of the shaft tunnel angles of the two techniques. The *x*-axis represents the technique employed and the *y*-axis represents the mean calculated. It can be noted that the transportal technique brought about a more obtuse and horizontal femoral tunnel angulation.

technique (Fig. 6), which indicated that the graft was horizontal in transportal technique. On comparing the TS angles in the anteroposterior radiographs, a mean of 12.57 ± 8.287° was noted for the transtibial technique and 5.5 ± 4.644° for the transportal technique (Fig. 7). This indicated a more acute angulation in the transportal technique, i.e.; reduced screw-tunnel divergence.

On comparing the TS angles in the lateral radiographs, the mean was noted to be 23.73 ± 12.174° in transtibial technique and 9.27 ± 8.25° in the transportal technique, also indicating reduced screw-tunnel divergence (Fig. 8).

5. Discussion

Our study reported a more vertically placed graft in the transtibial technique as compared to the transportal technique. Cain and Clancy reported a vertical placement of the graft in the femoral tunnel after transtibial technique of femoral tunnel drilling and also added that the tunnel was noted not to be centred on the native ACL footprint which

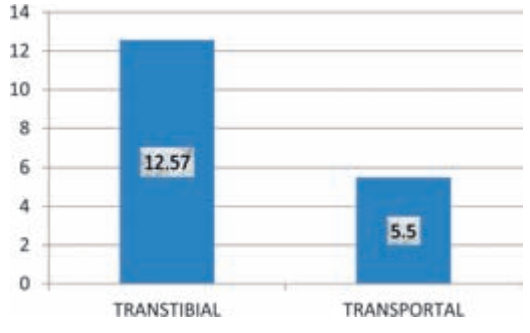

Fig. 7 – Bar graph showing the comparison of the tunnel screw angles in the anteroposterior radiographs of the two techniques. The *x*-axis represents the technique employed and the *y*-axis represents the mean calculated. It can be noted that the transportal technique brought about a more acute femoral tunnel angulation, thereby indicating a reduced screw tunnel divergence.

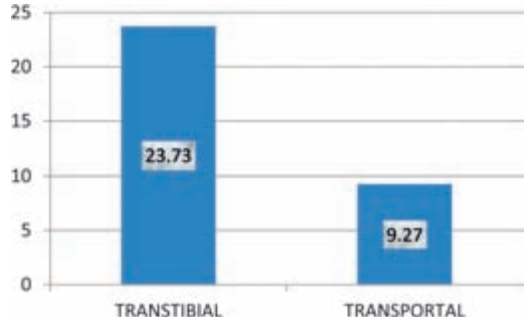

Fig. 8 – Bar graph showing the comparison of the tunnel screw angles in the lateral radiographs of the two techniques. The *x*-axis represents the technique employed and the *y*-axis represents the mean calculated. It can be noted that the transportal technique brought about a more acute femoral tunnel angulation, thereby indicating a reduced screw tunnel divergence.

could result in increased pivot shift.[17] Lee and colleagues reported that a subset of patients with vertically oriented grafts had poorer Lysholm scores as compared to ones with the more horizontally oriented grafts. They also added that this could result in reduced rotational stability.[18]

In transtibial technique, there is a tendency to place femoral tunnel more posteriorly.[19–22]

Kopf et al. compared tibial tunnel position in transtibial single bundle ACL reconstruction with cadaveric native ACL tibial footprint using CT scan. They concluded that anteroposterior position of tunnel in sagittal plane (48%) was significantly more posterior than the native anteromedial bundle footprint (25%).[21]

Steiner et al. performed ACL reconstructions using transtibial and transportal techniques on ten pairs of cadaveric knees. The graft placement was evaluated under direct vision. It was noted that there was more posterior placement of graft as compared to the transportal technique.[23]

There are studies which have reported that the anteromedial portal decreases graft tension and posterior cruciate ligament impingement as compared to transtibial technique.[24,25]

The results of this study indicate that both the angles prove horizontal position of the femoral tunnel using transportal approach. This supports the hypothesis that the use of a transportal approach in preparing the femoral tunnel in single bundle ACL reconstruction will result in a superior femoral tunnel position when compared with the transtibial technique.

6. Conclusion

Drilling of the femoral tunnel through the transportal technique enables a more horizontal and anatomical placement, resembling the native ACL of the femoral tunnel position with reduced screw-tunnel divergence when compared with the transtibial technique.

Conflicts of interest

All authors have none to declare.

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Original Article

Mucoid degeneration of the anterior cruciate ligament: Partial arthroscopic debridement and outcomes

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ABSTRACT

Background: Mucoid degeneration of the anterior cruciate ligament (ACL) is a common pathology but is often unknown and underdiagnosed. Mucinous material within the substance of ACL produces pain and limited motion in the knee. The purpose of this study was to diagnose mucoid degeneration of ACL and to assess the effectiveness of arthroscopic treatment in these patients.

Materials and methods: Between 2011 and 2014, 13 patients were diagnosed to be suffering from mucoid degeneration of ACL on the basis of magnetic resonance imaging (MRI), histopathology, and arthroscopy findings. All the patients had clinical symptoms of central knee pain behind patella and were unable to extend knees fully because of pain without instability. The aim of surgery was to remove as much of the degenerative mass as possible without having to sacrifice the entire ACL. Thus, the remaining ACL consisted of some intact anteromedial or posterolateral portion of the ACL interspersed with degenerate ACL tissue. Copious debridement of mucoid hypertrophied lesions of the ACL was performed.

Results: Mean follow-up was of 8.4 months (range 6–12 months) and all except one patient had a full range of painless motion. All patients have resumed their normal daily activities. None complained of any instability. Postoperatively, 12 knees showed complete pain relief and 1 showed pain improvement by at least 4 Visual Analogue Scale (VAS) grades and preoperative average International Knee Documentation Committee (IKDC) score 8 was 36.39 which improved postoperatively to the average 73.18.

Conclusions: Mucoid degeneration of the ACL should be suspected in patients presenting pain on terminal extension or flexion without preceding trauma. Prior knowledge of condition with high index of suspicion and careful interpretation of MRI can establish the diagnosis preoperatively. Arthroscopic debridement with or without notchplasty gives excellent functional results.

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Table 1 – Pre-OP data of the patients.

S. No.	Sex/age	Duration of symptoms (months)	H/o trauma	Complaints	Pre OP IKDC score
1.	M/32	04	Yes	Painful terminal extension	34.4
2	F/45	03	No	Painful terminal extension	32.1
3	F/40	15	No	Painful terminal extension	35.6
4	M/38	36	No	Painful terminal extension	39.1
5	M/46	24	No	Painful terminal extension	40.2
6	M/27	07	Yes	Painful terminal extension	31.03
7	F/42	06	No	Painful terminal extension	34.4
8	F/56	06	No	Painful terminal extension	29.9
9	F/31	10	Yes	Painful terminal flexion	37.9
10	F/36	08	No	Painful terminal extension	45.9
11	M/39	07	No	Painful terminal extension	40.2
12	F/46	24	No	Painful terminal extension	29.9
13	F/44	18	No	Painful terminal extension	42.5

1. Introduction

Mucoid degeneration (MD) of the anterior cruciate ligament (ACL) is a rare pathological entity with disputed theories of origin.[1] Its prevalence in magnetic resonance imaging (MRI) is 1.8–5.3%, but not all lesions are symptomatic.[2,3] It is characterized by infiltration of mucoid-like substance (glycosaminoglycans) interspersed within the substance of ACL causing knee pain and limited motion. This entity was described only a decade ago by Kumar et al. in 1999.[4] Since then, many authors have identified and described their experiences and suggested their own guidelines for management. Regarded as a rare occurrence in the past, of late many reports of MD have highlighted the fact that it is not a rare entity and possibly was under-diagnosed or misdiagnosed and reported as partial or complete tear of ACL.[5,6] The excision of the degenerated ACL has been the treatment of the choice, and the authors believe that if the taut and hypertrophied ACL were to be debulked and notchplasty done, full extension could be achieved without having to excise the entire ACL, thus maintaining stability. The objective of our study was to describe the clinical characteristics and diagnosis of MD of the ACL and to assess the outcomes of treatment by partial arthroscopic ACL resection with or without notchplasty in a series of 13 patients.[7]

2. Materials and methods

This prospective study performed between 2011 and 2014 involved 13 knees. We examined the medical histories of the injured knee, the time period between the onset of pain and development mode, the concept of initial trauma and the pain location and anterior translation at the Lachman manoeuvre. The average duration of symptoms before consultation was 12.9 months (3–36 months) [Table 1]. All the patients had clinical symptoms of central knee pain behind patella and were unable to extend knees fully because of pain without instability. Anterior Lachman and anterior drawer test showed firm endpoint in all patients. McMurray was painfully positive. All patients were treated with non-steroidal anti-inflammatory drugs and physiotherapy for a minimum of 2 months before contemplating MRI and treatment. MRI was performed with 1.5 T machines. ACL mucoid degeneration was validated by MRI according to diagnostic criteria defined by Bergin et al., overall hyper signal of the ACL in T1-T2, increased overall ACL volume, ligament fibres clearly seen in T2, continuous tibial to femoral insertion.[3] MRI also made it possible to measure ACL hypertrophy or notch stenosis [Fig. 1]. All the patients underwent diagnostic arthroscopy of the knee under tourniquet with appropriate anaesthesia. During diagnostic arthroscopy of the knee through standard anterolateral portal, the

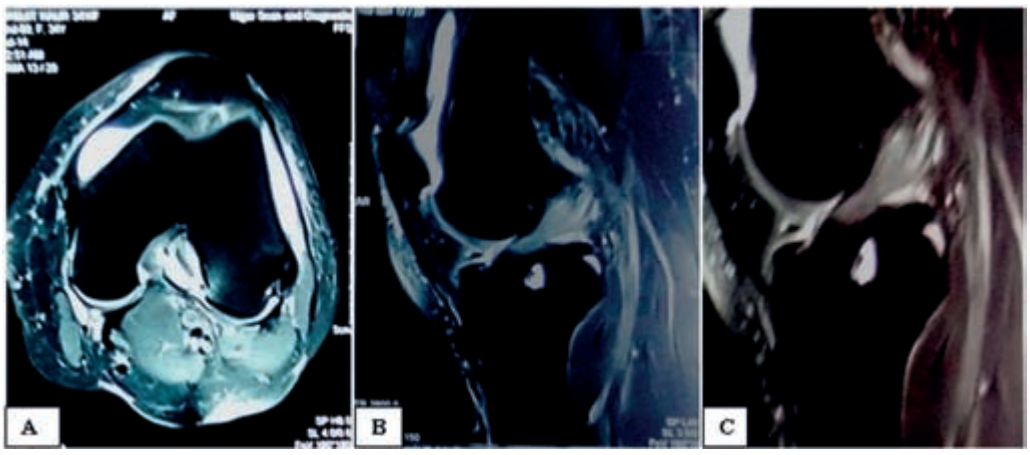

Fig. 1 – (A–C) Magnetic resonance images showing cyst in the anterior cruciate ligament with preserved fibres with bulky ACL and increased intensity.

Fig. 2 – Arthroscopic image of mucoid degeneration of ACL.

diagnosis of MD, initially established on MRI, was supported by a description of the ACL aspect corresponding to the arthroscopic diagnostic criteria enumerated by McIntyre et al. continuous ACL fibres, increased ACL volume, yellowish-coloured material expressed on palpation and loss of ACL synovial lining[8] [Fig. 2]. The aim of surgery was to remove as much of the degenerative mass as possible without having to sacrifice the entire ACL. Thus, the remaining ACL consisted of some intact anteromedial or posterolateral portion of the ACL interspersed with degenerate ACL tissue. Copious debridement of mucoid hypertrophied lesions of the ACL was performed by use of basket forceps as well as a 4.2-mm motorized shaver. The probe was used to assess the tension and the clearance of the remaining ACL and the notch. Care was taken to see that this remaining ACL had intact attachment to the femoral condyle and did not impinge on the roof or lateral wall of the notch. Notchplasty was done when a conflict was noted with the notch. The degenerated ACL and mucinous material was sent for histopathology examination. The materials were stained with H and E and then with mucoid tissue-specific Alcian blue. Histopathology was suggestive of MD of ACL [Fig. 3]. Weight-bearing with free

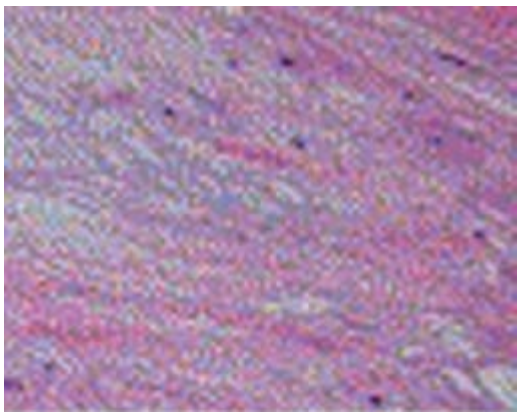

Fig. 3 – Histopathology images [H&E stain] showing collagen fibres mixed with mucoid material.

mobility was authorized in the immediate postoperative period. All other patients were encouraged to perform daily active range of motion exercises with quadriceps strengthening. The average follow-up was 8.4 months. Postoperative assessment included a clinical examination. Functional state was assessed by subjective International Knee Documentation Committee (IKDC)[9] questionnaires.

3. Results

Five males and eight females (Ratio of 1:1.6) were part of the study [Table 1]. Median age of patients was 36.4 years (range 27–46 years) in males and 42.5 years (range 31–56 years) in females. The type of activity performed was: physically active, two patients (15.3%); moderately active, five patients (38.5%) and sedentary, six patients (46.2%). The average duration of symptoms before consultation was 12.9 months (3–36 months). The mean follow-up was 8.4 months (range 6–12 months). Preoperative 12 patients presented with central knee pain on terminal extension which was moderate in 9 knees and severe in 3 knees while 1 patient had difficulty in knee flexion. Four patients (30.7%) reported trivial trauma prior to the onset of symptoms. Plain radiographs of index knee were normal in all the patients. MRI was done in every patient and 3 out of the 13 patients were initially reported as partial or complete tear of ACL, whereas remaining ten were reported as MD of ACL. Arthroscopy revealed bulge in the form of cyst in all 13 cases which was suggestive of MD. MD filled the entire intercondylar notch and was unusually taut, towards 90° of flexion in 1 patient with hypertrophied AM bundle of ACL, and taut in extension in rest of the patients with hypertrophied PL bundle of ACL. The ACL fibres were interspersed with a yellowish homogenous mass. The posterolateral portion of the ACL bulged into the lateral compartment in extension impinging in the notch. By flexion–extension manoeuvre, impingements were reproduced under direct vision. Impingement was particularly apparent in knees with a severely hypertrophied ACL or narrowed notch, as well as limited knee joint extension. MD was around the posterolateral ACL fibres and the anteromedial portion was retained in 11 patients. In 1 patient, posterolateral portion of ACL was retained because of hypertrophied degenerated AM bundle of ACL. Three medial meniscectomies were done at the same time in associated knees. After judicious debridement of mucoid ACL and associated cyst, the histopathology appearance and reports of the biopsy specimens were consistent with mucoid degeneration of the ACL in all 13 cases. In 4 knees with evident notch narrowing, notchplasty was performed first. Mean follow-up was of 8.4 months (range 6–12 months) and all except one patient had a full range of painless motion. All patients have resumed their normal daily activities. None complained of any instability [Fig. 4]. Postoperatively, 12 knees showed complete pain relief and 1 showed pain improvement by at least 4 Visual Analogue Scale (VAS) grades, Preoperative average IKDC score8 was 36.39 which improved postoperatively to the average 73.18 [Table 2]. However, few continued to have occasional pain while climbing stair, prolonged walking or squatting.

Fig. 4 – Post-OP images of patient showing complete range of motion of knee after debulking of ACL.

Table 2 – Post-OP data of the patients.

S. No.	Sex/age	Follow-up (month)	Post-OP clinically	Post-OP IKDC score
1.	M/32	06	Painless, Range on motion, No Instability	68.9
2.	F/45	07	Painless, Range on motion, No Instability	71.2
3.	F/40	12	Painless, Range on motion, No Instability	80.4
4.	M/38	08	Painless, Range on motion, No Instability	70.1
5.	M/46	08	Painless, Range on motion, No Instability	79.5
6.	M/27	08	Painless, Range on motion, No Instability	67.8
7.	F/42	12	Painless, Range on motion, No Instability	70.1
8.	F/56	10	Mild Pain But Improvement, No Instability	63.2
9.	F/31	09	Painless, Range on motion, No Instability	74.7
10.	F/36	06	Painless, Range on motion, No Instability	78.1
11.	M/39	06	Painless, Range on motion, No Instability	80.4
12.	F/46	08	Painless, Range on motion, No Instability	75.8
13.	F/44	10	Painless, Range on motion, No Instability	71.2

4. Discussion

The mucoid hypertrophy of the ACL is a rare condition found in middle-aged individuals. Bergin et al. and Salvati et al. reported its occurrence as 2% and 5%, respectively, of knee where MRI was done. It usually affects middle-aged individuals with mean age of 42 years. In our study, median age was found to be 40.15 years, which is also reported by other authors. Male to female sex ratio had been confirmed to be 1:1 by Bergin et al. and 1.28:1 by Salvati et al. Our study had the ratio of 1:1.6.[2,3]

It becomes apparent in two subpopulations of patients. The first group is younger, active, and athletic, in whom we can assume an ACL mechanism affected by real trauma or repeated micro-traumas causing an early lesion.[10] The second group is older and presents with progressive degenerative ACL lesions, with frequent concomitant degenerative meniscal lesions.[11] Multiple theories including synovial, traumatic, degenerative, ectopic, altered joint mechanics, etc. have been put forth to explain the elusive pathological origin of MD of ACL[6,12–18] [Fig. 5]. Majority of series have not reported any significant trauma prior to the onset of symptoms, whereas few others reported traumatic event before the onset of symptom. Lancaster et al.'s theory was also supported by Amiel et al. where they proved that injury to the synovium can result in exposure of ACL substance to the deleterious effects of haemarthrosis.[6,19] Deie et al. proved that the synovium enveloping the ACL has a healing and a protective capacity on the ACL and this diminishes once resected or damaged.[20]

Cha et al. believed that notch anatomy, especially smaller and vertical notch, predisposed the ACL to impingement and therefore resulting in microtrauma to the ACL.[13] At present, it is difficult to point out a single lone cause for the knee pain and with the literature available, it seems to be multifactorial. A study of Fealy et al. mentioned that pain could also be due to intratendinous nociceptor irritation during increased knee flexion. Decompression of ACL relieving tension amidst fibres supports this fact. Knee pain during flexion is probably due to the tightening of the anteromedial bundle. Knee pain during terminal extension has also been described. The active role of chemical mediators like substance P and calcitonin gene related peptide has also been mentioned.[21] Furthermore, associated pathologies like cartilage damage and meniscal tear do contribute to the pain and may be the reason of residual pain after the surgery for MD of ACL. Narvekar and Gajjar explained knee pain through increased volume and tension within the ligament.[22] For Kumar et al., the pain is attributable to the effect of the ACL mass in the posterior notch.[4] We believe that the most important source of pain is mechanical impingement, associated with unique function of the ACL in providing nociceptive sensory signals.

The gold standard imaging for the diagnosis of MD of ACL is MRI, which exhibits intermediate signal intensity on T1 weighted and high signal intensity on T2 weighted images. The ACL fibres are usually thick and ill-defined, but the orientation and continuity are usually maintained.[5] Bergin et al. in their study have reported detailed findings after retrospectively studying 4221 knee MRIs and helped

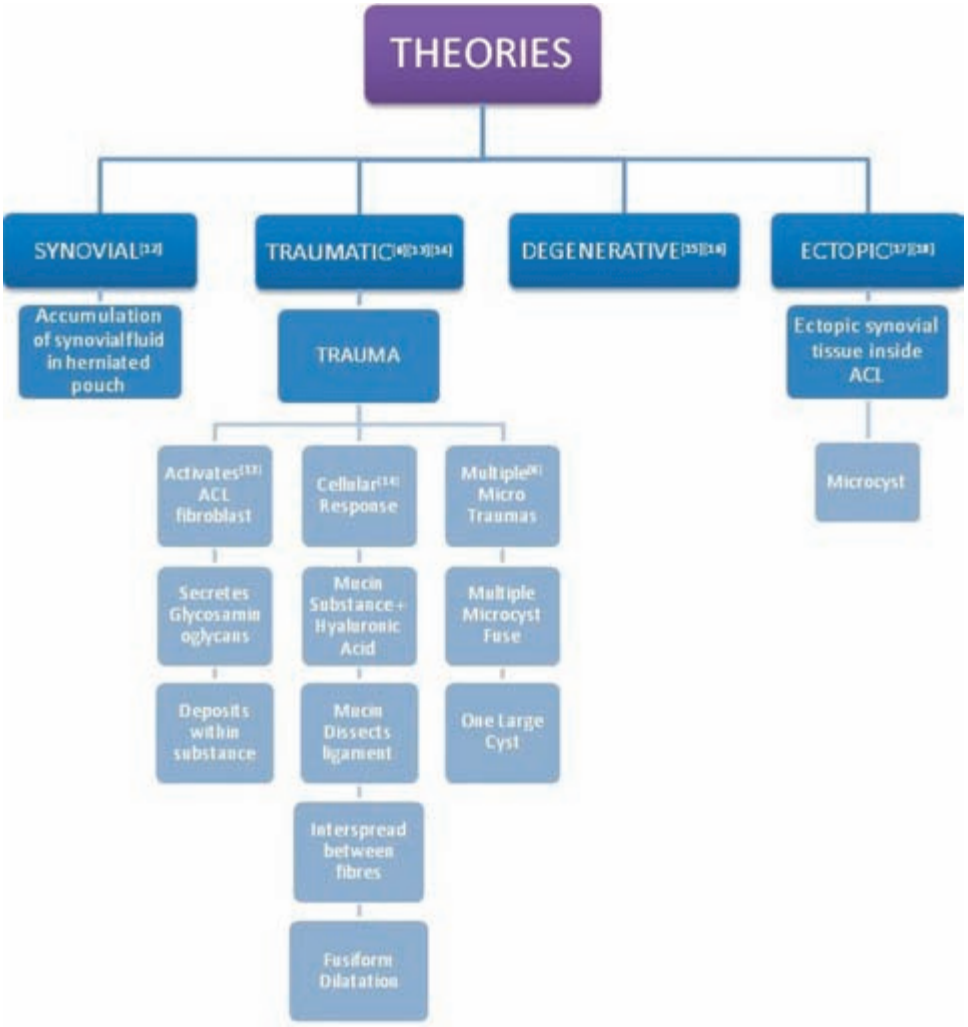

Fig. 5 – Theories of ACL mucoid degeneration.

differentiating MD from mucoid cyst.[10] However, the most characteristic appearance is that akin to a ''Celery stalk''. Considering the limited awareness, misdiagnosis as a tear is quiet common both clinically and on MRI. McIntyre et al. has described ten patients who were initially mistaken for tears on MRI, but arthroscopy and probing expressed mucoid material.[8] Makino et al. have described the presence of associated lesions like intraosseous tibial cyst and ganglion picked up on MRI.[23] The arthroscopic features include an intact but fibrillated, yellowish and hypertrophied ACL with interspersed yellowish mucinous material along the fibres exposed on probing, lack of smooth synovial lining and absent ligamentum mucosum.[5] In all the cases, ACL was devoid of synovial lining and ligamentum mucosum was absent as reported in the literature.

Under the microscope, MD is typically described to have dense granular glycoproteins and mucoproteins (glycosoaminoglycans) located between thin, fragile collagen fibrils of ACL, which are detectable by haematoxylin and eosin or Alcian blue.[7] Shelly et al. have reported a unique case of metastatic adenocarcinoma of the lung into the knee mimicking MD of the ACL.[24] This fact establishes the importance of sending the excised specimen for the histopathology.

Most of the authors believe that debridement of mucinous substance with partial ACL debulking is an effective therapeutic option which does not cause instability. An additional notchplasty is considered essential by some authors.[5] But Motmans and Verheyden specifically mention that notchplasty is not required, because thorough debridement by itself resolves the impingement and thereby the pathology.[25] Lintz et al. performed two notchplasties out of 29 patients but not routinely.[1] We performed a meticulous and judicious debridement of the mucoid ACL with the aim of reducing the volume, achieving removal of the mucoid mass and decompression of the bulky pathological ACL. We did not perform notchplasty in four patients. We believe that notchplasty may be needed in some cases where notch is quite stenotic and impinged by osteophytes especially in elderly patients. However, it may not be needed in middle-aged patients where notch is free of osteophytes. Debulking of ACL alone is sufficient to achieve full range of movement.

Though all patients regained full flexion after debulking mucinous ACL, some of them continued to experience mild pain while walking or climbing stairs. This could be explained probably because of concomitant lesions like cartilage damage

in patellofemoral or tibiofemoral joint or meniscal tear. Dejour et al. demonstrated positive anterior drawer in 36% and positive pivot shift in 55% of his patients after debridement.[26] None demonstrated a positive pivot shift. None developed instability until final follow-up.

However, it is premature to say that these patients will not develop instability in future, as all of these were patients with sedentary activities except one who plays badminton. Whether patients whose occupation requires heavy demand from knee or athletes would not develop instability in future after partial debulking, is a matter of debate. Another notion addressed by this work is that of secondary instability. It is mentioned elsewhere only by McIntyre et al. who reported one case of atraumatic ACL rupture at 1 postoperative year after partial resection.[8] Our results indicate that postoperative laxity, largely asymptomatic, can increase anterior laxity over time and evoke instability.

5. Conclusion

Mucoid degeneration of the ACL should be suspected in patients presenting pain on terminal extension or flexion without preceding trauma. Prior knowledge of condition with high index of suspicion and careful interpretation of MRI can establish the diagnosis preoperatively. Arthroscopic debridement with or without notchplasty gives excellent functional results.

Conflicts of interest

All authors have none to declare.

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Original Article

Intra-articular lipoma arborescence of the knee – A rare clinical entity

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ABSTRACT

Background: Intra-articular lipoma arborescence (LA) is a rare entity that presents with swelling and with recurrent effusion of the joints lined by synovium, especially the large joints like knee and others. Pathologically, it is characterised by replacement of subsynovial tissue by fat cells. Magnetic resonance imaging can clinch the diagnosis.
Method: We describe four cases of LA, who presented with chronic intermittent pain and swelling of the knee joint. Arthroscopic synovectomy and further biopsy helped establishing the diagnosis.
Result: Arthroscopic resection of lesion and management of concomitant lesion help in managing the symptoms.
Conclusions: LA should be included in the differential diagnosis of cases with persistent, refractory, chronic knee joint swelling and pain.

1. Introduction

Intra-articular lipoma arborescence (LA) is a rare, benign synovial neoplasm characterised by villous, polypoidal lipomatous transformation of synovium due to diffuse infiltration of the sub-synovial stroma by mature fat cells.[1,2] The exact aetiology of LA remains idiopathic and is still unclear that whether this condition is reactive to degenerative arthritis, and is post-inflammatory, post-traumatic or metaplastic. However, most of the cases reported in literature have been associated with degenerative arthritis, inflammation or trauma.[3–8] Clinically, it presents with a recurrent swelling of the joint with or without pain. Treatment involves synovectomy, open or arthroscopic, which is mostly curative. We present a series of four cases of LA in the knee with their clinical presentations, management and review of the literature.

2. Case reports

2.1. *Case 1*

A 39-year-old man presented with a history of pain and swelling in the left knee joint for the past 4 years. Pain was mechanical in nature with no rest pain, alleviated by NSAIDs. Swelling was progressive in nature. There was no history of trauma to the joint, fever or other constitutional symptoms.

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Fig. 1 – Coronal section T2-weighted MRI, effusion with villous mass in supra-patellar area.

Other joints were normal. The patient was treated initially by NSAIDS and physiotherapy. Physical examination revealed tenderness over the medial femoral condyle of the knee joint with synovial hypertrophy and effusion. Special tests for meniscal or ligament tears were negative. Blood tests were unremarkable. Magnetic resonance imaging (MRI) showed typical frond-like appearance of the synovium and joint effusion (Fig. 1). Due to persistent symptoms, the patient underwent arthroscopy that revealed yellowish tissue with synovial growth involving both parapatellar gutters and the supra-patellar pouch (Fig. 2). Menisci, cartilage and cruciates were normal. The yellowish frond-like synovial growth was excised arthroscopically using motorised shaver. Histopathological examination of the lesion showed synovium lined with a villous proliferation in which the villi were diffusely infiltrated by mature adipose tissue suggestive of LA (Fig. 3). At a follow-up in 42 months, the patient remains asymptomatic.

2.2. *Case 2*

A 42-year-old male presented with swelling in his right knee for the past 5 years. The swelling was more in popliteal fossa. He complained not only of pain while walking, but also morning stiffness of less than 30 min. No other joints were involved, and there were no systemic symptoms. Local examination of knee revealed synovial hypertrophy and effusion. Blood test revealed mildly elevated erythrocyte sedimentation rate (ESR) up to 40 mm per hour. Past history suggested that in view of elevated ESR, a medical practitioner empirically started him on DMARDs (hydroxychloroquine) for

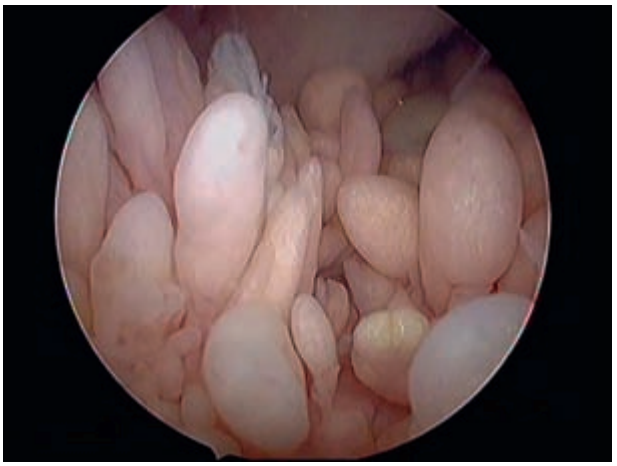

Fig. 2 – Arthroscopic view of the LA showing yellowish polypoidal villous mass in the supra-patellar pouch and adjacent medial parapatellar gutter of the knee.

6 months suspecting an inflammatory synovitis but to no respite. Intra-articular corticosteroid injections were also given, but they gave only temporary relief. MRI was suggestive of LA and Baker's cyst (Fig. 4). Arthroscopy was performed, which showed large villous transformation of synovium in the supra-patellar pouch. The rest of the joint was normal. Fatty polypoidal mass was excised using motorised shaver. Histopathological exam showed mature adipocytes with chronic inflammatory cells in the sub-intima of synovium. At a follow-up after 32 months, he remains asymptomatic with painless full range of movement. The Bakers cyst has subsided completely.

2.3. *Case 3*

A 21-year-old male presented with right-sided moderate knee pain with recurrent swelling for 3 years. No other joints were involved. There was no history of fever, loss of weight or

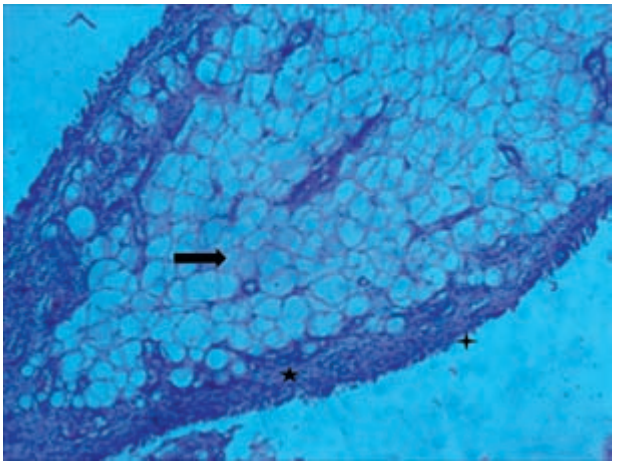

Fig. 3 – Photomicrograph of lipoma arborescens shows papillaroid structure (4 point star) with synovial lining cells (5-point star), which contain a stroma that exhibits increased mature adipose tissue (black arrow).

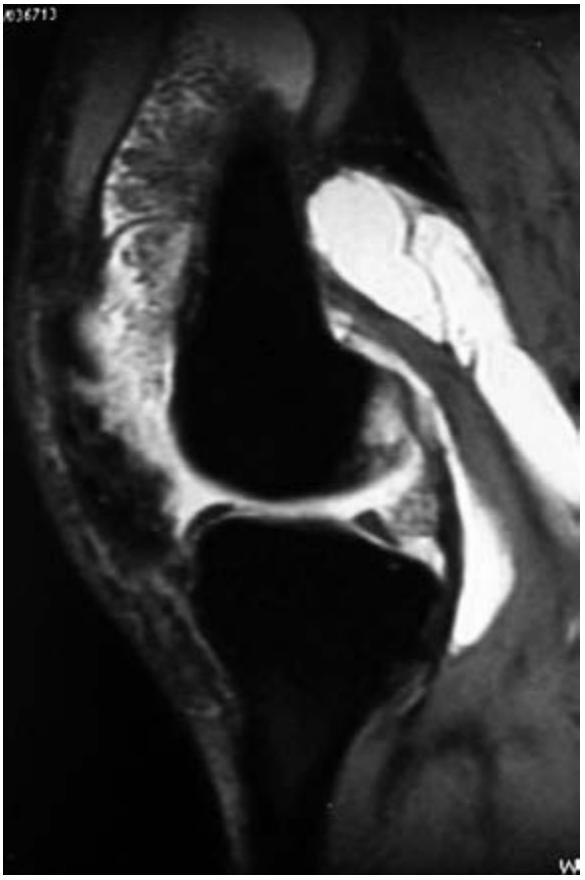

Fig. 4 – Sagittal section T2-weighted MRI, large effusion with polypoidal villous frond-like mass in supra-patellar area, with Baker's cyst.

appetite. He had taken conservative treatment in the form of NSAIDs and physical therapy for long but to no avail. Clinical examination of right knee revealed effusion with synovial hypertrophy. Plain radiograph of the knee was normal. MRI of the knee revealed an exophytic mass in the supra-patellar pouch with lobulated villous projections with fat signal intensity. Arthroscopy of the knee revealed fatty villous projections in the supra-patellar pouch. The remainder of the joint was found to be normal. The villous hypertrophied fatty projections were removed using motorised shaver. Histopathology of the specimen was suggestive of LA. At 48 months after the surgery, the patient was found to be pain free and without effusion.

2.4. *Case 4*

A 45-year-old male presented with acute exacerbation of left-sided non-traumatic mechanical knee pain with recurrent swelling for 2 years. No other joints were involved. There were no systemic complaints. Clinical examination of right knee revealed effusion and medial joint line tenderness with synovial hypertrophy in the supra-patellar pouch. Plain radiograph of the knee revealed narrowing of medial joint space suggestive of early osteoarthritis of the knee. MRI of the knee was not performed. Arthroscopy of the knee revealed fatty villous projections in the supra-patellar pouch with early osteoarthritis of the medial compartment of the knee. There was degenerative tear in the body of the medial meniscus. Remainder of the joint was found to be normal. The villous hypertrophied fatty projections were removed using motorised shaver, and a partial meniscectomy was performed for the degenerative meniscal tear. Histopathology of the resected synovium was not only suggestive of LA, but also of secondary synovial chondromatosis. At a follow-up after 24 months, patient has mild pain but no swelling.

3. Discussion

Lipoma arborescence is considered to be a rare, benign intra-articular lipomatous lesion seen in synovial joints.[9] Hallel et al. suggested the use of ''villous proliferative lesion of subsynovial fat'', a more suitable term, since lipoma in LA is suggestive of tumorous origin.[7] It is mostly reported in the supra-patellar space of the knee joint.[5,7,10–12] However, there are several reports of LA in the shoulder, elbow, hip, as well as the ankle.[13–16] Although LA is typically intra-articular, non-articular locations around bursae and tendon sheaths have also been reported.[17–19] Various authors have described mono-articular locations of LA, but there are rare reports of polyarticular involvement as well.[20–22] Polyarticular, especially bilateral knee, involvement may mistake the picture to be of inflammatory arthritis, especially due to the presence of minor elevations in inflammatory markers.

While the aetiology of LA remains elusive, most believe that it is a hyperplastic or a reactive process rather than a true neoplasm. Based on absence or presence of reactive stimulus in the joint, LA is considered to be of two types, primary and secondary. Primary LA is uncommon and is seen without any preceding trauma or inflammation. It is reported mostly in the children and adolescent population without a history of trauma or inflammation.[11,21,23] Rarely, primary LA can initiate degenerative change in the joint,[14,24,25] and possibly cause bony erosions too.[26] Secondary LA, which is more common, is often associated with chronic irritation due to osteoarthritis, inflammatory arthritis and trauma.[3,5,6,8,27,28] However, it is still unclear whether these associations are causal or merely coincidental.

LA typically presents in the 4th to 5th decade. It is quite rare in children and adolescents with very few reports available.[11,13,21,23,29] Patients with primary LA present with boggy swelling especially in the supra-patellar pouch and effusion with or without pain.[11,21,23] However, secondary LA can present as a painful swelling of the joint due to underlying inflammatory or degenerative disorder of the joint.[3,6,28] Some patients may present with locking or crepitus due to hypertrophied villi getting trapped between the articular surfaces. The mean age of patients in our series was 36.7 years (range: 21–45). Only one patient had associated early osteoarthritis of the medial compartment of the knee. All of them presented with painful swelling of the knee joint in the supra-patellar region. Table 1 summarises the demographic and clinical variables of all patients.

Most laboratory tests are within normal limit except in a situation where it is a case of secondary LA. Sometimes, the

Table 1 – Demographic and clinical variables of all cases.

Case	Age/ Sex	Physical findings	Blood test	Radiograph	Arthroscopic findings	Follow-up (months)	Recurrence
1	39/M	Medial femoral condyle tenderness, Synovial hypertrophy, effusion	Normal	Normal	Yellowish villous synovial tissue involving both parapatellar gutters and supra-patellar pouch	42	None
2	42/M	Joint effusion, Baker's cyst	Elevated ESR	Normal	Large villous transformation of synovium in supra-patellar pouch	32	None
3	21/M	Synovial hypertrophy, effusion	Normal	Normal	Fatty villous projections in the supra-patellar pouch	48	None
4	45/M	Medial joint line tenderness, Synovial hypertrophy, effusion	Normal	Narrowing of medial Joint space	Fatty villous projections in the supra-patellar pouch with early osteoarthritis of the medial compartment of the knee. Degenerative tear in the body of the medial meniscus	24	None

M, Male; ESR, erythrocyte sedimentation rate.

ESR may be high, which may cause confusion, and the patient may end up receiving treatment for inflammatory arthritis instead.

Plain radiographs are not diagnostic but may show features of secondary changes of osteoarthritis, inflammatory arthritis or trauma. Only one of the cases had osteoarthritic changes of medial compartment, whereas the rest were apparently normal. Ultrasound may reveal joint effusion and may show villus synovial projections. In most cases, MRI is the diagnostic modality of choice and is pathognomonic enough to zero down upon the near-certain diagnosis of this condition. MRI shows frond-like appearance with high-signal intensity of fat of LA in T1- and T2-weighted images and dark-signal images of fat in short tau inversion recovery (STIR) sequence. In their review of 32 MRIs of patients with LA, Vilanova et al. reported that 87% had associated degenerative changes, and 72% had a meniscal tear.[30] Others had synovial cyst (38%), bony erosions (25%) and chondromatosis (13%). Synovitis of infective, inflammatory, metaplastic, reactive states (giant cell tumour of synovium, gouty tophi) and degenerative origin would not show such characteristics. Occasionally, synovial haemangiomas can mimic similar MRI interpretations with regions of high-signal fat-like intensity. However, haemangiomas are always associated with dilated vascular spaces and phlebolith.[31]

Macroscopically, LA presents with frond-like appearance of broad-based polypoid or thin papillary villi composed of fatty yellow tissue. Although LA is considered to be non-invasive to the surrounding tissues, there are a few reports wherein authors have described invasion of LA into soft or bony tissues. Stephan et al. reported a case of extra-articular LA over the wrist where the lesion was found to be erosive over the extensor indices and extensor communis.[32] The tendon substance was eroded by 40–50%. Ryu et al. reported three cases of LA with bony erosion into the knee[26] and one by Chae et al. wherein LA of glenohumeral joint eroded into the humeral head.[33] Histopathologically, the central parts of villi are filled with mature adipose cells, and peripheral parts are lined with inflammatory cells.

Overall, LA is a specific entity, which perhaps represents a protective and adaptive response to some form of chronic injury to the joint in the form of fatty deposition and inflammatory lining of cells. Synovial resection, open or arthroscopic, is the definitive treatment and leads to complete cure of the disease. Open resection of LA used to be the treatment of choice in the past. However, currently, arthroscopy is the preferred treatment modality as it avoids the complications of open synovectomy, especially stiffness and scarring. Although the recurrence is not reported after complete excision of the lesion,[3,11,21,23,34] it can recur after incomplete excision, especially in secondary LA where it is a reactive hyperplastic lesion. All our cases at a mean follow-up of 36.5 months did not reveal any recurrence.

Differential diagnosis of a soft boggy swelling in the supra-patellar pouch includes pigmented villonodular synovitis (PVNS), synovial chondromatosis, synovial haemangioma, intra-articular lipoma and chronic synovitis. Typical brownish bloody knee aspirate and MRI appearance (PVNS has a low intensity on T1- and T2-weighted images due to haemosiderin accumulation) differentiate PVNS from LA. Synovial chondromatosis presents as multiple loose bodies, which are occasionally clinically palpable and might cause locking. It can also be visualised on plain radiograph and MRI (Low- to intermediate-signal intensities on T1- and T2-weighted images are characteristic of synovial chondromatosis). Synovial haemangioma and true intra-articular lipoma are diagnosed on the basis of classic MRI appearance. Histopathology confirms the diagnosis and certainly helps in differentiating classic LA from various differential diagnoses.

4. Conclusion

LA is a benign, indolent synovial hyperplastic reactive lesion, which should be kept in mind as a differential diagnosis in patients with painless or painful boggy swelling of the knee joint, even if it is bilateral. Knee remains the commonest joint

to be involved, but other joints, as well as extra-articular locations, can get involved. Secondary changes in the joint due to degenerative or inflammatory arthritis often accompany a diagnosis of LA. MRI is the diagnostic modality and helps in narrowing the differential diagnosis. Arthroscopic resection remains the treatment of choice, with no reported recurrences.

Conflicts of interest

All authors have none to declare.

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Case Report

Vertical intraarticular dislocation of patella

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ABSTRACT

Dislocation of patella is a known orthopaedic emergency. It is more common in adolescents who are involved in activities such as sports and dance. More commonly laterally, intraarticular dislocation has also been described. We describe here a case of vertical intraarticular dislocation of patella in a young male managed successfully by closed reduction. This rare condition should be among the differential diagnosis of a locked knee.

1. Case report

A 16-year-old male attended Accident and Emergency Department with severe pain, deformity and inability to stand on right knee. He reported a twisting injury while playing football few hours before. No previous history of any knee problems or family history of joint hyperlaxity was informed. During physical examination, there was visible skin tenting anteriorly in the patellar region without significant joint effusion. Patella was felt standing abruptly in front of his knee. One of the borders of patella was felt anteriorly with articular surface facing laterally. Quadriceps tendon was found to be taut and intact. No retinacular tenderness or soft tissue injuries were felt on palpation. No further tests could be done in emergency room due to discomfort of the patient. The distal neurovascular examination of the affected leg was normal.

2. What is your diagnosis?

Locked knee occurs commonly doe to meniscal or cartilage conditions. Radiographs of knee in our case (Fig. 1) confirmed intraarticular vertical dislocation of patella. Closed reduction under conscious sedation was attempted with intravenous fentanyl and midazolam. Intraarticular injection of local anaesthetic and saline was also administered. Patient's leg was elevated, hyperextended and with slight manipulation, medial border of the patella was lifted off the intercondylar groove of the femur and reduction achieved. Patient immediately recovered from discomfort and was able to actively extend and flex his knee. Post reduction radiographs (Fig. 2) confirmed the normal alignment of patella. Knee was immobilized in extension brace with immediate full weight bearing for 4 weeks along with advice of elevation, rest and appropriate analgesics. Regular follow-up for 6 months with

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Fig. 1 – Antero-posterior and lateral radiographs showing vertical dislocation of patella.

Fig. 2 – Post reduction antero-posterior and lateral radiographs showing normal alignment of patella.

dedicated knee physiotherapy team showed complete restoration of his knee movement without any sequelae.

3. Discussion

Patella dislocation can be extraarticular or intraarticular.[1] Intraarticular subtypes can be along horizontal[2] or vertical axis.[3] Superior/inferior pole of patella is locked in intercondylar groove in horizontal subtype, while patella rotates on its vertical axis such that either medial or lateral border is wedged in intercondylar groove of femur in vertical subtype.

Exact mechanism of injury is unknown. Most often these injuries are associated with sports and direct blow to the medial aspect of patella with knee in near extension or a twisting injury with forced internal rotation of femur on externally rotated planted tibia while the knee is flexed. The patella rotates on its vertical axis and gets wedged within intercondylar groove. A valgus strain on the knee also causes the patella to rotate on its vertical axis and the continued pull of the quadriceps can hold the patella on its edge. Ligaments laxity is a factor too in adolescent patients, as in our case.[4]

Closed reduction under sedation or general anaesthesia, sometimes percutaneously using AO clamp or a Schanz screw, can be employed. Open reduction has also gained popularity as it reduces the risk of any chondral damage caused by repeated reduction manoeuvres and can help in repair or removal of any osteochondral fragments.[4]

Purpose of this report is to keep this rare condition as differential in cases of locked knee. We achieved successful outcome in our case with closed reduction, but if required, especially in elderly with osteophytes, open reduction is necessary.

Ethical approval

Informed consent was obtained from the individual participant included in this study.

Conflicts of interest

All authors have none to declare.

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