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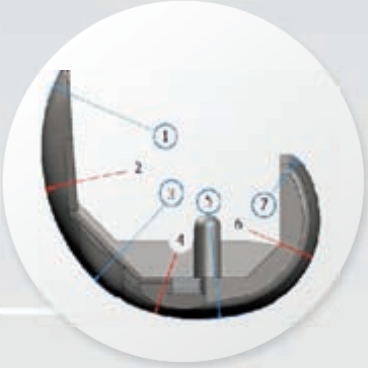

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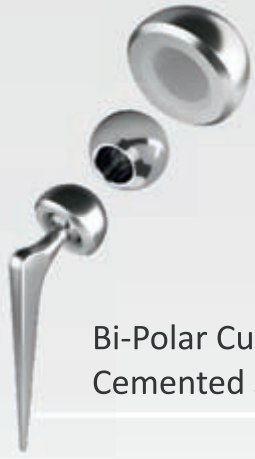

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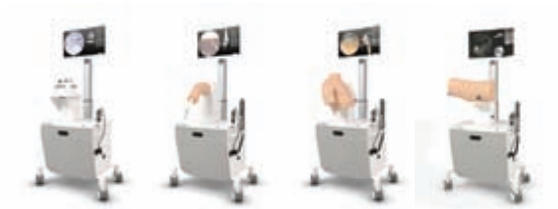

Fig. 1 VirtaMed ArthroS™ FAST model, knee model, shoulder model, hip model.

1. Case report

Orthopedic surgery requires an intensive didactic program, especially for the very specific skills needed to master arthroscopic surgery. With the VirtaMed ArthroS™ (Fig. 1), trainees use original medical devices to better facilitate the transfer of skills to the OR. Training cases include diagnostic and therapeutic arthroscopy in knee, shoulder and hip. Furthermore, the simulator allowes basic skill training on the FAST model, which was developed under the guidance of AANA and an ABOS task force.

2. Results

Using a VirtaMed ArthroS™ simulator helps surgical trainees feel more confident in the OR. They get to practice triangulation and ambidextrous procedures. The use of a simulator means trainees takes up less time in the OR and reduces the expense of using cadavers. With a virtual 3D view from inside and outside (Fig. 2a., b., and c.) trainees get a comprehensive understanding of the anatomy.

3. Conclusion

Using a VirtaMed simulator is the best way to train new surgeons, practice with new tools, and learn new skills.

a. b. c.

Fig. 2 VirtaMed ArthroS™ simulation view - (a.) Fluoroscopic access training, (b.) ACL graft placement simulation, (c.) Meniscus repair simulation

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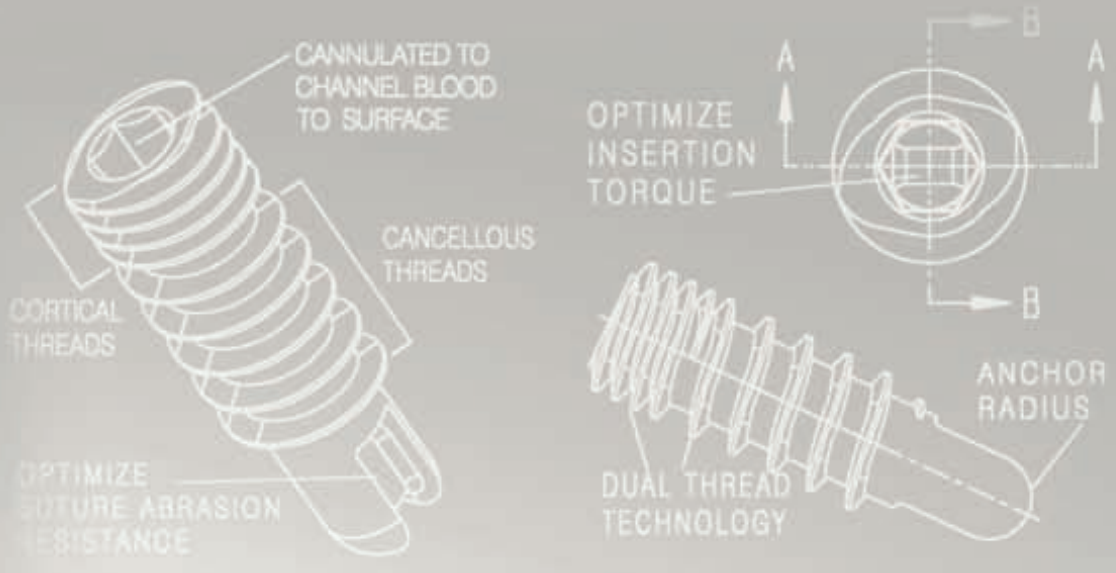

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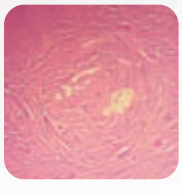

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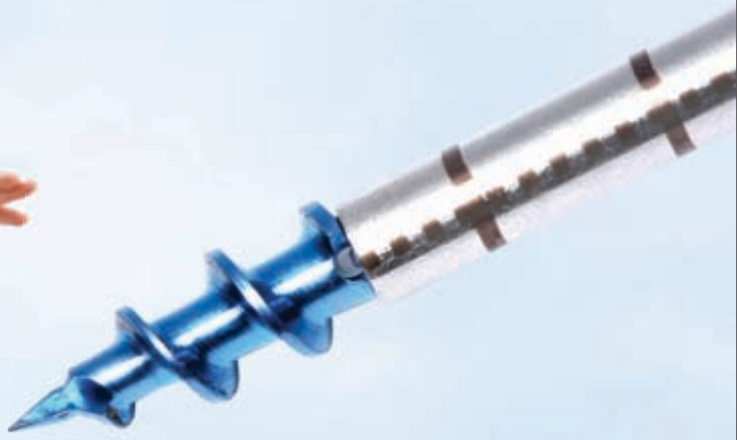

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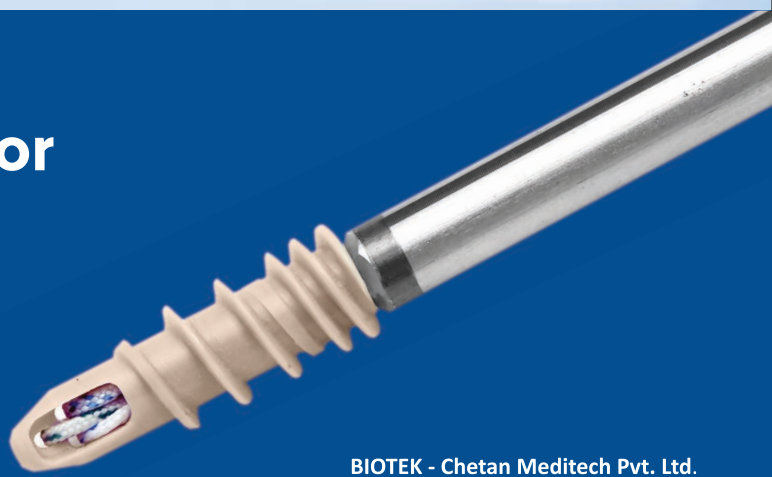

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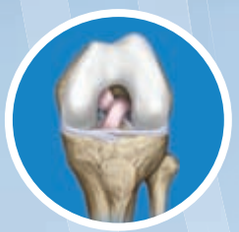
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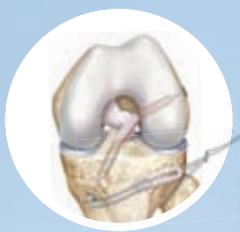
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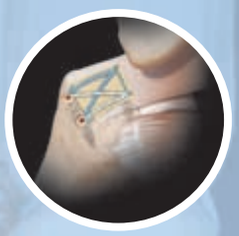
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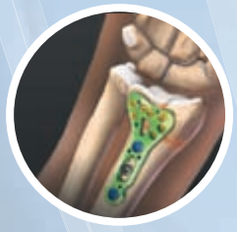
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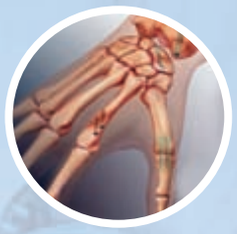
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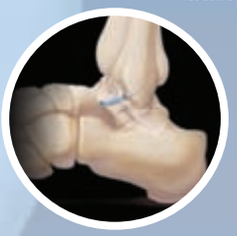
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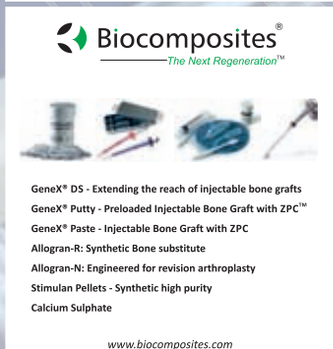

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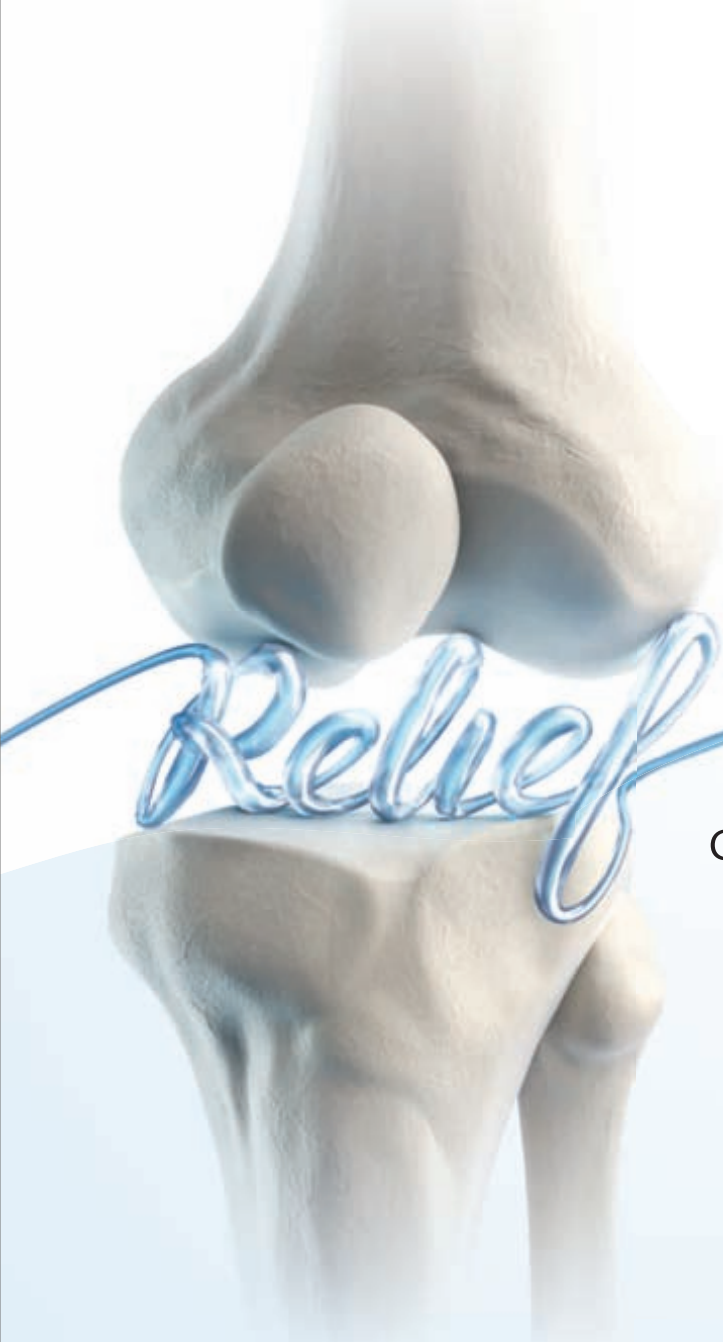

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Aims and Scope

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

Shoulder instability: Dealing with lesions or with devices?

The understanding of shoulder instability and its management has evolved over the years.

While the differentiation between traumatic shoulder instability and multidirectional instability is traditionally well described and understood, there also exists a spectrum of instability that is subtle and not fully recognized.[1–5] This includes various degrees of instability without dislocation of the joint that could be congenital; due to the unique biological aspects of the capsule,[6] or acquired; as seen in some overhead athletes.

Clearly, such a wide variation in presentation has led, over the years, to many different procedures and modifications to best approach each different aspect of the presenting lesion. The treatment for capsular and labral tears has shifted over the years from open to arthroscopic.

While arthroscopy was purely used for diagnostic purposes initially[7] it has now become the 'Frontline' strategy with similar outcomes, and sometimes pitfalls, of open surgeries.[8,9] Arthroscopy, even if 'minimally-invasive', is not free from complications related to the use of different implants.

One of the first described problems was related to osteolysis after the use of polylactic acid (PLA) tacks and concurrent shoulder instability due to insufficient capsular tensioning.[10] The increased use of anchors and metal devices has led to devastating arthritis of the glenohumeral joint often requiring arthroscopic[11] or open revision operations to remove the offending devices or, in some cases, even to implant a shoulder prosthesis.

A similar problem has been described with the use of local anaesthetics post-operatively in patients operated for shoulder instability. Complete destruction of the articular cartilage and massive gleno-humeral chondrolysis has led to implantation of shoulder prosthesis in very young patients.[12]

The evolution from metal anchors to absorbable anchors became critical in avoiding some these adverse outcomes. Absorbable anchors too are not free from complications, such as synovitis or osteolytic zones in the glenoid.[13] At times, extensive bone loss can occur after the use of numerous anchors that can lead to a fracture of the edge of the glenoid even with low-intensity trauma.[14] In this scenario, the best solution appears to be a bone graft operation like the Latarjet procedure, open or arthroscopic,[15,16] in order to correctly address the glenoid bone loss.

The assessment of glenoid bone-loss should be carried out with a CT scan that can also examine the feasibility of filling the glenoid defect with a bone graft like the coracoid.[17] While the glenoid defect is important for right decision making, humerus side defects also need consideration in the over all planning. The presence of Hill-Sachs fractures may require additional procedures; remplissage seems valid in cases of large Hill-Sachs without significant glenoid bone loss.[18,19] Given the reported complications of the afore mentioned devices, research is moving towards the use of ever smaller anchors that achieve good pull out strength without sacrificing excessive glenoid bone.[20]

Open surgery, such as the Latarjet or Eden-Hybinette procedures still provide a valid alternative in cases where the extent of the bone loss and capsular destruction exclude arthroscopic approach.

In conclusion we can affirm that shoulder instability is a problem still far from being known in its entirety. Often the correction of instability can lead to complications, recurrences, stiffness and even massive arthritis in young patients. The Orthopaedic surgeon must be familiar with all the aspects of this complex condition that will enable correct choice of procedure and implants to offer the most appropriate treatment.

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Review article

Management of rheumatoid arthritis: Review of current guidelines

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ABSTRACT

Rheumatoid arthritis, an autoimmune disease characterized by inflammatory polyarthritis of small and large joints, can cause significant disability and discomfort. Significant advances in its diagnosis and management have taken place in the last 20 years. Besides early diagnosis, these advances include early institution of disease modifying therapy with a goal of "treat to target", frequent assessments of disease activity to gauge control, consideration for and introduction of alternative or additive disease modifying therapeutic agents in case of inadequate or persistent disease activity. Growing recognition of therapeutic targets and thus agents for rheumatoid arthritis has significantly improved its course, as well as its short and long-term outcomes. This paper will review updates and current guidelines for management of rheumatoid arthritis.

1. Introduction

Rheumatoid arthritis (RA) is a progressive inflammatory disease which causes joint damage and disability.[1] Over the last 2 decades, the treatment of patients with RA has changed considerably. Currently the goal of therapy is not only symptom relief but also the prevention of structural damage and limitation of disability.[1] The management of RA rests primarily on the use of disease modifying anti-rheumatic drugs (DMARDs). DMARDs form two major classes: conventional synthetic DMARDs (csDMARDs) and biologic DMARDs (bDMARDs). csDMARDs such as methotrexate, sulfasalazine, hydroxychloroquine and leflunomide have been used in the management of RA traditionally. bDMARDs on the other hand have emerged in the last 20 years and continue to evolve. These include tumor necrosis factor (TNF) inhibitors (infliximab, etanercept, adalimumab, golimumab and certolizumab pegol); T cell co stimulation inhibitor (abatacept); anti B-cell agent (rituximab) and interleukin (IL)-6 receptor blocking agent (tocilizumab).[2] Other novel agents include synthetic inhibitor of Janus kinases – tofacitinib and biosimilars (bs) (bs-infliximab and bs-etanercept).[3] Abundancy of therapeutic options and insufficient information on differential efficacy and safety makes treatment decisions in clinical practice challenging. In this review we provide an overview of the medical management of RA with an emphasis on recent guidelines and highlight areas of future research.

The overall approach to the treatment of patients with RA depends upon the timely and judicious use of several types of therapeutic interventions which include early diagnosis, care by an expert in the treatment of rheumatic diseases such as a rheumatologist, early use of DMARDs with the target of remission or low disease activity and use of anti-inflammatory agents, including non-steroidal anti-inflammatory drugs (NSAIDs) and glucocorticoids, only as adjuncts to therapy.

2. Early diagnosis

Joint damage occurs early in the course of RA; 30% of patients have radiographic evidence of bony erosions at the time of diagnosis, and this proportion increases to 60% by 2 years.[4] Therefore, early diagnosis, albeit challenging, is critical. Using the 2010 American College of Rheumatology (ACR)/European League against Rheumatism (EULAR) classification criteria for RA, diagnosis as definite RA is based upon the presence of synovitis in at least one joint, in the absence of an alternative diagnosis that better explains the synovitis, and the achievement of a total score of at least 6 (of a possible 10) from the individual scores in four domains. These domains and their values are summarized in Table 1.[5]

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Table 1
2010 ACR/EULAR classification criteria for rheumatoid arthritis.[7]

Joint involvement	1 large joint (shoulder, elbow, hip, knee, ankle)	0
	2–10 large joints	1
	1–3 small joints (MCP, PIP, thumb IP, MTP, wrists)	2
	4–10 small joints	3
	>10 joints (at least 1 small joint)	5
Serology	Negative RF and negative Anti-CCP antibodies	0
	Low positive RF or low-positive anti-CCP antibodies (≤3 times ULN)	2
	High positive RF or high-positive anti-CCP antibodies (>3 times ULN)	3
Acute phase reactants	Normal CRP and normal ESR	0
	Abnormal CRP or abnormal ESR	1
Duration of symptoms	<6 weeks	0
	≥6 weeks	1

Abbreviations: CCP, cyclic citrullinated peptides; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; IP, interphalangeal joint; MCP, metacarpophalangeal joint; MTP, metatarsophalangeal joint; PIP, proximal interphalangeal joint; RF, rheumatoid factor; ULN, upper limit of normal.

3. Disease activity assessment

An important advance in the treatments for RA has been the adoption of standardized and validated clinical outcome measurements for disease activity. The "treat to target" strategy for RA is geared toward getting this disease activity, as measured by standardized tools, under control. Frequent assessments of disease activity thus allow opportunity for timely adaptation or revision of therapy, which is essential in preventing disease progression. Several such options are currently available; physicians may select their preferred measure based on their familiarity and comfort with the varied measures and the time available to perform these at every patient visit. Consistency of use, at each visit of all patients is the key, and one may perform whichever is best suited to their practice.

Continuous measures of disease activity such as the Disease Activity Score (DAS) 28 which assesses 28 joints, the Simplified Disease Activity Index (SDAI) and the Clinical Disease Activity Index (CDAI) help in monitoring disease activity at regular intervals.[6,7] These instruments are based on varied combinations of the counts of tender and swollen joints, patient's and physician's global assessment of disease activity and acute phase reactants (erythrocyte sedimentation rate or C-reactive protein) (Table 2). A clinical state defined as low disease activity or remission as per above outcome measures is the optimal goal of therapy and each disease activity measure pre-specifies these cut offs (Table 2).[8] Mobile applications are available to help the physicians calculate these scores. Furthermore, patient-reported outcome measures such as the Routine Assessment of Patient Index Data 3 (RAPID3), Patient Activity Scale (PAS) and PAS-II have also been approved by ACR as valid measures of disease activity.[9] RAPID 3 has been shown to correlate well with the physician-assessed measures of disease activity; also it can be obtained easily without expending any physician time and is frequently used in patient management.[10]

4. Treatment principles

Since no treatment cures RA; therefore, the therapeutic goal is remission of symptoms involving the joints, a return of full function and the maintenance of remission with DMARD therapy. A useful intermediate goal is to have all patients evaluated by a rheumatologist within 3 months of the onset of symptoms, so that essentially all the patients with early RA, receive DMARDs within 3 months of presentation. EULAR recommends that rheumatologists should primarily care for RA patients and the treatment must be based on a shared decision between the patient and the rheumatologist.[11]

4.1. Anti-inflammatory agents: adjuncts to treatment

The therapeutic armamentarium available to treat RA has expanded considerably in recent years. It currently comprises synthetic and biological DMARDs along with analgesics, cyclooxygenase-2 inhibitors, non-steroidal anti-inflammatory drugs (NSAIDs) and corticosteroids. Anti-inflammatory therapies, including systemic and intra-articular glucocorticoids and NSAIDs, primarily act as adjuncts for temporary control of disease activity for patients in whom treatment is being started with DMARDs, patients who require modification in DMARD regimen or patients who are experiencing disease flares.[12] In patients who receive glucocorticoids, the medication should be tapered once disease control is achieved and it can be maintained, with the ideal goal of discontinuing systemic glucocorticoid therapy. Although NSAIDs and/or glucocorticoids act rapidly to control inflammation, they do not provide any benefit on their own for long-term disease control or prevention of joint injury and are also associated with adverse effects when used long term. ACR recommends the use of glucocorticoids for management of disease flares, though at the lowest possible dose and for the shortest possible duration.[9] EULAR on the other hand recommends using low-dose glucocorticoids (dose of 7.5 mg prednisone or equivalent per day or less) as part of the initial treatment strategy (in combination with one or more csDMARDs) for up to 6 months, but they also should be tapered as clinically feasible.[11] Above recommendation is supported by a review by the EULAR task force which showed that at doses less than or equal to 5 mg/day for up to 6 months, there is an acceptably low level of harm for osteoporosis, hyperglycemia, cardiovascular diseases and infections.[13]

Table 2
Disease activity assessment in RA.[6–8]

Measure	Formulae	Cut points
DAS 28 (range 0–9.4)	$[0.56 \times \sqrt{(TJC28)} + 0.28 \times \sqrt{(SJC28)} + 0.70 \times \log(ESR)] \times 1.08 + 0.16$	<2.6: remission 2.6–3.2: low disease activity >3.2–5.1: moderate disease activity >5.1: high disease activity
SDAI (range 0–86.0)	SJC28 + TJC28 + PGA + EGA + CRP	≤3.3: remission >3.3–11: low disease activity >11–26: moderate disease activity >26: high disease activity
CDAI (range 0–76.0)	SJC28 + TJC28 + PGA + EGA	≤2.8: remission >2.8–10: low disease activity >10–22: moderate disease activity >22: high disease activity

Abbreviations: SJC28, TJC28: swollen and tender joint count based on evaluation of 28 joints; PGA, EGA: patient and evaluator global assessment of disease activity; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein.

4.2. Early use of DMARDs

All patients diagnosed with RA should be started on DMARD therapy as soon as possible. Better outcomes are achieved by early, as compared to delayed intervention with DMARDs. An observational study comparing early (median disease duration of 3 months) with late (median disease duration of 12 months) initiation of csDMARD therapy showed significantly greater improvement in disease activity in the early group (within 3 months after starting DMARDs); the greater degree of improvement in the early treatment group remained statistically and clinically significant after 36 weeks of DMARD therapy (DAS28 improvement of 2.8 versus 1.7).[14]

4.3. Treat to target strategy

Treat to target strategy implies that treatment should be aimed at reaching a target of remission or low disease activity in every patient, using the standardized disease activity tool. It necessitates frequent monitoring during active disease (every 1–3 months) using a standardized disease activity tool, and if there is no improvement by at most 3 months after the start of treatment or the target has not been reached by 6 months, therapy should be adjusted. Evidence for treat to target strategy in RA comes from a systematic review of 76 papers comprising of 4 randomized trials. All identified studies showed significantly better clinical outcomes in treat to target approaches than routine approaches. Four studies compared radiographic outcomes, two of them showed significant benefit of the treat to target approach.[15] EULAR recommends starting therapy with DMARDs as soon as the diagnosis of RA is made aiming to reach a target of remission or low disease activity in every patient.[11] For patients of both early and established RA (based on disease duration less than or more than 6 months, respectively); ACR also recommends using a treat to target strategy rather than a non-targeted approach, regardless of disease activity level.[9]

4.4. DMARDs

DMARDs are so named because of their ability to slow or prevent structural progression of RA. Table 3 describes commonly used DMARDs for the treatment of RA along with their indication of use, toxicity and recommendations for monitoring. Methotrexate (MTX) is recommended as the DMARD of choice for the initial treatment of patients with moderate to severe active RA unless contraindicated.[9,11] It also serves as the "anchor" drug for the most commonly used DMARD combinations. Randomized head-to-head trials have found that MTX has a faster onset of action, comparable or greater efficacy and better long-term tolerance compared to other non-biologic DMARD mono-therapy.[16] It is also relatively cheap and available worldwide. ACR recommends using DMARD monotherapy (MTX preferred) as initial treatment over combination therapy for patients with early or established RA who have never taken a DMARD irrespective of disease activity level.[9] The rationale being that MTX is available as less costly first line therapy that has an extensive safety record with well documented clinical efficacy and those with an inadequate response can be quickly identified and subsequently treated with combination therapy prior to the development of irreversible injury. Clinical outcomes after several years of treatment are similar in trials that compared patients initially receiving MTX, who were then stepped up to combination therapy after an inadequate response, with patients initially treated with combination therapy.[17] EULAR, though, considers that both monotherapy or combination therapy of csDMARDs are effective as initial treatment strategy in DMARD naïve patients and that patient preferences and expectations of adverse events should be considered when discussing treatment options with them.[11] Combinations of MTX with either sulfasalazine (SSZ) or hydroxychloroquine (HCQ), with both SSZ and HCQ have been shown to have efficacy for initial treatment of active RA patients.[18]

The choice of therapy in patients who are unable to take MTX is based on patient preferences regarding relative risks and benefits, route of administration, and cost. Leflunomide (LEF) or SSZ may be indicated in patients who prefer an orally administered or less costly agent, while TNF-α inhibitors may be indicated for those who are not restricted by regulatory or cost constraints. Large placebo-controlled studies comparing LEF with SSZ or MTX suggest that these drugs have similar efficacy.[19,20] TNF-α inhibitors, have also been proven effective as monotherapy, compared with placebo or MTX, in randomized trials involving patients with moderately and severely active RA.[21] Additional agents like tocilizumab and tofacitinib, although comparable to MTX in achieving clinical remission,[3,22] are not preferred as initial therapy, given concerns regarding potential toxicities, costs, regulatory limitations, the limited number of trials and a lack of long-term evidence for any advantage over other therapies when a treat to target approach is employed.

Disease activity and the response to therapy should be regularly reassessed, along with monitoring for drug toxicities; every 3–5 weeks until the patient is stable and disease is under control. In patients who are resistant to initial DMARD monotherapy, which is defined as failure to achieve remission or low disease activity within 3–6 months of initiating the drug, ACR recommends using combination csDMARDs or biologics (TNF or non-TNF) or tofacitinib (all choices with or without MTX, in no particular order of preference) rather than continuing DMARD monotherapy alone, while also treating active inflammation with anti-inflammatory agents.[9] EULAR on the other hand recommends risk stratification of such patients based upon presence or absence of poor prognostic factors (high disease activity state, autoantibody positivity (rheumatoid factor and/or antibodies to citrullinated proteins) and the presence of joint damage). Those without poor prognostic factors may be changed to another csDMARD strategy and those who have poor prognostic factors may be considered for bDMARD therapy.[11]

The choice between TNF-α inhibitors or non-TNF biologics i.e. abatacept, tocilizumab and rituximab depends upon factors like availability, patient characteristics and preference; comorbidities; side effect profile of agents; regulatory, insurance, and cost limitations; and clinician experience. There is no convincing evidence that any one of the TNF-α inhibitors has greater efficacy than the others.[24] If disease activity remains moderate or high despite use of a TNF-α inhibitor (with MTX), use of a non-TNF biologic with or without MTX is preferred over using another TNF-α inhibitor.[9] Non-TNF biologics have been shown to provide similar improvement with good safety profile in patients refractory to one or more TNF-α inhibitor in an indirect meta-analysis of randomized trial data.[25] Tofacitinib is an orally administered JAK inhibitor which has shown to be effective as monotherapy or as co-therapy with MTX in patients with an inadequate response to MTX.[23,26] It has also been shown to have efficacy in patients who have not responded adequately to TNF inhibitor therapy.[27] ACR and EULAR recommend using tofacitinib for patients who have failed biological treatment.[9,11]

Most patients with RA require sustained therapy and adjustments in their treatment regimen over months to years to achieve treatment goals. Those who achieve a sustained clinical remission; ACR and EULAR recommend tapering of therapy without discontinuation of all RA therapies because the risk of flare and the need for resumption of therapy are high.[9,11]

Table 3
Commonly used DMARDs in the treatment of RA.[1,2,9,11]

DMARDS	Mechanism of action	Dose	Indication	Toxicity	Monitoring
Methotrexate (csDMARD)	Anti-inflammatory in weekly low doses	- 10–25 mg/week, orally or SC - Folic acid 1 mg/d to reduce toxicities	As 1st csDMARD or in combination to other csDMARDs and to bDMARD	- Hepatotoxicity - Myelosuppression - Infection - Interstitial pneumonitis - Pregnancy category X	CBC, chemistries monthly for 1–2 months then 8–24 weekly
Hydroxychloroquine (csDMARD)	Affects immune regulation	- 200–400 mg/d PO qd	As alternative to 2nd csDMARD or in combination with other csDMARDs	- Irreversible retinal damage - Cardiotoxicity - Blood dyscrasia	Fundus and visual field every 12 months
Sulfasalazine (csDMARD)	Anti-inflammatory salicylate and sulfa moieties	1 g b.i.d. daily, oral (500 mg b.i.d. initially)	As alternative to 1 st or 2nd csDMARD or in combination with other csDMARDs	- Granulocytopenia - Hemolytic anemia (with G6PD deficiency)	CBC and chemistry every 3 months
Leflunomide (csDMARD)	Inhibits pyrimidine synthesis	10–20 mg daily oral	As above	- Hepatotoxicity - Myelosuppression - Infection - Pregnancy category X	CBC and chemistry every 3 months
Infliximab (bDMARD)	Chimeric anti–TNF-α antibody	3–5 mg/kg body weight, 8 weekly after induction, IV	As 1 st or 2nd bDMARD after inadequate response to ≥1 csDMARDs	- ↑ risk bacterial, fungal infections - Reactivation of latent TB - ↑ lymphoma risk - Drug-induced lupus - Neurologic deficits	LFTs periodically
Etanercept (bDMARD)	Anti-TNF-α–receptor protein	50 mg weekly, SC	As above	- As above	Monitor for injection site reactions
Adalimumab (bDMARD)	Human anti–TNF-α antibody	40 mg 2 weekly, SC	As above	- As above	Monitor for injection site reactions
Golimumab (bDMARD)	Human antibody to TNF-α	50 mg/monthly, SC	As above	- As above	Monitor for injection site reactions
Certolizumab (bDMARD)	Fab portion of monoclonal antibody to TNF-α	200 mg/2 weekly after induction	As above	- As above	Monitor for injection site reactions
Abatacept (bDMARD)	Downregulation of T cells using recombinant CTLA4	IV: 10 mg/kg/4 weekly after induction SC:125 mg weekly	As 1st or 2nd bDMARD after inadequate response to ≥1 csDMARDs	- ↑ risk bacterial, viral infections	Monitor for infusion reactions
Rituximab (bDMARD)	Monoclonal antibody against CD20. Targets B cells	2 times 1 g (within 2 weeks), 6–12 monthly	As 2nd bDMARD after inadequate response to ≥1 csDMARDs	- ↑ risk bacterial, viral infections - Infusion reaction - Cytopenia - Hepatitis B reactivation	CBC at regular intervals
Tocilizumab (bDMARD)	Humanized monoclonal antibody to IL-6 receptor	i.v.: 8 mg/kg body weight/4 weekly s.c.: 162 mg weekly	As 1st or 2nd bDMARD after inadequate response to ≥1 csDMARDs	- Risk of infection - Infusion reaction - LFT elevation - Dyslipidemia - Cytopenias	CBC and LFTs at regular intervals
Tofacitinib (new agent-synthetic DMARD)	Inhibits Janus kinases (JAK)	5 mg b.i.d. orally	As 1st or 2nd DMARD after inadequate response to ≥1 csDMARDs	- Risk of infection - LFT elevation - Dyslipidemia - Neutropenia	CBC, LFTs, and lipids at regular intervals

Abbreviations: CBC, complete blood count; LFT, liver function test.

5. Knowledge gaps, future trends and research recommendations

The guidelines presented above are only to serve the providers with guidance on management of patients with RA. One must realize that the ACR and EULAR guidelines were formulated for RA patients in the developed countries, with access to care, rheumatologists and medications. These guidelines may not always apply or be feasible for application to patients with RA in some other parts of the world. Patient characteristics, disease features and response of the patients who participated in the clinical trials may not be generalizable to all RA patients.

Furthermore, access to care, access to a rheumatologist, and some of the medications may not be available to all RA patients or may be too expensive.[28] Rate of infections e.g. tuberculosis (TB), hepatitis B and C may be another factor. Thus the recommendations may not be contextually appropriate in all scenarios. Asia Pacific League Against Rheumatism (APLAR) has developed guidelines for Asia Pacific patients with RA focusing on local issues to ensure the delivery of basic care to these patients and to improve their outcomes.[29]

Issues that still need more work include prevention of infections through immunizations, screening of infection prior to initiating and during treatment with immunosuppressive medications, prevention and management of cardiovascular diseases and treatment of osteoporosis in patients of RA. APLAR recommends screening of all patients for TB, hepatitis B and C infections before initiating bDMARD therapy.[29] Those found to have an active infection should be treated before therapy with bDMARDs. It also advocates administration of all indicated vaccines at least 4 weeks prior to initiating bDMARD therapy.[29] Since these infections are preventable in patients who are to be started on immunosuppressive therapy, there is a need of universal acceptance and implementation of these recommendations.

The risk of cardiovascular disease (CVD) is doubled in RA; CVD also being the major source of morbidity and mortality in RA. The increased risk is due to both an excess of "traditional" cardiovascular risk factors as well as the underlying chronic inflammatory process. An RA specific CVD risk prediction chart is although lacking but some studies have shown support for the multiplication factor of 1.5 in the existing CV prediction charts for better delineation of this risk. EULAR recommends for prevention of CVD in RA by control of disease activity and classical risk factors like smoking, hypercholesterolemia, hypertension and obesity and the use of minimal glucocorticoid doses.[30] There is an unmet need for CVD prevention trials and RA specific CVD risk prediction charts, however due to the increased burden of CVD in RA, risk assessment with the available means and management of risk factors should be incorporated in the standard care of all RA patients.

RA patients also have a higher risk of osteoporosis and fracture compared to the general population. Mechanism for osteoporosis in RA is multifactorial and following factors have been proposed: systemic effect of RA synovitis, glucocorticoids, weight loss and endocrine changes. Higher functional disability, dose of glucocorticoid and longer disease duration has been identified as RA specific risk factors for fracture in these patients. In addition to control of RA inflammation and management of glucocorticoid-induced osteoporosis, antiresorptive therapy, such as bisphosphonates has shown efficacy. Assessment of risk using standard tools along with prevention and management of osteoporosis in RA also needs incorporation in the routine care of all RA patients.[31]

Cost effective analysis of varied "treat to target" regimens, that include head to head trials to compare the efficacy of combination csDMARDs versus bDMARDs as step up therapy after resistance to DMARD monotherapy and also to compare biological agents with each other are needed, especially for appropriate health resource allocation and utilization. In this direction, research on biosimilars, their effectiveness and safety would be a step in the right direction, as cost of some of the parent drugs may be prohibitive for some patients and countries. Trials have shown equivalent clinical efficacy of Infliximab and Etanercept biosimilars to their parent drugs for the treatment of RA, however further work is needed for their acceptance and use in the real world.

Conflicts of interest

The authors have none to declare.

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Research paper

Anterior cruciate ligament reconstruction with 70° arthroscope and flexible reamers – Early operative experience

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ABSTRACT

Anatomical graft position for anterior cruciate ligament (ACL) reconstruction is desirable. However, visualisation and positioning are challenges with the standard technique. It is known that graft integration can be improved by maximising femoral tunnel length and graft failure reduced by limiting bending angle. We planned to evaluate the use of new techniques whilst monitoring femoral tunnel length and angle.

A 70° arthroscope, through the anterolateral portal, provided improved footprint visualisation without the need to switch to a medial portal. A flexible reamer system created the femoral tunnel without hyperflexion of the knee. Femoral tunnel length was measured intra-operatively using the graduations on the reamer, and femoral tunnel angle was assessed on the post-operative radiograph (using a digital measuring tool).

In a single-surgeon, consecutive series, 55 patients were treated. When compared to the surgeon's 65 previous cases, femoral tunnel length increased significantly by 3.11 mm (40.1 (±3.49)° vs. 36.9 (±3.87)°; $p < 0.05$) with no significant change in femoral tunnel angle (37.8 (±4.97) mm vs. 39.6 (±5.11) mm; $p = 0.075$).

We discuss this technique with reference to potential advantages and disadvantages of this technology.

1. Introduction

Achieving an anatomically positioned graft has been shown to be one of the most important technical goals in anterior cruciate ligament (ACL) reconstruction with increased failure in non-anatomic grafts.[1,2] However, the surgical technique required, to accurately perform this, has proved challenging. The use of a 70° arthroscope, to visualise the ACL footprints, and flexible reamers, to create the femoral tunnel without the need for hyperflexion, offers some potential benefits.[3] However, improvements in technique must be balanced against the desire to minimise graft failure. Decreasing the femoral tunnel length and changing the graft-bending angle have both been shown to result in increased failure rates.[4] Therefore, we set out to assess our ability to use these new techniques without adversely affecting the femoral tunnel parameters.

2. Methods and materials

2.1. Patients

55 consecutive single-bundle primary ACL reconstructions (using the 70° arthroscope and flexible reamers) were compared to the 65 consecutive previous cases (using a 30° arthroscope and straight reamers). The data was prospectively collected in a database derived from the operation notes. Radiological data was added prospectively following completion of the post-operative radiographs. The group demographics are displayed in Table 1 demonstrating good age- and sex-matching.

Table 1
Patient demographics in study groups.

	Group	
	Using straight reamers	Using flexible reamers
Total number	65	55
Mean age (yrs)	29	32
Sex	44M:21F	39M:16F

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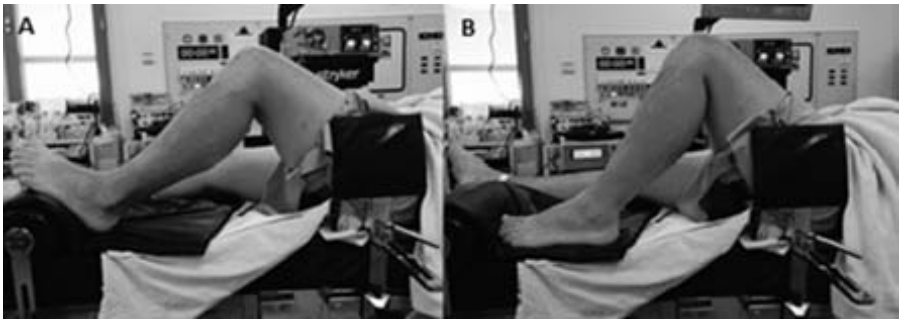

Fig. 1. Photographs of set-up showing: (A) 90° flexed position for arthroscopy and preparation and (B) 90–100° position needed for reaming with the flexible system.

2.2. Surgical technique

After induction of anaesthesia and administration of prophylactic antibiotics, an examination was performed of both knees. A high tourniquet was applied and the limb was prepared and draped. The leg was positioned at 90°, using a cylindrical prop under the foot, and a lateral support. This allowed for an additional small amount of flexion without moving the props (Fig. 1).

Autologous hamstring graft was used in all cases. After harvesting and sizing of the graft, the two portals were established (Fig. 2). The anterolateral (AL) portal was positioned high and close to the lateral edge of patella tendon. A low anteromedial (AM) portal (slightly away from the medial edge of the patella tendon) was then made under direct vision, just above the medial meniscus.

Systematic arthroscopy was performed (using a 30° arthroscope) and treatment for any co-existing pathology was completed. At this stage, the 30° arthroscope was changed to the 70° arthroscope. This was achieved swiftly using a Clinicon quick-change camera drape (P3 Medical, Bristol, England), meaning only one camera was required (Fig. 3).

The tibial tunnel was prepared first and blocked to limit loss of fluid. To drill the tibial tunnel, the 70° arthroscope (via the high AL portal) provided a bird's eye view of the footprint. The posterior border of the anterior horn of the lateral meniscus (PBAHLM) was used, as a landmark, as the senior author believes this to be the most consistent and easily identifiable landmark for remnant preserving ACL reconstruction. The tunnel was centred either at the same level as the PBAHLM or just anterior to it (depending on preoperative magnetic resonance imaging (MRI) assessment).

To drill the femoral tunnel, the footprint was identified based on the remaining stump and the bony landmarks (intercondylar and bifurcate ridges). There was no need to hyperflex the knee. The entry point for the femoral tunnel was marked with a microfracture awl. We then used the Stryker VersiTomic Flexible Reaming System (Kalamazoo, MI). The curved guide was used to position the flexible guidewire (Fig. 4). This compensates for the decreased flexion used by allowing curvature in the wire prior to the entry point (the wire is straight within the femur). The angle and direction of the guide, along with the degree of knee flexion, dictates the length and the angle of the tunnel and also the aperture shape (round or elliptical) of the tunnels.

Fig. 2. Photograph of standard portal position for right knee. Anterolateral – high and medial (close to patella tendon). Anteromedial – low and medial just about the medial meniscus.

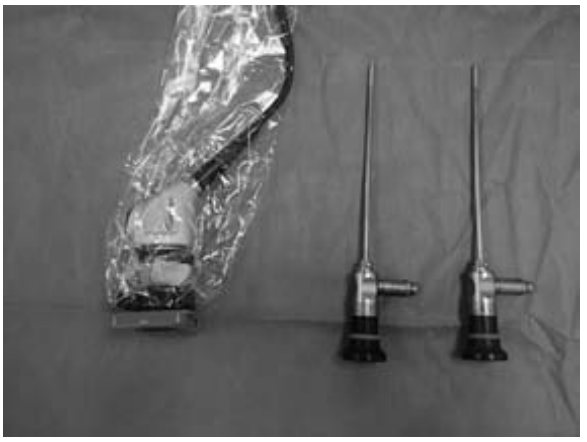

Fig. 3. Stryker camera (Kalamazoo, MI) covered with Clinicon drape and Olympus 30° and 70° arthroscopies (Center Valley, PA).

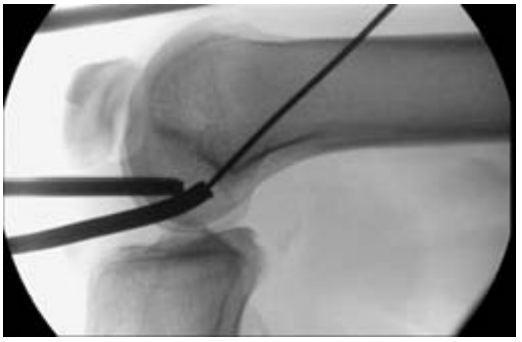

Fig. 4. Lateral radiograph showing curved guide within the knee and guidewire straight within the femur.

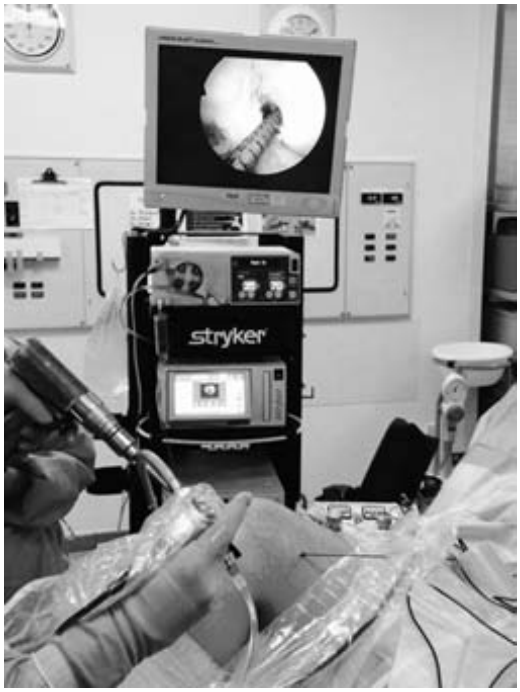

Fig. 5. Photograph showing flexible reamers in use through AL portal. On screen, graduations on reamer clearly seen.

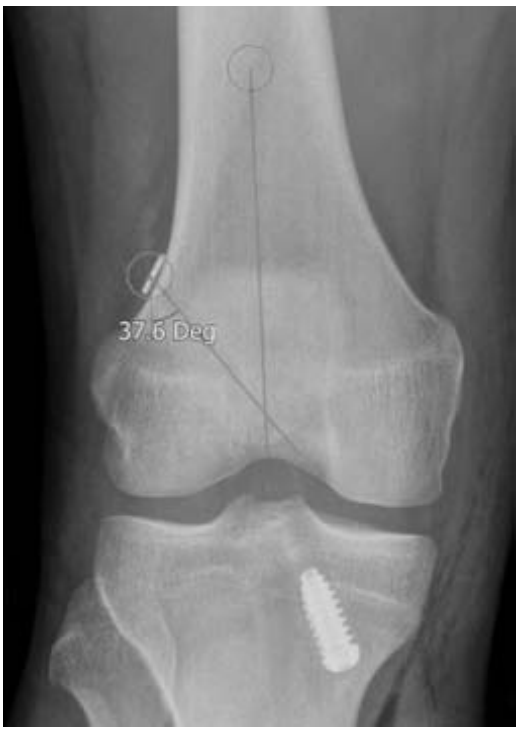

Fig. 6. Illustrative radiograph demonstrating calculation of femoral tunnel angle – measured angle between femoral anatomical axis and line through centre of femoral tunnel.

The femoral tunnel was then created using the flexible reamers. The benefit of a clear view at this stage (having prevented the poor flow encountered in a hyperflexed position) can be noted (Fig. 5). Next, a suture loop was passed retrograde up this tunnel.

The suture loop was grabbed into the tibial tunnel and the graft pulled from the tibial tunnel into the femoral tunnel and fixed using a suspensory device.

Following repetitive cycling of the knee, arthroscopic inspection was performed and final images captured.

2.3. Evaluation and comparison

Femoral tunnel length was recorded intra-operatively for each case using the graduations on the reamer. Femoral tunnel angle, as a surrogate for graft-bending angle, was calculated from the post-operative anteroposterior radiograph using a digital measuring tool (Insight Web, Insignia Medical Systems, Hampshire, UK) (Fig. 6).

Statistical analysis was performed using SPSS Statistics v22.0 (IBM, Armonk, NY) with groups compared using an unpaired *T*-test.

3. Results

The results are summarised in Table 2.

The femoral tunnel length was found to increase from 36.9 (±3.87) mm to 40.1 (±3.49) mm with the use of flexible reamers. This was statistically significant ($p < 0.05$).

The femoral tunnel angle was not changed by the use of flexible reamers in a less flexed position (39.6 (±5.11)° vs. 37.8 (±4.97)°; $p > 0.05$). There were no cases of posterior wall blow-out and no guidewire breakage.

Table 2
Comparison of femoral tunnel between groups.

	Group		*p*-Value
	Using straight reamers	Using flexible reamers	
Femoral tunnel length (mm)	36.9 (±3.87)	40.1 (±3.49)	0.003
Femoral tunnel angle (°)	39.6 (± 5.11)	37.8 (±4.97)	0.075

4. Discussion

Graft position and surgical technique have evolved as our understanding of ACL biomechanics and reasons for graft-failure has improved. Transtibial femoral tunnel placement is still used by some surgeons but this has largely been replaced by transportal drilling. The main reason for this is that, using a transtibial method, the femoral tunnel position is dependent on the tibial tunnel. This relationship has been shown to result, more frequently, in a tibial tunnel in the posterior aspect of the footprint, a high femoral tunnel position and a vertical graft.[5,6] As such, much published work has focused on the importance of anatomical ACL reconstruction using the native footprints as a guide to graft positioning.

Although transportal techniques allow for independent positioning of the femoral tunnel, they are not without their problems. Traditional arthroscopic set-up (using a 30° arthroscope through an AL viewing portal and instruments via an AM portal) makes visualisation of the footprints of the ACL on the femur and tibia difficult (Figs. 7 and 8). This can be improved by viewing through the AM portal and drilling through and accessory medial portal.[7] The improved view is shown in Fig. 7b. However, the surgeon is limited by instrument crowding on the medial side. In addition, this set-up varies from one that most surgeons find comfortable and requires additional time establishing this portal and switching the arthroscope.

Using rigid guidewires requires a hyperflexed position to avoid a short femoral tunnel or posterior wall blow-out. This hyperflexed position can decrease saline flow and may result in fat-pad obstruction of the visual field. This creates difficulties in accessing

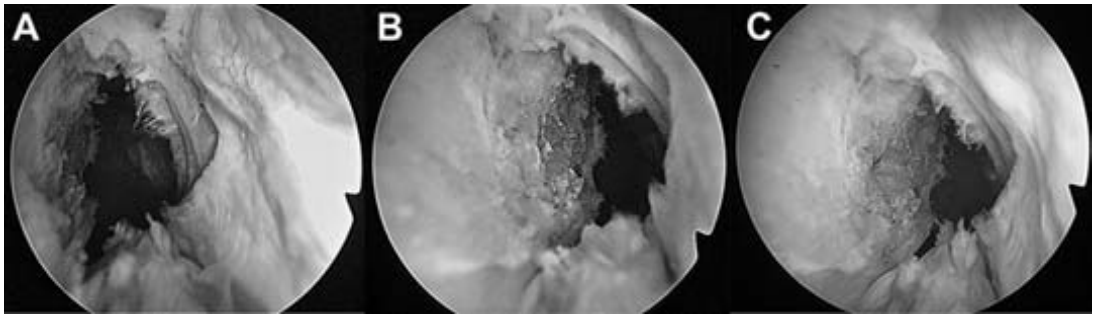

Fig. 7. Arthroscopic photographs showing a comparison of views of femoral footprint using 30° arthroscope ((A) via anterolateral portal; (B) via anteromedial portal) against (C) view from 70° arthroscope via anterolateral portal.

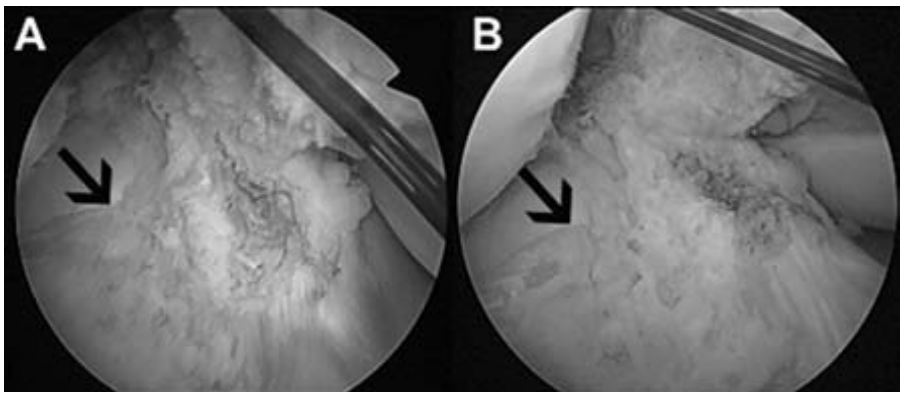

Fig. 8. Arthroscopic photographs showing a comparison of tibial footprint viewed (A) via AL portal using a 30° arthroscope and (B) a 70° arthroscope.

measurements (tunnel length) and requires frequent clearance adding more to the surgical time. In addition, a hyperflexed position is difficult to achieve in obese or highly muscled patients and risks damage to the medial femoral condyle and posterolateral neurovascular structures. Our described method addresses these problems without adding to surgical time.

We have previously described the use of a 70° arthroscope via the AL portal to provide excellent views of the femoral and tibial footprints without the need to establish additional portals.[8] The use of a quick-change camera drape means this adds minimal time to the procedure. An additional benefit of using the 70° arthroscope is that it gives an improved view down each of the created tunnels. It facilitates a 360° view of both femoral and tibial tunnels that can be used to ensure that there is no posterior blow-out of the femoral tunnel and that the tunnel walls are healthy. This is particularly important to ascertain in revision cases.

The use of the 70° arthroscope should be something that skilled surgeons are able to adapt to with little difficulty. This arthroscope is routinely used in the hip and many knee surgeons will have experience of using it for posterior cruciate reconstruction. Using the 70° arthroscope through a more accustomed AL portal prevents crowding on the medial side (and within the notch). The view of the footprints is superior to the 30° arthroscope via the AL or AM portals (Figs. 7 and 8). This allows for more accurate positioning of the femoral tunnel (particularly in remnant-preserving surgery) as well as providing a ''Bird's-eye'' view of the tibial footprint and PBAHLM.

The use of the flexible reamer system has a number of benefits. The system allows the guidewire to be introduced in a 90–100° flexed position (negating the problems associated with a hyper-flexed position). Also, studies have both shown that the use of flexible reamers more accurately positions the graft and produces longer femoral tunnels.[9,10] Furthermore, the curved guide results in the guidewire entering obliquely to the medial wall of the femoral condyle. The result of changing this angle is that the aperture is more oblique.[10] It has been suggested that this may benefit the fixation of the graft and the coverage of the femoral footprint.[5,11–13]

The operative technique for the combined use of a 70° arthroscope and flexible reamers has been previously reported Rasmussen et al.[3] This group highlighted many of the benefits that we have suggested. Further to this, our work demonstrates the perceived benefits of femoral tunnel length and graft bending angle are achieved over a series of cases.

Potential disadvantages of the flexible reaming system include the additional cost of the equipment and risk of guidewire breakage.[14] However, the additional expense, limited to the purchase of the guidewires (once the reaming system has been purchased), may be off-set against potential operative time savings. The flexible wire becomes rigid (due to friction as it passes through the guide). Therefore, breakage within the bone seems unlikely and can be limited by reaming in a fixed position (preventing stress at the femoral entry point).[14] A further potential risk is that of deflection of the wire on the skin. However, we found no reports of this. We encountered none of these issues in our series and larger studies may be required to quantify these specific risks.

Limitations of our work include a lack of patient height measurement. Graft-bending angle can be more accurately calculated using three-dimensional imaging techniques but we believe that FTA provides an adequate surrogate for this comparison.

In a single-surgeon, consecutive-patient series, our data suggests that this combination of using a 70° arthroscope and flexible reamers provides the benefit of increased femoral tunnel length without affecting the FTA. Improved visualisation (and graft position) is achieved without the need for an additional portal, instrument crowding or hyperflexion. We feel this technique is

therefore worth consideration. Further work is required to fully prove the apparent advantages of this technique and correlate these to potential improvements in clinical outcome. As the described technique is now our standard for primary ACL reconstruction, we plan to combine this work with three-dimensional computer tomography analysis of tunnel volume and position, femoral aperture dimensions and shape.

Author's contribution

Vipul I. Mandalia: Development of technique, performed surgery, provided pictures, edited manuscript; Jonathan D. Kosy: Radiological review, literature search, prepared manuscript, edited manuscript.

Conflicts of interest

The authors have none to declare.

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Original Article

Comparative study of anatomical anterior cruciate ligament reconstruction versus conventional anterior cruciate ligament reconstruction

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ABSTRACT

Background: Aim of our study was whether anatomical placement of femoral tunnel using central Gillquist portal for visualization improves the rotational and antero-posterior translational stability as compared to conventional two portal technique of placement of femoral tunnel, where anterolateral portal is the visualization portal and anteromedial portal is the working portal. We define this latter method as non-anatomical placement, because we cannot visualize the face of medial surface of lateral femoral condyle and use jig to make the femoral tunnels.

Materials and methods: This study was a retrospective and prospective study conducted in the Department of Orthopaedic Surgery, NSCB Subharti Medical College, Meerut, over a period of 4 years in patients undergoing arthroscopic ACL reconstruction. The follow-up examination included knee joint range of movement assessment, Lachman test, Pivot shift test, IKDC score and Lysholm score at 6 weeks, 3 months, 6 months and 1 year.

Results and conclusions: On final assessment, we concluded that anatomical method of ACL reconstruction gives superior results for antero-posterior stability and although there is not much difference in functional scores when assessed using IKDC scores, but a small statistically significant difference is seen when assessed by using Lysholm scores for functional scoring.

1. Introduction

A torn anterior cruciate ligament (ACL) is a common injury of knee joint, and its reconstruction is a challenging one. It is mostly related to sports activities. The activities of modern life, be it domestic or professional, predispose the individual to ACL injury.

The primary function of the ACL is to prevent anterior translation of the tibia. It acts as a secondary stabilizer

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against internal rotation of the tibia and valgus angulation at the knee. Loss of the ACL leads to a decreased magnitude of this coupled rotation during flexion and an unstable knee.

The main mechanism of injury to the ACL being torn is usually non-contact involvement. The most frequent way that the ACL is torn is that the athlete has a planted foot with the knee in an almost extended position (sometimes hyper-extended)[1] and the tibia is generally rotated toward the inside or mid-line of the body, while the knee is flexed greater than 90°.

Review of literature for ACL surgery suggests that it took a long time for some diagnostic and management techniques to establish themselves. Since the early 20th century, there has been increasing awareness of, and interest in, the ligament and its lesions.[2]

In conventional method of ACL reconstruction, we do not try to identify the original insertion points on the lateral femoral condyle but in anatomical reconstructions an attempt is made to place the graft lower down in center of the femoral insertion of ACL on the medial side of lateral femoral condyle below the resident's ridge on either side of the lateral bifurcate ridge. It is difficult to visualize the face of the medial surface of lateral femoral condyle using a scope in antero-lateral portal because of the overhang of the anterior surface of condyle but it is possible to visualize it better with a central portal through the ligament patellae or through the conventional antero-medial portal.

We were able to directly visualize and identify the resident's ridge as well as the footprints of the femoral attachment of the ACL more clearly using the central Gillquist portal.[3] This method of reconstruction has been considered as the anatomical method of ACL reconstruction in our study.

ACL reconstruction with conventional two-portal technique was defined as the non-anatomical method of reconstruction of ACL, which we have used jig to make the femoral tunnel.

Aim of our study was to determine, whether anatomical placement of the femoral tunnel using central Gillquist[3] portal for visualization improves the rotational and antero-posterior translational stability as compared to the conventional two portal non-anatomical ACL reconstruction technique of placement of the femoral tunnel.

2. Materials and methods

This study was a retrospective and prospective study conducted in the Department of Orthopaedic Surgery, NSCB Subharti Medical College, Meerut, over a period of 4 years in patients undergoing arthroscopic ACL reconstruction. A total of 60 patients were included in the final study. All the patients included in the study were operated by the same surgeons. 30 patients were operated by the anatomical method of ACL reconstruction using a third Gillquist[3] portal to visualize the femoral attachment of ACL between August 2013 and August 2015, comprised our prospective study group. The data of thirty patients, who had undergone ACL reconstruction by conventional two portal technique from August 2011 to August 2013 was collected from hospital records and were followed up. This comprised our retrospective study group.

In both anatomical and non-anatomical groups patients were young active individuals between 18 and 45 years of age from the western region of Uttar Pradesh, India. Majority of the patients were male individuals. In anatomical group there were 27 males and 3 females and in non-anatomical group there were 28 males and 2 female patients.

Standard arthroscopic portals antero-lateral and antero-medial were created. In the anatomical group of patients, besides these two portals an additional central Gillquist[3] portal was made through the center of patellar tendon 1 cm below the apex of patella. A single femoral tunnel was created from the antero-medial portal while the scope was placed in the central portal. The tunnel was placed in the center of the ACL footprints under direct vision. Tibial tunnel was made in the standard fashion in both groups using standard tibial jig.

A mean follow-up of 1 year was taken. Lysholm and IKDC scoring was done in all patients preoperatively and at the end of follow-up to evaluate the functional outcome and they were compared in the two groups and put to statistical analysis to reach our conclusions. Further clinical evaluation was done using Lachman and Pivot shift test to test the antero-posterior and the rotational stability, and the two groups were compared based on their results. We indigenously designed a device called Laxometer based on principles of the Rolimeter to objectively assess the anterior translation of tibia on Lachman and Anterior Drawer test, but Pivot shift test remained a subjective test. In order to eliminate inter-observer bias, the findings were verified by two independent consultants (Photograph 1).

The follow-up examination was done at 6 weeks, 3 months, 6 months and 1 year.

Rehabilitation protocol was same for both the groups. Statistical analysis was done using chi square test for quantification of Lachman and Pivot shift test, as it is a frequency table and t test was used to quantify Lysholm and IKDC scores. In all tests value below 0.05 was considered significant.

3. Results

On final assessment, we concluded that anatomical method of ACL reconstruction gives superior results for antero-posterior

Photograph 1 – Showing Lachman test with the Laxometer.

Table 1 – Comparison of Lachman test.

Lachman's test	Pre-operative		Post-operative		P-value	Significance
	AN ($n = 30$)	NA ($n = 30$)	AN ($n = 30$)	NA ($n = 30$)		
Negative	0	0	9 (30%)	2 (6.66%)	0.019	Yes
Grade-1	0	0	21 (70%)	28 (93.33%)		
Grade-2	27 (90%)	28 (93.33%)	0	0		
Grade-3	3 (10%)	2 (6.66%)	0	0		

AN, anatomical; NA non-anatomical.

Table 2 – Comparison of Pivot shift test.

Pivot shift test	Pre-operative		Post-operative		P-value	Significance
	AN ($n = 30$)	NA ($n = 30$)	AN ($n = 30$)	NA ($n = 30$)		
Grade-0	0	0	28 (93.33%)	26 (86.66%)	0.389	No
Grade-1	0	0	2 (6.66%)	4 (13.33%)		
Grade-2	0	0	0	0		
Grade-3	30 (100%)	30 (100%)	0	0		

AN, anatomical; NA non-anatomical.

stability but statistically insignificant difference in the functional scores, when assessed using IKDC scores, and a statistically significant difference is seen when assessed by using Lysholm scores for functional scoring.

Table 1 demonstrates that there was an improvement in the antero-posterior stability in both groups of patients after ACL reconstruction surgery at final follow-up but it appears from the table that nine of the patients (30%) in anatomical group could achieve a negative Lachman at final follow-up but only two of the patients from the non-anatomical group could achieve similar results. This shows that the results were better in patients in anatomical group compared to patients in non-anatomical group, which is also confirmed on statistical analysis.

Rotatory stability was tested by Pivot shift test and graded according to the degree of shift. In order to reduce the influence of inter personal variation two independent surgeons performed the tests in addition to the main investigator to confirm the value. The results are shown in Table 2. Statistical comparison done between the two groups of patients on post-operative follow-up does not show a significant difference in rotational stability in patients operated by anatomical method of ACL reconstruction.

At the end of final follow-up, all patients in both groups achieved good stability on performing the Anterior Drawer test though the amount of laxity was more in non-anatomical group as compared to anatomical group as shown in Table 3.

Functional scoring was done by calculating IKDC and Lysholm scores in pre-operative period and again at final follow-up and comparison of results was done in the two groups of patients operated by anatomical method of ACL reconstruction and those by non-anatomical method of ACL reconstruction. There was significant improvement in the functional scores by both methods between the pre and post-operative periods but the mean functional scores were higher in anatomical group on final follow-up as compared to patients in non-anatomical group respectively.

However on statistical analysis done using the unpaired *T* score shows that there was no significant difference between the two groups on IKDC scores but a significant difference could be seen between the two groups on Lysholm scores as shown in Table 4.

4. Discussion

The purpose of this study was to compare the anatomical method of making femoral tunnels in the footprint of ACL (by direct visualization using the additional central Gillquist portal[3]) by single bundle technique versus the conventional non-anatomical method of making femoral tunnels (using the traditional antero-lateral portal for visualization and using the femoral ACL jig using the antero-medial portal for making femoral tunnel) in patients undergoing arthroscopic ACL reconstruction in our institute.

Table 3 – Anterior Drawer test.

Anterior Drawer test (mm)	Pre-operative		Post-operative	
	AN ($n = 30$)	NA ($n = 30$)	AN ($n = 30$)	NA ($n = 30$)
1	0	0	17 (56.66%)	0
2	0	0	12 (40%)	3 (10%)
3	0	0	1 (3.33%)	26 (86.66%)
4	0	0	0	1 (3.33%)
5	0	0	0	0
6	4 (13.33%)	4 (13.33%)	0	0
7	18 (60%)	20 (66.66%)	0	0
8	8 (26.66%)	6 (20%)	0	0

AN, anatomical; NA non-anatomical.

Table 4 – Comparison of Lysholm and IKDC scores.

Mean score	Pre-operative		Post-operative		P-value	Significant (yes/no)
	AN ($n = 30$)	AN ($n = 30$)	NA ($n = 30$)	NA ($n = 30$)		
Lysholm's	37.61	31.93	95.63	92.56	0.012	Yes
IKDC	35.47	32.33	92.90	91.96	0.637	No

AN, anatomical; NA non-anatomical.

ACL reconstruction has progressed from the trans-tibial placement of isometric single bundle grafts through the complex surgery of double bundle reconstruction.[4] The appreciation of the technical difficulty of double bundle reconstruction showing the lack of a clear advantage in clinical outcome and the improved awareness of the anatomy of the ACL insertion has led to a consideration of resorting to anatomical single bundle ACL reconstruction.[5]

The concept of complete footprint restoration has recently been suggested by Siebold et al.[4] This concept is based on the hypothesis that restoration of the biomechanical function of an ACL restored knee is a function of the reconstructed ACL insertion site area. The natural variations in insertion site morphology with length measurement between 8 and 21 mm. Small footprints up to 13 mm can be restored using anatomical single bundle reconstruction whereas larger double bundle grafts may be required for footprints of 16 mm or more.

The principles for anatomical ACL reconstruction are to functionally re-establish the ACL to its native dimensions, collagen orientation, and insertion sites, which are likely to achieve better function and satisfactory long-term outcomes. The basis for the completion of these principles lies in the correct identification of the insertion sites.

In our study, we have also used a third central Gillquist[3] portal popularized by Fu.[5] A ''central'' portal was placed using a spinal needle under arthroscopic visualization following the orientation of the previous ACL fibers. This portal was used to place the arthroscope for visualization of medial aspect of the lateral femoral condyle to get a proper view of the soft tissue remnants and bony landmarks facilitating an anatomical positioning of the graft. The femoral tunnel was made using an antero-medial or accessory antero-medial portal.

With the conventional two portal technique, a limited view is obtained of the lateral wall of the femoral inter condylar notch, which could result in inaccurate placement of the femoral tunnel. The use of a third Gillquist[3] portal is gaining popularity with the increased number of surgeons performing anatomical ACL reconstructions. This technique allows interchangeable use of the portals as a viewing and working portals depending on the specific task that is being performed. It allows a straightforward view of the femoral ACL bundles insertion sites that are unlikely visualized with the standard antero-lateral portal. Thus, once adequate view of the lateral intercondylar notch is achieved, there are no indications for additional procedures as notchplasty. This allows preservation of the native bony anatomy and soft tissue remnants, which can be used as landmarks to guide anatomical positioning of the femoral tunnel.

The present study showed that anatomical method of ACL reconstruction by making a central Gillquist[3] portal for better visualization of ACL footprint on medial femoral condyle and making femoral tunnel under direct vision is better than the conventional non-anatomical method (using two portal technique), because it gives better antero-posterior and rotational stability and has superior results for functional scoring with Lysholm score but identical results using IKDC scores. These results are similar to various studies as done by Hussein et al.[6] and Zantop et al.[7]

Zantop et al.[7] showed that ACL reconstruction with non-anatomical postero-lateral bundle placement showed significantly higher anterior tibial translation under anterior tibial and combined rotatory load than did the intact knee at 0° and 30° of knee flexion ($P < 0.05$). Reconstruction with an anatomical postero-lateral tunnel placement restored the intact knee kinematics and showed significantly lower anterior tibial translation under anterior tibial and combined rotatory load when compared with reconstruction with non-anatomical postero-lateral placement ($P < 0.05$).

In our study we also obtained similar results in anatomical ACL reconstruction group of patients where antero-posterior tibial translation was significantly lower compared to those operated by non-anatomical ACL reconstruction as shown by Lachman test ($P = 0.019$).

In a study of 281 cases Hussein et al.[6] showed anatomic single-bundle reconstruction resulted in better antero-posterior and rotational stability than non-anatomical single bundle reconstruction. In Pivot shift test, the difference was also significant.

In their study Hussein and Fu[6] had a significant difference between two groups on Pivot shift tests and Lachman tests but Lysholm score was not significant. In our study, significant difference was present between the two groups on Lachman test, and Lysholm score was better for anatomical group.

The contrast between our study and Hussein et al.[6] is maybe due to the large no. of patients in their study compared to ours. They also had a follow-up of 2–5 years compared to just 1 year in our study. While in our study, all patients were operated by antero-medial portal in Hussein[6] study transtibial route was also used.

Fujita et al.[9] showed no difference between the two groups with respect to Pivot shift test. The limitations of his study were the decreased follow-up of 1 year same as in our study wherein the follow-up was also only for 1 year.

There were several limitations to our study. Firstly we had a small sample size of only 60 patients. Also our follow-up was also only for 1 year. Longer follow-ups though do not necessarily imply worse results, if we take into account the existing literature for anatomical technique.[10] Moreover, the same rehabilitation instructions were given to all patients and physical therapists. Considering the lack of comparison studies between both techniques, investigations with high internal validity are evidently warranted. Third, the causal-effect relationship between the surgical technique and the

main outcomes may be questioned given the observational cross-sectional nature of this study. However, because both groups were highly homogeneous, discrepancies between groups can be attributed to differences in surgical technique. Overall, a small sample size may not be considered a limitation as 60 patients were an adequate sample size to detect significant differences in main clinical outcomes (knee stability and Lysholm, IKDC values). Following the same reasoning, subjective variables (which were not significantly different) may be affected by a small sample size. We are confident on the limited impact of these differences on the outcome comparisons, since the minimum 1 year follow-up period established in this study is considered enough time to return to normal life and sports.[8]

5. Conclusion

Anatomical method of ACL reconstruction by making a central Gillquist[3] portal for better visualization of ACL footprint on medial femoral condyle and making femoral tunnel under direct vision is better than conventional non-anatomical method (using two portal technique), because it gives better antero-posterior stability and has superior results for functional scoring in Lysholm's.

Conflicts of interest

The authors have none to declare.

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Research paper

Traumatic isolated osteochondral fractures of medial femoral condyle treated with multiple retrograde Kirschner wires – A simple cost-effective technique

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ABSTRACT

Management of osteochondral fractures of the knee is very crucial to prevent early onset osteoarthritis in young adults. Currently, fixation by biodegradable screws, bioresorbable pins or meniscus arrows can be expensive and also carries risk of complications, such as synovitis and osteonecrosis. In a developing country such as India, there is a need of cost-effective, safe and reproducible treatment option to fix these kinds of fractures. We report the results in 11 patients (seven males and four females) with mean age of 28.09 years, with isolated traumatic osteochondral fracture of medial femoral condyle that was treated between June 2011 and May 2015 with multiple Kirschner wires (K wires). Mean time interval between injury and surgery was 4 days (range, 2–6 days). Through medial parapatellar arthrotomy, the fragment was fixed to its corresponding bed in the medial femoral condyle in a retrograde manner with multiple non-parallel K wires (1.6–2.5 mm). K wires were first drilled through the reduced fragment, the medial femoral condyle and out through the skin on medial side of knee and distal thigh while ensuring through the arthrotomy site that the intra-articular tips of the wires were flush or just buried below the cartilaginous surface of the fragment. Mean time of the union was 8.5 weeks and full range of motion was achieved by 11 weeks. Mean follow-up was 54 weeks (range, 40–64 weeks). Clinical outcomes were found to be excellent in all the patients. Mean IKDC score was 94.9, mean Lysholm score was 94.8 and mean Likert score was 4.63 (range, 4–5) indicating a high level of satisfaction. None of the patients developed any major complications. In third world countries with limited resources, multiple K wires are a safe, reproducible and relatively inexpensive method of treating these complex joint injuries in young adults.

1. Introduction

Traumatic osteochondral fracture of the knee is a common clinical entity in orthopaedic surgery and was first described in 1943 by Milgram.[1] Large osteochondral fractures are uncommon and an early diagnosis is essential for primary fixation of the fragment. The main purpose of fragment fixation is to maintain contour of the joint and prevent the development of early onset osteoarthritis. The aetiology and management of osteochondral fracture is very well different from other osteochondral problems, such as Ahlbacks disease or osteochondritis dissecans. Osteochondral fractures generally present at lateral femoral condyle and are associated with tearing of anterior cruciate ligament (ACL) and patellar dislocation.[2] However, a direct shearing force to the knee can also lead to an isolated osteochondral fracture of the medial femoral condyle. The management of osteochondral fracture presents a complex and a daunting task for orthopaedic surgeons, particularly in young patients with large osteochondral fragments. There are only a handful of options available in literature for fixing the fractures. Management of these lesions can be done by two different ways, either removal of small fragment and allowing injured part to regenerate or re-fixation of osteochondral fragment

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Table 1
Patient master chart.

S no.	Age (in years)	Side	Interval between injury and surgery (in days)	Union time (in weeks)	IKDC score at final follow-up	Lysholm score at final follow-up	Likert scale at final follow-up
1	24	Right	3	8	98	96	5
2	26	Left	4	10	93	93	4
3	22	Right	4	8	96	97	5
4	28	Right	5	9	94	95	5
5	32	Left	6	8	97	97	5
6	36	Right	2	9	95	94	4
7	29	Left	2	8	94	94	5
8	27	Right	4	9	92	93	4
9	31	Right	6	9	94	92	4
10	30	Left	3	8	96	96	5
11	24	Right	5	8	95	96	5

to its original anatomical position. In the past, various surgeons considered it as loose body and had a tendency to remove it, leaving an area of bone denude of cartilage.[2] Currently, in modern orthopaedics, there has been an inclination towards complete restoration of osteochondral fragment. Several surgical techniques have been proposed for the fixation of the osteochondral fractures, such as fixation of osteochondral fragment by means of biodegradable screws, bioresorbable pins, bridging sutures or meniscus arrows.[3,4] If avascular and comminuted osteochondral fragments are there, then artificial osteochondral grafts and autologous chondrocyte implantation (ACI) can be employed to fill the cartilage defect. In a developing country like India, where a large number of athletes sustain this type of injury, these treatment options are quite expensive procedures and cannot be afforded by most patients. Further, The Central Drugs Standard Control Organization (CDSCO) in India has not yet approved the laboratories for culture preparation for autologous chondrocyte implantation. Fixation of a displaced viable osteochondral fragment to its bed in the femoral condyle with multiple Kirschner wires (K wires) is a novel, simple, cost-effective and reproducible treatment alternative for managing these type of injuries in young population. The purpose of this study is to report our clinical results and highlight a safe, economical and effective surgical method for fixation of osteochondral fractures.

2. Materials and methods

This was a retrospective study where we retrieved the records of 21 patients who underwent fixation of osteochondral fragment between June 2010 and May 2015. Isolated traumatic osteochondral fractures of medial femoral condyle were included in the study whilst excluding patients with associated ligament injuries, meniscus tear or patellar instabilities. 12 patients fulfilled the inclusion criteria; one patient was untraceable, leaving 11 patients (seven males and four females) in the present study. Their mean age was 28.09 years (range, 22–36 years) and right side ($n = 7$) was more commonly involved than the left ($n = 4$) (Table 1). The predominant mechanism of injury was a twisting injury imparting

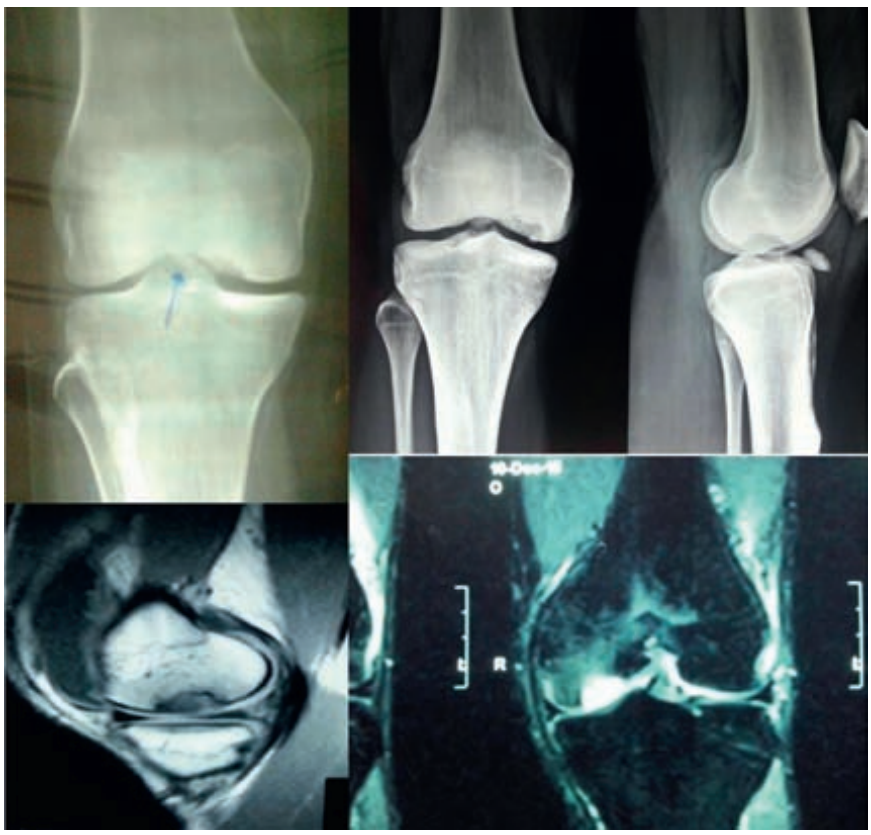

Fig. 1. Preoperative radiographs and MRI scan of knee showing displaced osteochondral fragment (OCF) and defect in the medial femoral condyle (MFC).

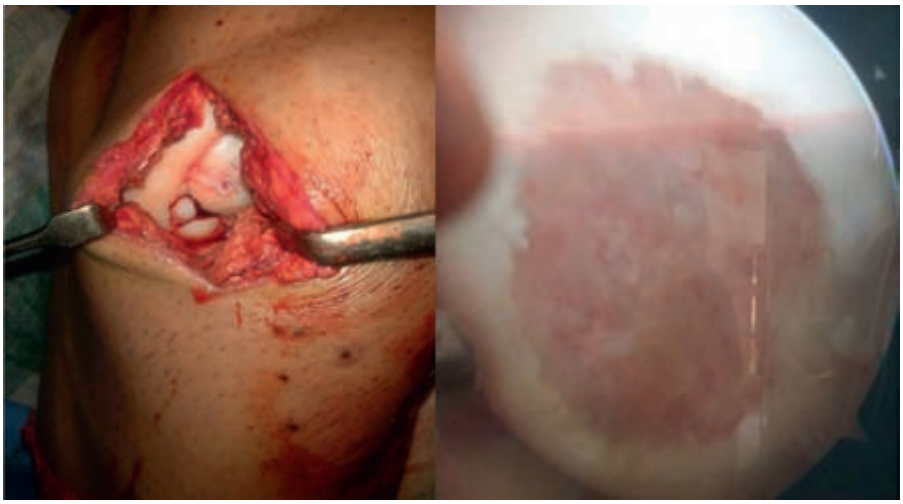

Fig. 2. Intraoperative arthroscopic and arthrotomy pictures showing cartilage defect in MFC and after fixation of the fragment in its bed with multiple K wires.

a shearing force to the knee. All patients had presented with pain, swelling, tenderness and restricted range of motion in the involved knee. The limb was initially splinted and elevated. Eight patients had significant haemarthrosis at presentation, which was aspirated under local anaesthesia. Standard radiographs (anteroposterior and lateral) of the involved knee showed the presence of osteochondral fracture of the medial femoral condyle that was completely displaced (Fig. 1). All the patients were then subjected to preoperative MRI of the knee for confirming the diagnosis, revealing the extent and size of osteochondral fragment, and ruling out associated patellar dislocation or other ligamentous injuries (Fig. 1). All the patients were planned for surgical treatment after an informed written consent was obtained. The mean time interval between injury and surgery was 4 days (range, 2–6 days) (Table 1). With the patient in supine position, standard anterolateral and anteromedial portals were made. The knee joint was subjected to diagnostic arthroscopy and the osteochondral fractured fragment along with the native bed of the fractured fragment on the femoral condyle was identified (Fig. 2). Medial parapatellar arthrotomy was done by extending the anteromedial portal (Fig. 2). Osteochondral fragment was fixed to its bed in the medial femoral condyle with multiple Kirschner (K) wires (1.5–2.5 mm). Through

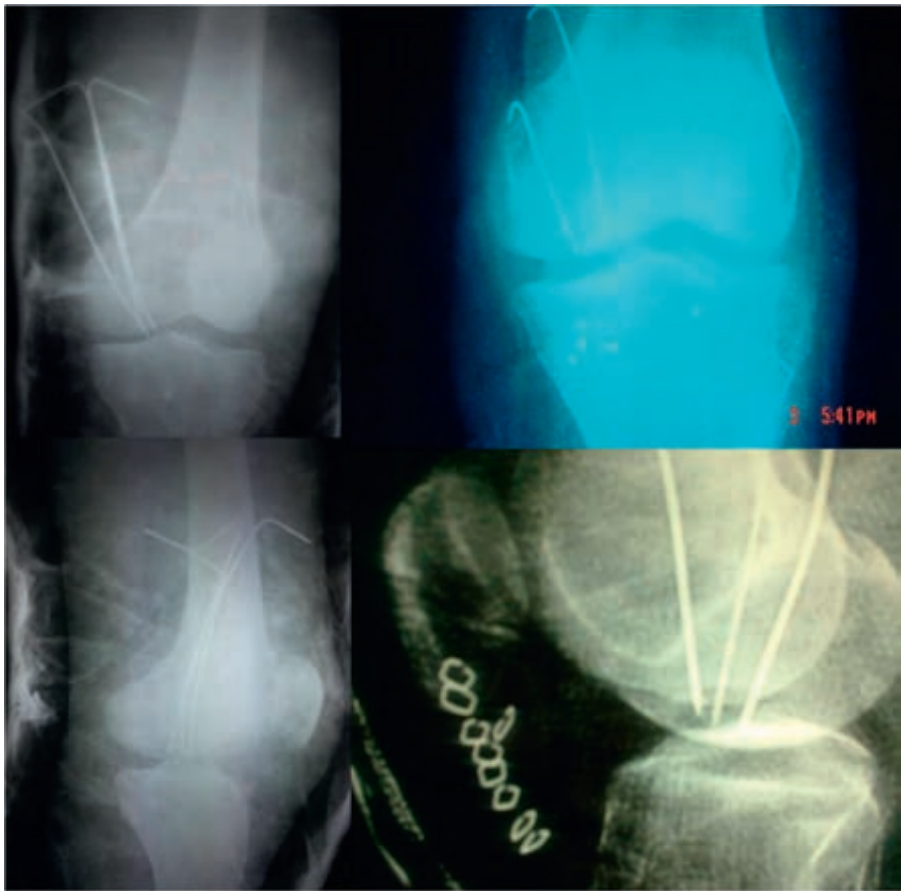

Fig. 3. Postoperative AP and lateral X-rays of knee showing fixation of the OCF with multiple K wires.

the arthrotomy site, K wires were first drilled slowly, through the reduced fragment, medial femoral condyle and then out through the skin over medial thigh. Once they penetrated the skin on medial side, they were slowly drilled out using a hand drill attached to their medial and proximal protruding ends, in a retrograde manner. At the same time, careful inspection through the arthrotomy site was done to ensure that the tips of the wires were either flush or just buried deep to cartilaginous surface of the fragment (Fig. 2). Two to three K wires were passed in this manner in convergent or divergent directions so as to impart rotational and translational stability and prevent future back out of the fragment (Fig. 3). The protruding ends of wires on the medial femur were then bent and cut long. After ensuring haemostasis, medial parapatellar arthrotomy was closed in layers. Above knee plaster cast was then applied, keeping knee in 20–30° flexion and incorporating the bent ends of K wires in the plaster. Postoperatively, limb was raised on a pillow and static quadriceps setting exercises were commenced inside the plaster cast. At 2 weeks, a window was made in the plaster and stitches on the arthrotomy site were removed. Plaster was continued for 6 weeks postoperatively while allowing non-weight bearing ambulation with bilateral axillary crutches.

At 6th week postoperatively, the cast was removed and K wires were removed by pulling out on the bent protruding ends from the medial thigh. Patients were allowed partial weight bearing and progressive range of motion exercises. Full weight bearing was allowed only after the clinico-radiological union after 8–9 weeks. All the patients were followed at 6, 8, 10, 12 weeks and then every 3 months. The clinical outcomes were assessed by International Knee Documentation Committee (IKDC) score[5] and Lysholm score.[6] Patient satisfaction was assessed by Likert scale that represented the following: 5 – excellent, 4 – very good, 3 – good, 2 – average and 1 – poor satisfaction.

3. Results

The mean duration of surgery was 38 min (range, 28–45 min). The mean duration of hospital stay was 6 days (4–11 days). All 11 patients were available for evaluation after a mean duration of follow-up for 54 weeks (range, 40–64). The mean time of the union was 8.5 weeks (range, 8–10 weeks) (Table 2). Full weight bearing was possible in a mean time of 9 weeks (8–11 weeks). All the patients achieved full range of motion by 11 weeks with an average of 10.4 weeks. The clinical outcomes assessed were found to be excellent in all the patients. The mean IKDC score was 94.9 (range, 92–98) and the mean Lysholm score was 94.8 (range, 92–97). The patient satisfaction was assessed as per Likert scale, which showed a mean score of 4.63 (range, 4–5) indicating a high level of contentment post-surgery. None of the patients developed any major complications. There were no wire and plaster cast associated complications except mild wire tract discharge in one patient that was successfully managed with antibiotics and local pin tract debridement and dressings. Complications, such as osteoarthritis of the knee or avascular necrosis of the fragment, were not seen in any patient, up till the last follow-up.

Table 2
Postoperative clinical outcomes.

Outcome	Mean	S.D.	Range
Age (in years)	28.09	4.08	22–36
Time of union (in weeks)	8.5	0.68	8–10
IKDC score	94.9	1.76	92–98
Lysholm score	94.81	1.72	92–97
Likert scale	4.63	0.50	4–5

4. Discussion

Osteochondral knee fractures are well known as athletic fractures. They can occur at any age but most commonly in patients of age group 20–30 years and very rarely in children.[7] Most of these injuries are related to patellar dislocation and rupture of anterior cruciate ligament (ACL),[2] but isolated osteochondral fracture are also seen to occur via direct shearing traumatic injury to knee. Kennedy et al.[8] described the possible mechanisms of osteochondral fractures of knee, which included direct force of patella during traumatic patellar dislocation and indirect forces, such as external rotation of tibia or the femur in hyperextension or slight flexion (cause of ACL rupture). In the present study, only isolated osteochondral fractures of the medial femoral condyle have been considered without any associated patellar dislocation or ligament injury as location of osteochondral fracture and other concomitant pathologies like anterior cruciate ligament (ACL) rupture and patellar instability can potentially influence the treatment decision, rehabilitation protocol and eventual results.

In majority of the cases, small osteochondral fractures (OCF) are frequently missed clinically. Hence, the critical step for management of osteochondral fractures is its diagnosis. As the resolving power of conventional X-rays is limited for this situation, MRI is regarded as the gold standard for diagnosis. Arthroscopy is a better diagnostic and therapeutic tool as standard radiographs can often mislead regarding the size and location of the fragment.[9] Anteroposterior and lateral radiographs can be misleading, so tunnel view of the knee joint is recommended. Needle aspiration of joint space shows haemarthrosis with fat globules, but there is mild risk of introducing infection in joint. MRI or CT scan of the knee is a good, non-invasive investigation for the diagnosis as one can look for location, size and anatomy of the fractured fragment with associated ligaments and cartilage damage. Arthroscopic repair has gained popularity for osteochondral lesion with associated ligament injuries, as it is both diagnostic and therapeutic.

The presence of OCF is a primary indication for surgical interventions. Although there are many treatment modalities for fixation of osteochondral fragment, each method has its own pros and cons.[3,4] The main disadvantage of metal fixation devices like K wires and headless screws like Herbert screws is that they require removal if displaced and postoperative MRI cannot be performed. In our method, intra-articular protrusion of Kirschner wires is also a potential danger; however, bending and fixation of the end by incorporating them in plaster cast can take care of this. None of the cases had any intra-articular migration of the K wires prior to their removal at 6 weeks postoperative.

The introduction of biodegradable fixation devices was a revolution in the field of osteochondral fragment fixation. Their main advantage is that they do not require removal and postoperative MRI is possible; still, the potential but rare long-term effects of using biodegradable screws are synovitis, osteosclerosis, aseptic swelling and osteolytic radiographic changes.[10,11]

Most authors have reported satisfying clinical results independent of what kind of treatment modality was applied; however, the data on the incidence of postoperative osteoarthritis and integration of fragment after re-fixation are still lacking due to limited number of patients available, and the functional outcomes following fixation cannot be compared sufficiently as none of the standardized scores were used. Paar and Boszotta[12] managed 118 cases of OCF by different surgical procedures including K-wire fixation, fibrin glue fixation and biodegradable implants fixation. They did not mention any specific indication of type of fixation and their benefits over each other. Savarese and Lunghi[13] reported the outcomes of 20 patients with osteochondral fracture following patellar dislocation, treated with either debridement or suture re-fixation. At the mean follow-up of 36 months, the success rate in

terms of "excellent" and "good" was 75%. Mayer and Seidlein[14] published the outcomes of 16 patients with different fixation techniques including allogenic cortical pins. No treatment failure was observed in this group. Fuchs et al.[15] reported the outcomes of 15 patients with osteochondral fractures treated with re-fixation using a bioresorbable implant. At mean follow-up of 14.3 months, the clinical outcomes of all the patients were good (average McDermott score was 89 points and Tegner score was 5.1) and the surgical treatment proved to be successful. A longer follow-up of 6.5 years was reported by Wachowski et al.[16] including 12 patients. The clinical scores showed good to excellent results (Tegner: 5.0 [±1.7], Lysholm: 84.8 [±14.3], McDermott: 91.3 [±7.9]). Although, good, short-term results of various studies are reported, no potential superiority or inferiority of any specific technique for fragment fixation was concluded by any author. Hence, more studies with a longer follow-up are needed to properly evaluate various techniques.

We conducted this retrospective study including 11 patients with isolated osteochondral fracture of medial condyle of femur whereby the osteochondral fragment was fixed to its anatomical position with a novel technique of using multiple retrograde Kirschner wires. We precisely advanced 2–3 K wires in a non-parallel fashion to achieve a better rotational and translational stability and kept their intra-articular ends flush with the cartilaginous surface of the fragment. To prevent the K wires from protruding back into joint, the ends that came out from medial thigh were bent and then incorporated in the plaster cast. This method of OCF fixation by passing multiple K wires in a retrograde non-parallel manner and then incorporating the protruding ends in cast has not been described previously in literature.

The clinical outcomes in our study were excellent in all the patients with the mean IKDC score of 94.9 and the mean Lysholm score of 94.8. The patient satisfaction assessed as per Likert scale also showed excellent results with a mean score of 4.63. They were comparable or better than other fixation devices as reported in literature.

Another aspect that is especially important in a developing country like India is cost-effectiveness and affordability of the implants. Biodegradable pins, screws and meniscal arrows are quite expensive and also can have potential complications.[10,11] Osteochondral grafts and ACI are techniques that can be used to replace avascular, and comminuted osteochondral fragments also require expensive implants and elaborate laboratory set up. In our country, chondrocyte culture laboratory set up is still awaiting approval from government regulatory body. Therefore, in a third world country with limited resources, this technique of fixation using multiple K wires can take its place as a simple, safe, reproducible and relatively inexpensive method for treating these complex joint injuries in the young population. It has shown promising results and can be safely and effectively employed in peripheral hospitals that cater to population with limited resources and have limited access to expensive implants.

The small sample size and a shorter duration of follow-up were the main limitations of our study. However, the excellent outcomes and patient satisfaction achieved without any notable complications is the strength of our study.

5. Conclusion

The management of osteochondral knee fractures is a complex task for orthopaedic surgeons. The treatment options such as biodegradable screws and meniscal arrows are expensive procedures and have potential complications. Therefore, we present a unique, safe, reproducible, cost-effective and successful option of treatment for the management of osteochondral knee fractures.

Author's contribution

Amit Batra: Assisted all surgeries and helped in manuscript data compilation; Rajesh Rohilla: Assisted all surgeries and helped in manuscript data compilation; Aditya Jain: Providing language help, writing assistance or proof reading the article; Sidhant Singh: Assisted surgeries and helped in manuscript data compilation; Sahil Arora: Assisted surgeries and helped in manuscript data compilation; Milind Tanwar: Providing language help, writing assistance or proof reading the article; Radika Devgan: Providing language help, writing assistance or proof reading the article.

Conflicts of interest

The authors have none to declare.

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Research paper

"Is articular cartilage reconstruction feasible in OTA-C2, C3 comminuted patellar fractures?" A prospective study of methodical reduction and fixation

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ABSTRACT

Background: Comminuted patellar fracture reduction and articular reconstruction is surgically demanding situation to deal with, as patellar articular surface is complex with two diverging facets separated by a median ridge.
Purpose: The objective of this study is to evaluate functional outcome of OTA-34 C2, C3 comminuted patellar fractures treated surgically by methodical reduction and fixation.
Methods: We prospectively analyzed 12 patients of OTA-34 C2, C3 patellar fracture operated by our technique in 2 female and 10 male patients. We obtained three dimensional patellar articular facet reconstruction, by direct observation and reduction of articular surface and fixation with mini fragment screws and cerclage wire. The knee outcome survey – Activity of Daily Living Scale (ADLS) was used to assess functional outcome and follow-up X-rays were taken to assess radiological outcome of the fracture fixation.
Results: In all cases fracture union was achieved at an average of 10.83 weeks (2.49 months). The mean age was 43.58 years, average follow-up was 27.83 months and mean knee outcome survey ADLS – 90.08%. Functional knee range of motion was achieved by the end of 12 weeks (mean ROM – 119.08°). None of the patients had any infection, avascular necrosis of patellar fragments; implant cut out or patellofemoral arthritis. Three patients with associated ipsilateral long bone fracture showed delayed return to work.
Conclusion: Three dimensional patellar articular reconstruction and restoration of extensor apparatus is possible in comminuted patellar fracture with good clinical outcome by accurate and meticulous surgical reduction and fixation.

1. Introduction

Patellar fractures constitute about 1% of all skeletal injuries.[1] Comminuted patellar fractures are usually due to high velocity injuries following direct impact. Currently, many methods of treatment are advocated for comminuted patellar fractures like patellectomy (partial/complete), tension band wiring, cerclage wiring, and screw fixation.[2] Like any other Intra articular fractures, patellar fracture warrants anatomical reduction of articular fragments to restore articular congruity. The goal of surgical procedure is to obtain anatomic reduction of the articular fragments, stable fixation, and with restoration of the knee-extensor apparatus, so early mobilization of knee could be started.[3] Articular reconstruction of the comminuted fracture is surgically demanding, as the patellar articular surface is three dimensionally complex with diverging medial facet, lateral facet and median ridge separating the two facets. In regular techniques, patella articular surface reduction and restoration is checked blindly by

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retropatellar palpation and with the help of intraoperative fluoroscopy. Also, articular reconstruction is difficult in cases of articular comminution and many small fragments may not be adequately reduced by current techniques leading to non-congruent reduction and early patellofemoral arthritis. The aim of our technique is directly observed reduction of comminuted fragments by everting them and fixation using minifragments screws, cerclage wire and tension band wire. We evaluated our results where this technique was followed to reconstruct the three dimensional patellar articular surface to restore the extensor apparatus and allow early mobilization of knee joint.

2. Patients and methods

We prospectively analyzed 12 patients with 34-C2, C3 type comminuted patellar fractures (AO/Orthopaedic Trauma Association Classification) who sustained it following road traffic accident/direct fall on the knee during February 2011–July 2014. The mean age was 43.58 years (range 29–53 years) and included 2 females and 10 males (Table 1). We excluded simple transverse fractures, OTA A type, B type and C1 fractures for this study. Nine patients had injury in right knee and 3 patients had fracture in left knee. All patients underwent preoperative radiological workup with X-rays and CT scan to study fracture geometry and plan surgical fixation. Nine fractures were closed fracture and 3 patients with open fracture (2 patients type IIIA and 1 patient type II Gustilo Anderson classification) were treated by wound wash, wound debridement, primary internal fixation of the patella and primary wound closure in all the cases. Two patients had associated fracture of femur and 1 had tibia fracture which was fixed at the index surgery. The objective of our surgical technique is to achieve articular reconstruction and congruity of patellofemoral joint.

3. Surgical technique

The patellar fracture was exposed through a midline approach in closed fracture and in case of open fractures extending the laceration. Thorough wound wash was given to clear the blood clots from the knee joint, across fracture surface to define fracture geometry and to delineate major/larger fragments and smaller fragments by atraumatic blunt dissection. For convenience of reduction, patellar fragments was divided into upper and lower pole fragments. Upper pole fragments were everted and articular surface visualized, they were methodically reduced and, held temporarily by 1.2 mm k wire (Figs. 1 and 2) and then fixed with 2.4 mm mini fragment screws. Lower pole fragment reduction was

Table 1
Patients demographic details.

Sl. no.	Age (years)	Side	Sex	MOI	Classification	Associated injuries	Open fracture	Follow-up (months)	ROM	Time to union (weeks)	Knee outcome survey ADLS (%)
1	45	R	M	RTA	34-C2	Nil		49	130	8	96.4
2	51	R	M	RTA	34-C2	Nil	Type IIIA	44	125	14	95.2
3	39	R	F	RTA	34-C2	Nil		40	120	10	94.36
4	29	R	M	RTA	34-C2	Nil		34	124	12	88.78
5	44	L	M	RTA	34-C3	Femur #		31	95	8	77.67
6	49	L	M	RTA	34-C2	Nil	Type II	28	124	11	95.45
7	53	R	M	Fall on knee	34-C2	Nil		26	132	9	97.11
8	35	R	F	RTA	34-C2	Tibial #		25	105	10	84.42
9	39	R	M	RTA	34-C3	Nil		15	120	12	96.47
10	46	R	M	RTA	34-C2	Nil		15	122	9	82.8
11	41	L	M	RTA	34-C3	Femur #		14	108	14	78.98
12	52	R	M	RTA	34-C3	Nil	Type IIIA	13	124	13	93.4

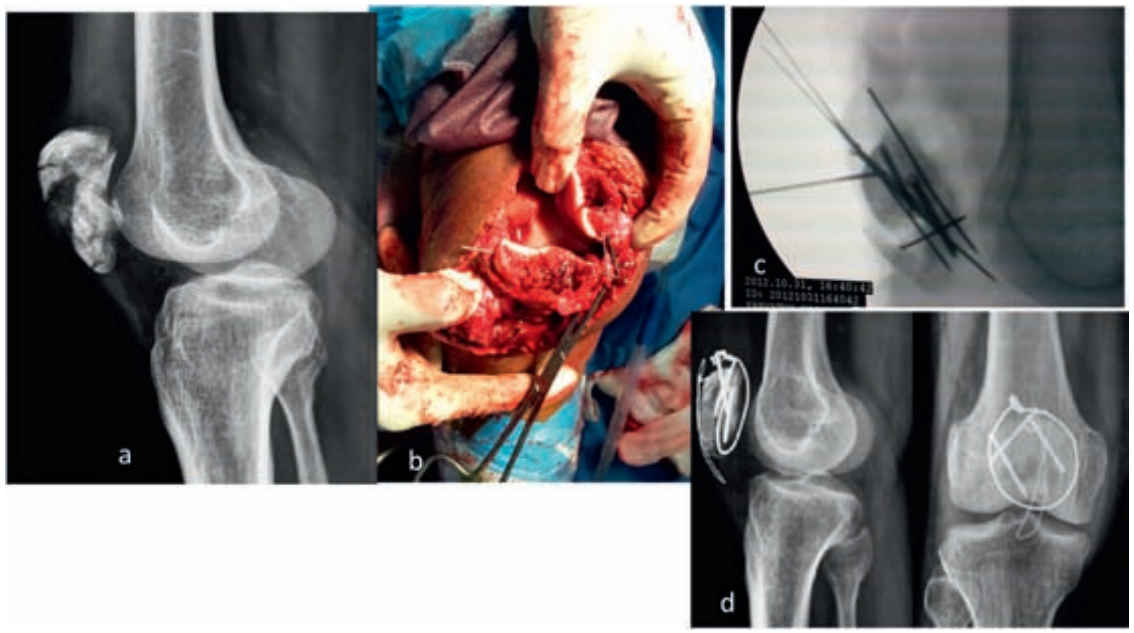

Fig. 1. (a) Preoperative X-ray with OTA 34-C3 comminuted fracture. (b) Intraoperative reduction and temporary fixation with 1.2 mm k-wire for upper major fragment and lower major fragment. (c) Intraoperative fluoroscopy to confirm articular reconstruction. (d) 24-months follow X-ray of the same patient.

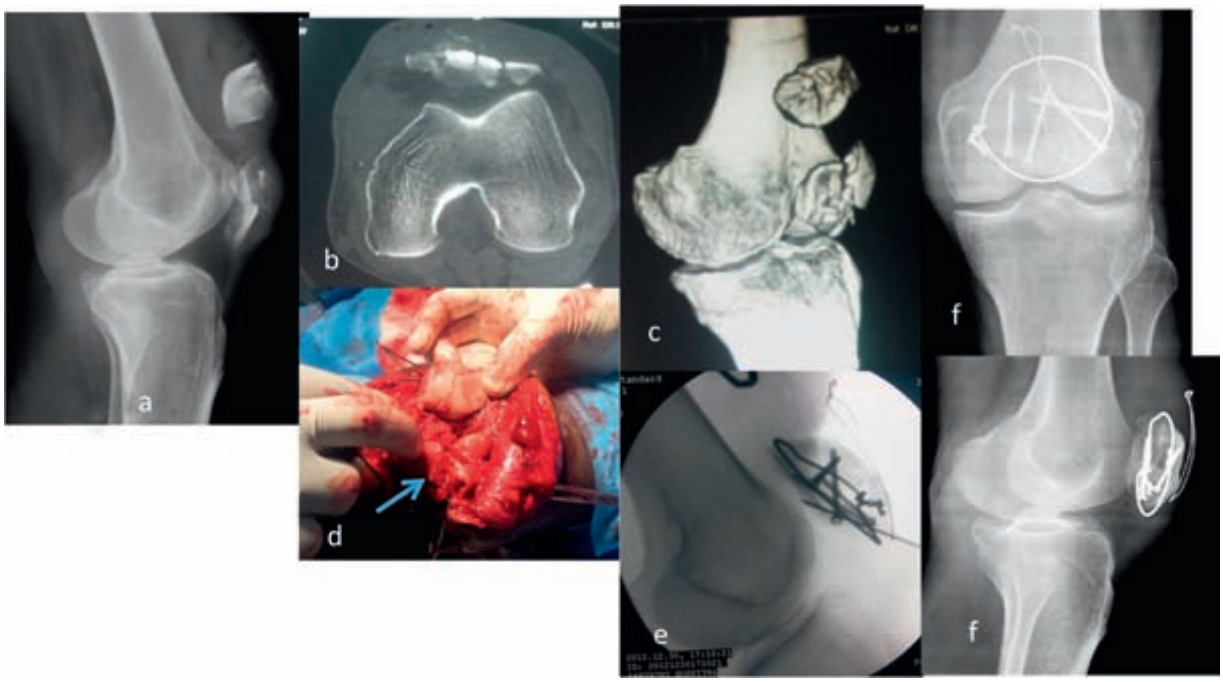

Fig. 2. (a) Another patient with preoperative X-ray of OTA 34-C3 comminuted fracture. (b and c) Preoperative CT scan. (d) Intraoperative picture medial half of fragment everted, reduced and temporarily fixated with 1.2 mm k-wire and lateral half fragment showed by arrow. (e) Intraoperative fluoroscopy to confirm articular reconstruction. (f) 30 months (2 years 6 months) follow X-ray of the same patient.

similarly handled and articular reconstruction achieved. Loose small non-articular fragments without soft tissue attachment were discarded. Loose articular fragment with dense subchondral bone was matched to the articular surface of larger fragment like jigsaw puzzle for the reconstruction and were held reduced with 1.2 mm k wire temporarily (Figs. 1 and 2). Then the major upper pole and lower pole fragments was reduced, held by temporary k wire, articular facet reduction was palpated on both sides of retro-patellar surface and checked by intraoperative fluoroscopy. Major fragments were finally fixed by 2.4 mm screws and augmentation done with cerclage wire and tension band wire. Thorough wound wash given, medial and lateral retinacular tears repaired and wound closed in layers with drain in situ. Post-operatively patient was splinted with knee immobilizer in extension for 2–3 weeks for soft tissue healing. Partial weight bearing was advised during this period for isolated patellar fracture and non-weight bearing walking for patients with associated long bone fracture. Static quadriceps exercise was advised to maintain the tone of the muscles. For isolated fractures, knee continuous passive movements (CPM), gentle active knee bending exercises were advised from 3 week onwards for all the patients and progressed to full weight bearing. Non-weight bearing walking was continued till long bone healing in patients with associated long bone fractures. Patients were followed up in 2 weekly intervals for up to 8 weeks then followed up at 3, 6, 9, 12, 18, and 24 months. Follow-up X-rays (Figs. 1d and 2f) and the knee outcome survey – Activity of Daily Living Scale (ADLS)[3] was used to assess the radiological and functional outcome of the knee.

4. Results

In this study there were 8 patients with 34-C2 type and 4 patients with 34-C3 type fractures. The average follow-up was 27.83 months (13–49 months) and average knee outcome survey ADLS was 90.08% (range 78.98–97.11%). Complete union was seen in all the cases by 14 weeks (mean 10.83 weeks). All patients achieved functional range of movements for routine daily activity and average knee range of motion at final follow-up was 119.08°. Three patients had restricted knee movements (less than 120°) due to poor compliance of patients for rehabilitation due to ipsilateral long bone fracture. None of the patients had knee extensor lag. There was no implant cut out, non-union, or avascular necrosis of the bony fragments observed. One patient had delayed wound healing and superficial infection in open fracture, which settled with regular dressing and antibiotics. All patients returned to work within 2 months of surgery, while 3 patients who had ipsilateral long bone fractures showed delayed recovery. During the last follow-up, all patients were completely pain free and only 2 had minimal swelling of the knee, which did not affect their daily activities. Nine patients could squat, climb and descend stairs without any problem whereas 3 patients who had other associated fractures had difficulty in squatting and had to use a railing occasionally while climbing stairs.

5. Discussion

Patella plays an important role in extensor apparatus of the knee by acting as a pulley and reducing the quadriceps force required for extending knee giving mechanical advantage. With increase in high velocity motor vehicle accidents, comminuted patellar fractures are becoming common these days. The amount of comminution and articular damage determines the need for salvage of the entire patella/partial or total patellectomy. Haxton[4] in his studies showed the importance of patella and its effect on knee function after excision. He showed that the force required for extension of the knee is more as the joint extends; that is, the power of extension is greater with the knee at 30° of flexion than at 60, 90, or 120°. Kaufer[5] in his cadaveric studies compared intact and patellectomized cadaver knees and discovered that 15–30% more quadriceps muscle force was required to fully extend patellectomized knees than intact knees. Since extension of knee is the most important function of the knee, and patella provides the mechanical advantage, it was concluded that patellectomy definitely impairs the efficiency of the quadriceps mechanism. In two different studies

with long-term follow-up, Jakobsen et al. and Edwards et al.[6] has shown that there is a loss of quadriceps strength of 33% and 44% respectively after patellectomy. These authors stress on the importance of patella and need for preservation of patella for restoration of optimal knee function.

In an attempt to preserve the length of the patella and allow earlier motion, various techniques have been described in literature to preserve rather than excise patella in comminuted fractures. The recommended fixation for comminuted fractures of patella is modified tension band, which can be combined with a cerclage wire or lag screws Reudi,[7] Yang and Bryan[8] reported good functional results and no hardware failure, infections, delayed unions, or non-union in 25 patients treated with a separate vertical wiring technique for comminuted fractures of the inferior pole of the patella. However did not classify the fractures according to OTA classification and degree of articular comminution. Matejcic et al.[9] used basket plate for fixation of comminuted inferior pole patella fractures. In their study of 51 patients, he had excellent results in 30, good in 16, and satisfactory in 5. None had a no poor result. Because of the objections to patellectomy, these authors tried to save full length of the patella or at least the proximal or distal third in all possible situations. In their techniques when distal or proximal pole of the patella is comminuted, they removed small fragments and preserved large fragment. When comminution was extensive, reconstruction of the articular surface was not attempted and complete patellectomy was performed by these authors.

But there is no technique described in literature to completely salvage comminuted patella by attending to the details of fragments and soft tissue. With high velocity injury associated with patellar comminuted fracture, there is always a retinacular injury which is seen. Hence everting fragments are possible and adequate articular reduction can be achieved. In our surgical technique we have given utmost care during handing major/minor fragments with the soft tissue attachments. Atraumatic blunt dissection was carried out in all our cases while everting the fragments and during reduction (by direct observation of articular reconstruction and fixation). We have shown that it is possible to achieve good articular reconstruction by good technique while handling the major and minor fragments with soft tissue attachments. 1.2 mm k-wire being low profile will aid in holding the fragments until replacing them with 2.4 mm mini-fragment screws. Comminuted articular fragments were matched like a jigsaw puzzle and brought down to upper pole and lower pole fragments before final reduction. The objective of using mini fragment screws for fixing comminuted fragments are that, being a low profile implant they will have good purchase of the cancellous bone fragments till final reduction of major fragments. Also they can be applied close to subchondral bone of articular fragment without damaging/splintering the fragments. We have observed that these mini fragment screws being low profile in nature do not propagate any torsion force to the fragments during their insertion; hence there was no comminution/splintering of these cancellous fragments. Once comminuted fragments are assembled into 2 or 3 major fragments the final reduction was carried out by routine technique and augmented with cerclage wire and in a figure of 8 configuration. This will hold the reduction and provide adequate stability till the union. Some of the small fragments over the ventral surface with soft tissue attachments were stitched back to the major fragment with absorbable suture material to keep them in place. Loose non-articular cancellous fragments were put back into the void on the ventral surface of patella and gently impacted in to the major fragment, like a bone graft. Peeples and Margo[10] in their study found that 15% of 49 patients had an extensor lag, and 50% of them reported weakness that affected them during stair climbing. We did not find any extensor lag in any of our patients. All patients achieved functional range of movements by about 12 weeks.

Open reduction and external fixation using superior and inferior pins placed transversely, adjacent to the proximal and distal poles and connected externally to compressive clamps have been used successfully to treat transverse and comminuted fractures. Liang and Wu[11] recommended saving all major fragments, beginning motion at 2 weeks, and removing the external fixator at 4 weeks. We have no experience with this method.

Marya et al.[12] compared anterior tension band fixation with patellectomy and found 80% excellent results after osteosynthesis compared to 50% excellent results after patellectomy. By our technique we had 11 out of 12 patients with knee outcome survey ADLS more than 80% showing 87% good to excellent result.

We had no implant cut out and fracture healing issues in any of our patients. Since mini fragment screws are placed within the fracture and within the patella, they are not feasible to remove after fracture union. Further, since the screws are intraosseus they do not cause any implant related issued (such as skin impingement, implant propagation, discomfort and pain).

The lack of a uniform surgical technique or a standardized assessment scale limits the utility of the reported outcomes of operative fixation of comminuted patellar fracture. As a result, the literature provides generalization about "good" or "excellent" outcomes[13–15] based on subjective patient complaints of pain, loss of motion, or limitations in daily activities. Moreover, these subjective results may not correlate with the articular damage.[16] The authors have not specified the OTA type of articular comminution of patellar fracture. Furthermore, it is well accepted that more the articular comminution, greater is the possibility of patellofemoral arthritis. We have attempted to reconstruct OTA C2, C3 fractures and have given our good to excellent results in a short-term follow-up. However, long term radiological evaluation and arthroscopic evaluation is required to support our results. Hakler et al.[17] found grade II or III cartilage irregularities of the patella and/trochlea in 73% of patients who underwent arthroscopy at the time of anterior tension band hardware removal despite all patients in the series having good to excellent results at follow-up. They have not specified the type of patellar fracture in their study. The authors felt these findings may predict future symptomatic patellofemoral arthritis.

6. Conclusion

Patellectomy is no longer considered a primary option for the treatment of patellar fractures unless there is severe articular comminution with multifragmentary articular fragments where reduction of the fragments is impossible. Good three dimensional articular reconstruction of patellar facet is possible by directly observed fragments reduction and by meticulous handling of soft tissues. By this methodical reduction technique good functional results can be achieved for comminuted patellar fractures.

Small study group and short-term follow-up are limitations of this study. Long-term follow-up is required to know about patellofemoral arthritis.

Conflicts of interest

The authors have none to declare.

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Research paper

Baksi's sloppy hinged prosthesis in rheumatoid arthritis of elbow: A midterm follow-up study

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ABSTRACT

Background: Rheumatoid arthritis is a systemic inflammatory disorder that is characterized by polyarticular involvement. In rheumatoid patients, elbow joint involvement occurs in 20–40% of cases. The aim of our study was to evaluate the functional outcome of Baksi's sloppy hinged elbow prosthesis in rheumatoid arthritis of elbow at mid term follow-up.
Materials and methods: All patients who underwent total elbow replacement using the Baksi's sloppy hinged prosthesis for rheumatoid arthritis of elbow from 2005 to 2012 were included in the study. Of the twelve patients studied, four patients were males and eight were females. Mayo elbow performance score was used pre-operatively and post-operatively for the functional outcome of total elbow replacement. Mean age of the patients in this study was 38.58 (range 20–60 years). The average pre-operative pain score was 21.25 (range 5–45).
Results: Mayo elbow performance score improved from 40.83 preoperatively to 82.91 post-operatively ($p < 0.05$). The average range of motion was 110° (10–120°). Postoperatively all patients had good pain relief. The average post-operative pain score was 38.75 (range 15–45). The post-operative functional score was 20 (range 15–25).
Conclusion: Baksi's prosthesis has good result in rheumatoid arthritis of elbow, with good patient satisfaction in mid term follow-up. The overall functional outcome, pain improvement and stability of joint are satisfactory using the Baksi's sloppy hinged prosthesis for rheumatoid arthritis of elbow.

1. Introduction

Rheumatoid arthritis is a systemic inflammatory disorder that is characterized by polyarticular involvement. In contrast to osteoarthritis it is characterized by severe articular surface involvement and joint destruction. In rheumatoid patients, elbow joint involvement occurs in 20–40% of cases. Isolated involvement is rare.[1] Total elbow arthroplasty (TEA) is a reliable procedure for the treatment of elbow arthritis when

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other interventions have failed. Pain is the most common indication for total elbow replacement.[2] Most patients requiring TEA will have pain throughout the arc of motion. We present our mid-term follow-up of Baksi's sloppy hinged prosthesis in rheumatoid arthritis of elbow.[3]

2. Materials and method

All patients who underwent Baksi's sloppy hinged total elbow replacement for rheumatoid arthritis elbow from 2005 to 2012 were included in this study. Patients were followed up every month till the 6th month then every year. 13 patients underwent the procedure, one patient was lost to follow-up. The average pre-operative pain score was 21.25 (range 5–45). The pre-operative functional score was 7.5 (range 0–20). Using Mayo classification eight patients had grade III (66.5%) and four patients had grade IV (33.5%) involvement of the elbow. Eight were left elbow and four were right elbow. Clinical evaluations were done using Mayo elbow performance score for functional results, and X-rays were taken for radiological follow-up. The preoperative mean range of motion was 40.25° (20–60). All cases were operated by one surgeon.

Surgical method (Baksi's technique): With patient under general anesthesia, the limb was prepped with tourniquet application. Postero-medial incision was done. After subfascial dissection ulnar nerve was isolated and secured by an umbilical tape. Medial epicondyle, coronoid, olecranon, and

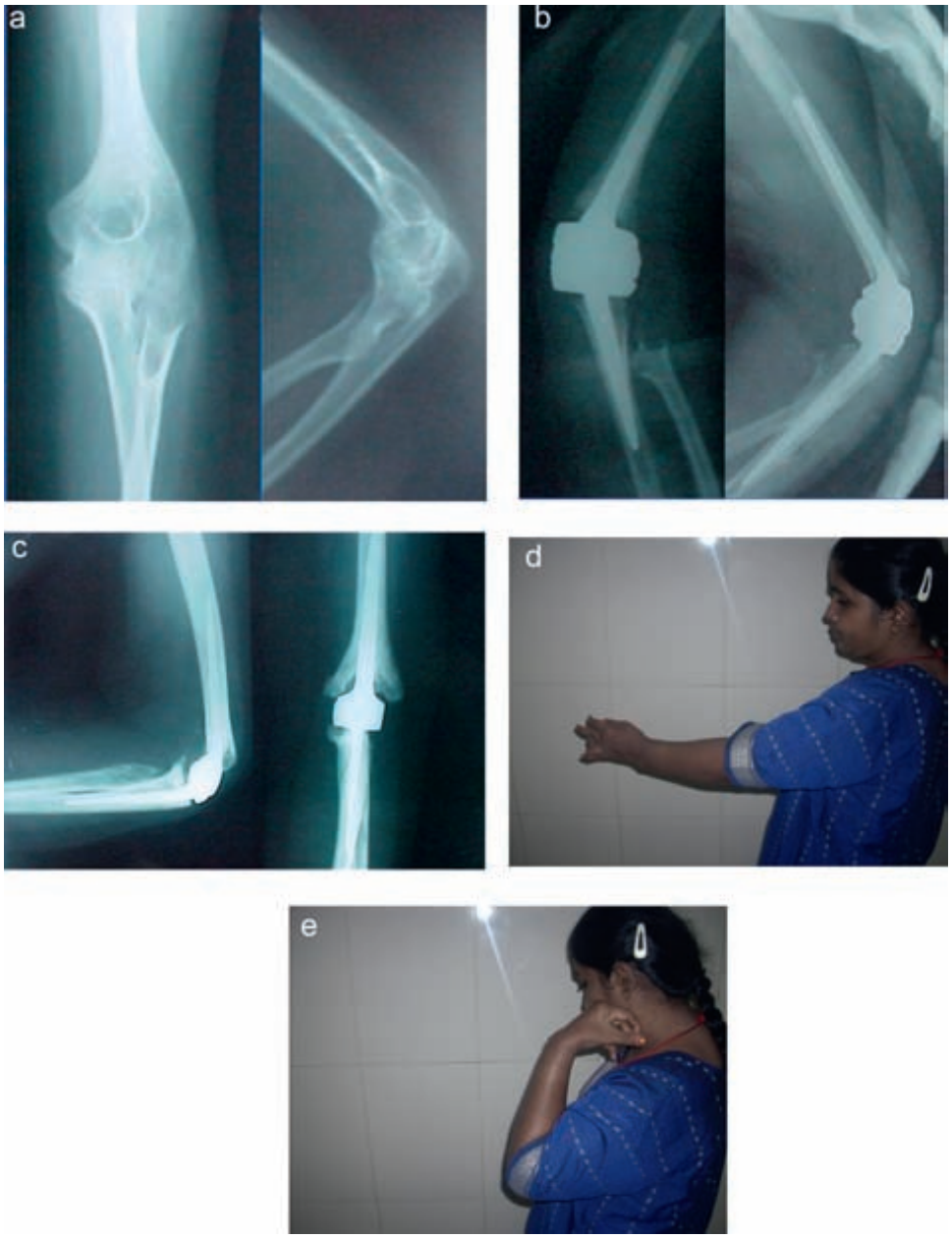

Fig. 1 – (a) Pre operative radiograph of a case of rheumatoid arthritis of left elbow. (b) Post operative radiograph of the same patient's left elbow. (c) Radiograph taken at 4 years follow-up. (d) Clinical image showing the left elbow extension at 4 years. (e) Clinical image showing the left elbow flexion at 4 years.

lower humerus were then exposed. Lateral epicondyle and supracondylar ridge were exposed. Humeral preparation was done by making a cut just above olecranon fossa. Radial head is then excised at the level of annular ligament. Ulna was cut sub-articularly in an L shaped pattern preserving triceps and brachialis insertion. Ankylosed elbow was then excised. Medullary canals were reamed. Cementing was done. Prosthesis assembled on table and inserted into the medullary canal. Range of movements was checked. Wound was then close in layers. Antibiotics were used for five days intravenously. Elbow was then mobilized once the pain subsided usually after the fourth or fifth day. Twelfth day suture removal was done.

3. Results

Twelve patients were available for analysis at final follow-up. Four patients were males and eight were females. Mean age of the patients in this study was 38.58 (range 20–60 years). The average period of follow-up was 6 years (range 3–10 years). Using the Mayo elbow performance score, two patients had excellent results, nine patients had good (Fig. 1a–e), and one patient had fair outcome. The average postoperative Mayo score was 82.91 (range 55–95). The average range of motion was 110° (10–120°). Post-operatively all patients had good pain relief. The average postoperative pain score was 38.75 (range 15–45). The postoperative functional score was 20 (range 15–25). In the immediate post-op period, one patient had superficial infection, which was treated conservatively by change of intravenous antibiotic. There were no deep infections in our series. Two patients had implant loosening, one at the end of first year and the other at the end of 4 years (Tables 1 and 2).

Table 1 – Mayo elbow performance score.

Function	Points	Definition	Points
Pain	45	None	45
		Mild	30
		Moderate	15
		Severe	0
Motion	20	Arc >100	20
		Arc 50–100	1
		Arc <50	5
Stability	10	Stable	10
		Moderate instability	5
		Gross instability	0
Function	25	Comb hair	5
		Feed	5
		Hygiene	5
		Wear shirt	5
		Wear shoes	5

Total score = 100, excellent result >90, good result = 75–89, fair 60–74, poor result <60.

4. Discussion

Rheumatoid arthritis is a disabling disease. In its advance stage, it severely impairs the functions of the joints. A classification of rheumatoid arthritis was developed by the Mayo clinic.[4] Grade I signifies normal radiographic findings except for osteopenia with mild synovitis, Grade II: loss of joint space, Grade III: loss of joint space and joint architecture, Grade IV: extensive articular damage with loss of sub-chondral bone and subluxation or ankylosis of the joint. Early presentation is synovitis characterized by pain, swelling, limitation of joint motion. In later stages, peri-articular soft tissue damage and bony destruction leads to bone loss and instability. But the recent advances in pharmacotherapy have substantially reduced the involvement of elbow joint.

Many total elbow replacement designs are currently available. Rigid hinge, non-constrained and semi constrained. Rigid implants have a high failure rate. Nonconstrained implants have lessened rates of loosening. But their use is limited in that they need adequate bone stock and collateral ligaments have to be intact.[5] Semi-constrained Baksi's sloppy prosthesis is made up of stainless steel (SMO 316 LV). It is simple and low cost. It has humeral component with stem of same diameter as that of ulnar component but shorter. Linking screw is thinner in diameter than the hole diameter of humeral component. It allows laxity of 7–10°. Forces across prosthesis are dissipated primarily to soft tissues surrounding

Table 2 – Results of twelve elbow replacements at latest follow-up evaluation.

Serial no.	Age/ sex	Side	Preoperative Mayo elbow performance score (Pain 45, ROM 20, Stability 10, Function 25)						Postoperative Mayo elbow performance score (Pain 45, ROM 20, Stability 10, Function 25)					
			Diagnosis	Pain	ROM	Stability	Function	Total	Pain	ROM	Stability	Function	Total	Follow-up
1	21/F	R	RA	15	20	10	10	55	45	20	10	20	85	10 years
2	45/F	L	RA	15	15	5	10	40	45	15	5	20	80	5 years
3	40/F	L	RA	15	15	0	20	45	45	15	10	20	85	7 years
4	20/F	L	RA	15	15	0	10	35	30	20	10	20	80	7 years
5	20/M	R	RA	30	5	0	0	35	45	15	10	20	80	4 years
6	41/M	L	RA	45	5	0	5	55	45	20	10	20	95	6 years
7	50/F	L	RA	30	5	0	0	35	30	20	10	20	80	6 years
8	60/F	R	RA	15	15	0	10	45	45	20	10	20	85	7 years
9	45/F	L	RA	15	5	0	5	25	30	15	10	25	80	3 years
10	50/M	L	RA	15	15	5	5	35	15	20	5	15	55	4 years
11	36/F	R	RA	30	5	5	5	45	45	20	10	20	85	5 years
12	35/M	L	RA	15	15	0	10	40	45	20	10	20	95	8 years

the implant, thus protecting cement–bone interfaces. At our institute outcome of Baksi's sloppy hinged prosthesis in rheumatoid arthritis of elbow has given us good results. Baksi's prosthesis is cost effective and gives good results for patients in developing countries like India.[3]

Baksi et al., in their study of 68 ankylosed elbow, found the mean arc of painless range of movement as 88.5 (range 27–115), and 80% had good results in that study.[3] In our study the mean arc of painless movement was 95° (15–120°). It showed no significant difference in using Baksi's prosthesis in ankylosed elbow and rheumatoid arthritis ($p > 0.05$). Ewald et al., in their study of 202 TEA, had a mean postoperative range of motion of 105° (30–135°). They had good range of movement using the capitellocondylar total elbow replacement in rheumatoid arthritis ($p < 0.05$).[6]

Mighell et al. showed semiconstrained TEA decreases pain and restores function.[2] In our study reduction in pain and restoration of function were achieved. The mean pain score improved from 21 to 38.75 ($p < 0.05$) and the functional score improved from 7.5 to 20 ($p < 0.05$). Lee et al. in their short-term follow-up study in RA showed Mayo elbow performance was 93.1 (75–100).[6] In our midterm follow-up, the Mayo score has improved from 40.8 to 82.91 ($p < 0.05$).

Lee et al. in their short term study of rheumatoid patient undergoing TEA, had no major complications except one fracture of the lateral condyle during the surgery, which was fixed with screw.[7] Gill et al., in their long-term review of TEA for rheumatoid elbow, had 13% complications requiring resurgery. These included three avulsion of triceps, 2 deep infection, ulna fracture in 2 patients and a fracture of the ulna component.[8] In our series, one patient had intra-operative fracture of the medial condyle of humerus during the preparation of distal humerus. It was reduced and internal fixation was done with 4 mm lag screw and rest of the surgical steps remained the same. This patient went on to do well clinically and had good functional result and pain relief. For the one patient, who had superficial infection, conservative treatment in the form of intravenous antibiotic therapy was given.

In their review of literature, Little et al. suggested that TEA may have slightly increased rate of aseptic loosening in rheumatoid arthritis than in other condition.[9] They found the overall rate of loosening in rheumatoid elbow to be 12%. In our series, the rate of loosening was 17% ($p > 0.05$). Of the two patients, who had aseptic loosening, in one patient it occurred at the end of one-year follow-up following a trivial lifting of heavy weight. There was no fracture, and implant was intact. In the second patient aseptic loosening occurred at the end of 4-year and two months follow-up. Both of them underwent revision TEA following work up for revision TER. For the first patient, we used the same implant with fresh cement, and for the second patient, a new implant with long stem was used. Both the patients were on follow-up for 2 years and did well clinically.

Although the study population is less in our series, the overall improvement in pain scores and the functional score is significant. A larger study may be required to describe the benefit of a semiconstrained prosthesis over other types of implants in the management of rheumatoid elbow.

5. Conclusion

Baksi's sloppy hinged elbow prosthesis gives good results in rheumatoid arthritis of elbow, with good patient satisfaction in mid term follow-up. The overall functional outcome, pain improvement, and stability of joint are satisfactory using the Baksi's sloppy hinged prosthesis for rheumatoid arthritis of elbow.

Conflicts of interest

All authors have none to declare.

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Case report

Error in surgical technique causing ceramic acetabular liner fracture in primary total hip arthroplasty – A report of two cases

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ABSTRACT

In view of excellent tribological properties and good survivorship, ceramic on ceramic bearing surfaces for hip arthroplasty are becoming increasing popular in carefully selected young and active patients. Though the complication of ceramic liner fracture is well known, it is rarely reported in published literature. Two cases of the fracture of ceramic liner are being reported following errors in surgical technique in primary total hip arthroplasty. These fractures were encountered during post-operative follow-up and managed by revision of the acetabular liner and ceramic head components in both the cases with uneventful outcome. These two cases highlight the requirement of meticulous surgical techniques to prevent any intra-operative malaligned ceramic liner which can potentially lead to catastrophes like ceramic liner fracture.

1. Introduction

Third generation ceramic on ceramic bearings are being increasingly used in total hip arthroplasty, especially in relatively young and active patients. The use of this bearing surface is being increasingly preferred in view of its extremely low wear rates and favourable lubrication characteristics which are probably the best out of all commercially available bearing surfaces.[1,2] The BIOLOX Delta ceramic (CeramTec, Plochingen, Germany) has emerged as the most popular third generation ceramic with high toughness and low wear characteristics.[3,4] However, occasional squeaking and fractures remain a concern despite their favourable characteristics.[5] Most of the cases of squeaking as well as fractures have been attributed to component malpositioning. Though there have been occasional reports of fractures of BIOLOX Delta ceramic modular cup liner during insertion, post-operative fractures have been rarely reported.[5–7]

We are reporting two cases of fracture of the BIOLOX Delta ceramic cup following incomplete seating during primary surgery and failure to recognize the problem peroperatively or in immediate post-operative follow-up.

2. Materials and methods

2.1. Case no. 1

In May 2012, a 44 years old male with post-traumatic arthritis of the left hip (secondary to 10 years old healed acetabular fracture) and BMI = 24, underwent an uncemented total hip replacement surgery through a posterolateral approach to left hip using Pinnacle acetabular cup, Summit femoral stem (DePuy, Warsaw, IN, USA) and BIOLOX Delta ceramic on ceramic bearing surface (CeramTec, Plochingen, Germany). Fixation of acetabular shell was augmented using two additional 6.5 mm cancellous screws. Difficulty was faced by the operating team during insertion of the ceramic liner but it was felt that liner was seated fully peroperatively. Rest of the surgery was uneventful. The patient had an uneventful immediate post-operative phase and was permitted full weight bearing as tolerated. However, the patient continued to have discomfort on full weight bearing throughout (reported with the same complaints at 6 weeks post-operatively).

At 3-months post-operatively, his discomfort had increased with occasional noise in his left hip. At this stage, he reported back to another surgical team as the lead surgeon of the previous team had relocated. Radiographs at this stage revealed a break in acetabular liner inferomedially with two loose fragments (Fig. 1). Careful review of the earliest available post-operative images revealed a small fractured fragment and that the liner was

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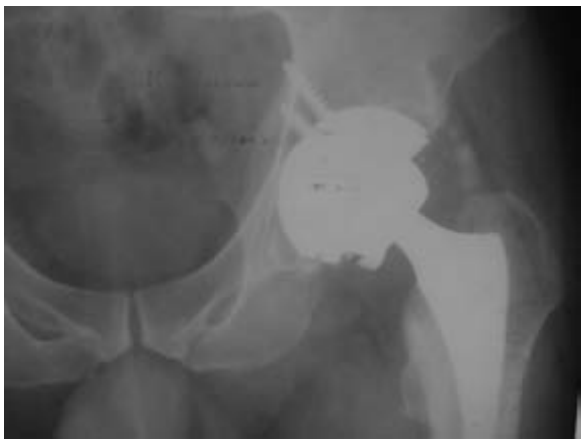

Fig. 1. Radiograph showing inferomedial break in ceramic liner.

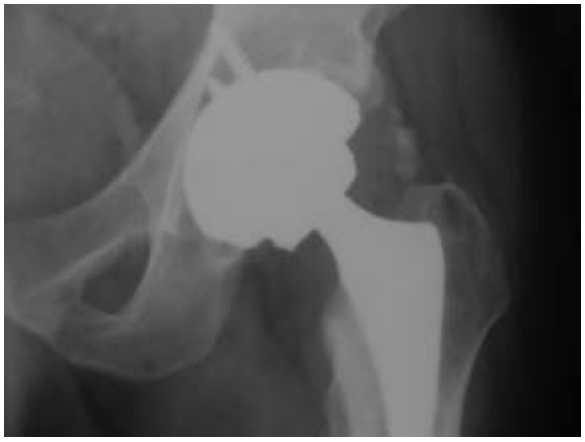

Fig. 2. Postoperative radiograph after initial surgery showing incomplete seating of ceramic acetabular liner.

incompletely seated even at that stage (Fig. 2). The acetabular cup and femoral stem were found to be well positioned.

The patient was taken up for revision surgery through the same surgical approach during which the ceramic cup liner was found to be fractured at its rim inferiorly with scratching of femoral head component (Fig. 3). Both ceramic liner and femoral head were changed with BIOLOX Delta ceramic components of same size. Patient had an uneventful post-operative recovery. He has been followed up for 2 years and remains asymptomatic though there is evidence of minimal heterotopic ossification radiologically (Brooker grade I). Follow-up radiographic image at 2 years is illustrated in Fig. 4.

2.2. Case no. 2

54-Year-old male patient underwent ceramic on ceramic primary hip arthroplasty for non-union of fracture neck of femur in September 2012 using implants from same manufacturers as in case no. 1. This patient also presented to the same team for follow-up as in case no. 1 due to relocation of lead surgeon for index surgery. He presented with squeaking sounds with every step from 6th post-op week onwards. He also had mild pain with squeaking on bearing weight on operated limb. Radiographs at this stage revealed shattering of the ceramic liner with well positioned acetabular and femoral components (Fig. 5). Careful review of available old radiographs showed incomplete seating of acetabular liner once again. He was taken up for revision arthroplasty. Per-operatively

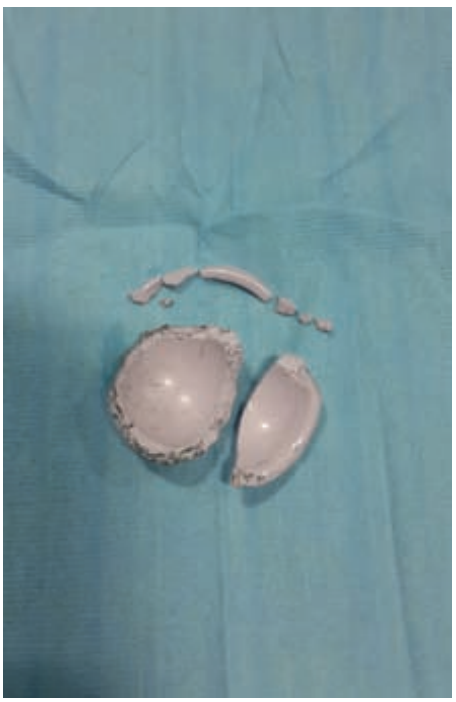

Fig. 3. Fractured ceramic liner.

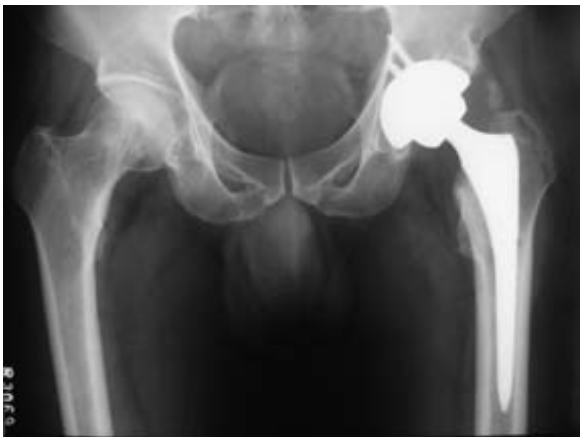

Fig. 4. Follow-up radiograph at 2 year post-revision of ceramic liner and head.

there was evidence of shattering of ceramic liner into multiple pieces which were spread extensively into soft tissues as well. This was revised by extensive soft tissue debridement to remove maximum possible broken ceramic pieces and replacement of ceramic head

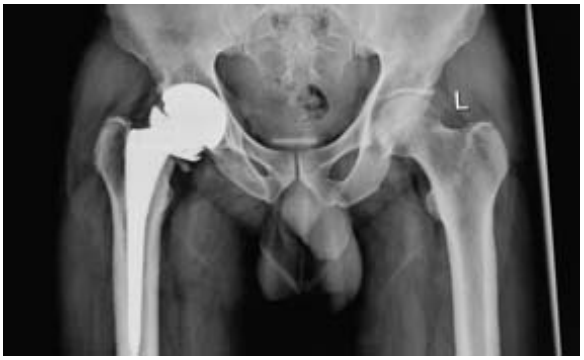

Fig. 5. Radiograph showing shattered ceramic liner in second case.

and liner of same size and manufacturer. Post-operatively patient was ambulant without support and pain free without any squeaking noises. Patient has been followed up for 2 years and his recovery has been uneventful till now.

3. Discussion

Although improvements in technology have significantly decreased the risk of fracture of ceramic components, occasional squeaking and rare fracture makes this bearing surface unpredictable in relatively inexperienced hands. In the rarely reported liner fracture cases, acetabular cup malpositioning, impingement and obesity have been considered as significant risk factors. Our patients had none of these characteristics. Incomplete seating of a ceramic liner leading to fracture of rim of the liner during the post-operative phase has been only rarely reported in literature till now.[6,7] Complications like squeaking noise and ceramic fractures have been more commonly associated with acetabular component malposition (more vertical cups), smaller femoral heads and non-adherence to meticulous surgical technique.[8] In vitro analysis using impaction and push out test have revealed importance of meticulous technique while impacting the ceramic liner leading to better engagement of taper and improved pull-out strength.[4]

Visual inspection of the retrieved components in first case revealed several small sized fragments broken from the rim inferiorly (Fig. 3). This fracture occurred probably due to asymmetric loading of an incompletely seated acetabular cup ceramic liner during full weight bearing ambulation. No further biomechanical assessment of the component was considered due to obvious structural damage.

Histological examination of periprosthetic soft tissues in ceramic fracture cases have revealed presence of microscopic ceramic particles which are associated with higher third body wear rates, if a change of articulation to polyethylene liner with femoral head is done. Therefore, the revision of the broken liner and scratched femoral head was done with ceramic on ceramic bearing surface only.[10]

Third generation ceramic on ceramic bearings in total hip replacement surgery are gradually becoming a dependable option with high longevity especially in relatively young and active patients. The incidence of complications like squeaking articulations and ceramic fracture has decreased with better materials and improved understanding of implant positioning.[9] However, despite improved materials, risk of ceramic fracture remains a concern to be addressed by better surgical techniques. In view of possible complications like squeaking and ceramic component fractures, use of ceramic on ceramic bearing surface should be restricted to surgical teams who have adequate experience in using them and to patients who are likely to benefit the most from it.

Conflicts of interest

The authors have none to declare.

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Case report

Tuberculosis: An unusual etiology of Baker's cyst

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ABSTRACT

Baker's cyst is usually degenerative in origin, infective etiology is rare, and tubercular origin is exceptional; only 5 such cases have been reported in English literature till date. We present a case of a young female who presented with clinico-radiological features suggestive of Baker's cyst with associated posterior horn medial meniscal tear. Arthroscopic evaluation revealed suspicious synovial hypertrophy along with meniscal tear and Baker's cyst. Arthroscopic management of Baker's cyst and meniscal pathology was done along with radical synovectomy. Histopathological examination revealed epitheloid granulomas and Langhans giant cells pointing toward a tubercular etiology. Standard ATT protocol with rehabilitation was followed. The patient was asymptomatic at 1 year with complete resolution of symptoms and full range of motion. This case highlights the need to maintain high index of suspicion in cases hailing from endemic region with unusual intra-operative findings; also, it underlines the importance of routine histo-pathological examination.

1. Introduction

Baker's cyst is a distension of the gastrocnemius–semimembranosus bursa of the knee, which communicates with the posterior portion of the joint capsule.[1] It usually appears as swelling in the medial aspect of the popliteal fossa secondary to pathological changes in the knee joint causing effusion. Usually degenerative in origin, an infected Baker's cyst is far less common and tuberculous arthritis is exceptional[2] and only 5 cases have been described in literature till date.[3–7] We report an isolated tubercular Baker's cyst in a 22-year-old who presented to us with a popliteal swelling.

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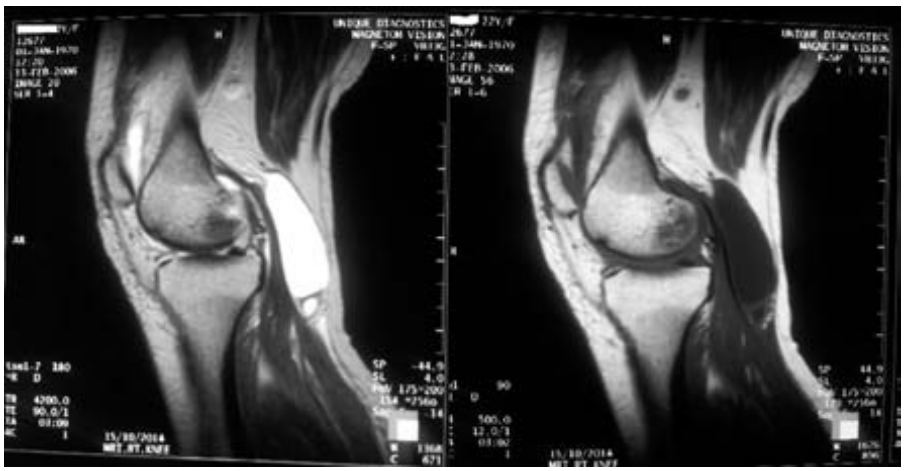

Fig. 1 – (a and b) T1 and T2 weighted sagittal MR images revealed tear in the posterior horn of medial meniscus along with a well-defined, cystic lesion in gastrocnemius–semimembranosus bursa appearing hypointense in T1 and hyperintense on T2 weighted images suggestive of a Baker's cyst.

2. Case report

A 22-year-old woman presented with complaints of pain and swelling in the right knee for 4 months. The pain was mild to moderate in intensity, continuous in nature, and localized to the posterior aspect of the knee. She noticed a swelling in the posterior aspect of her knee which was gradually increasing in size. There was no history of trauma, any constitutional symptoms, or any other associated systemic involvement.

On examination, she had an antalgic gait with a VAS (Visual Analogue Scale) score of five. Local examination revealed a well-defined, soft, non-tender, fluctuant swelling in the medial aspect of popliteal fossa, which reduced in size partially in deep flexion. Overlying skin temperature was normal. It was not associated with any redness, discharging sinus, or other significant skin changes.

There was medial joint line tenderness associated with positive McMurray test in deep flexion. There was no bruit on auscultation. Her range of motion was not restricted although terminal flexion was painful. There was no regional lymphadenopathy. Systemic examination was unremarkable.

Plain radiograph of the right knee showed increased soft tissue shadow in the posterior aspect without any significant bony abnormality. MR imaging revealed tear in the posterior horn of medial meniscus with an associated, 55 mm × 29 mm well defined, cystic lesion in gastrocnemius–semimembranosus bursa appearing hypointense in T1 and hyperintense on T2 weighted images suggestive of a Baker's cyst (Fig. 1).

The patient was planned for an arthroscopic decompression of the Baker's cyst with simultaneous management of the medial meniscal tear. Diagnostic arthroscopy revealed a grade III meniscal tear in the posterior horn of medial meniscus associated with significant synovial hypertrophy, raising suspicions of an associated infective/inflammatory pathology (Fig. 2). ''One way valve'' or ''trap door'' mechanism of Baker's cyst was also evident on arthroscopic examination of the posteromedial compartment (Fig. 3). The decompression of the Baker's cyst was done utilizing the posteromedial portal along with partial meniscectomy of the medial meniscus and subtotal synovectomy (Fig. 4). The contents of the cyst were sent for bacteriological staining and culture while synovial tissue was sent for routine histopathological examination.

Postoperatively, the patient was allowed full weight bearing walking from day 1. She had no residual swelling and the intensity of pain decreased as highlighted by a postop VAS score of two.

Significant synovial hypertrophy as noticed during surgery prompted us to investigate for inflammatory/infective etiology. A relook history revealed no significant personal or family history or history of contact. There was no history of any other joint involvement or morning stiffness. She denied

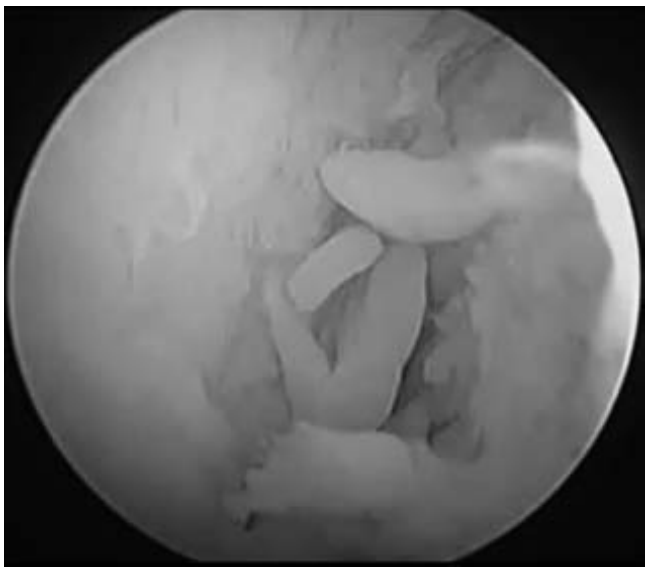

Fig. 2 – Intraoperative arthroscopic view showing significant synovial hypertrophy.

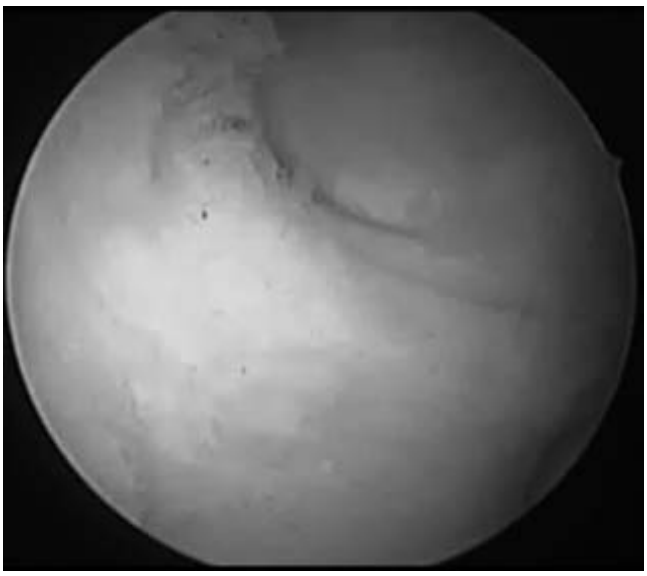

Fig. 3 – Arthroscopic view showing the classical ''one way valve'' or ''trap door'' mechanism of Baker's cyst.

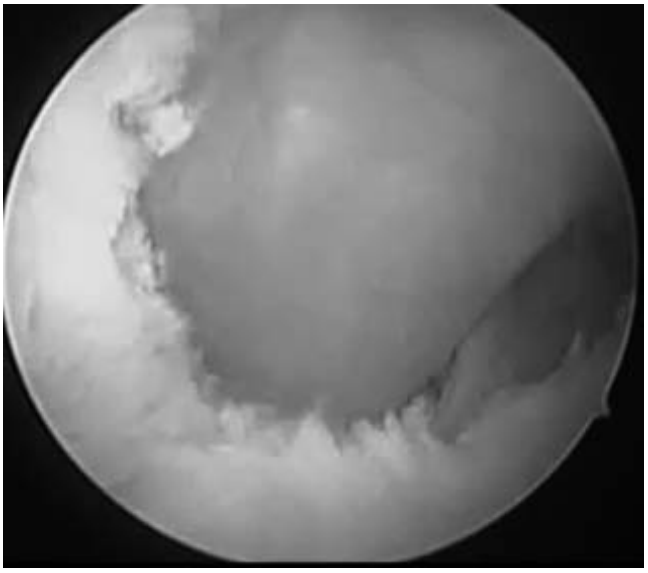

Fig. 4 – Post-arthroscopic decompression of the Baker's cyst, the trapdoor has been completely removed.

ever having any constitutional symptoms (low grade fever, anorexia, and weight loss). The laboratory investigations revealed a leukocyte count of 9.2 × 100 cells/L with differential count (N61L34E1B0M4), a raised ESR (40 mm), CRP (6 mg/L); however, RA factor and anti-cyclic citrullinated peptide antibodies were negative. Bacteriological staining and culture were also negative. There was 10 mm induration in Tuberculin Skin Test (Mantoux). The chest X-ray was unremarkable.

The diagnosis of tuberculosis was confirmed on histopathological evidence of caseous granulomas with typical Langhans giant cells in the tissue sent (Fig. 5a and b). The patient was started on ATT as per protocol along with knee range of motion exercises. Three months post-surgery, she had complete relief in pain with full range of motion and continued to be completely symptom-free at 1 year of ATT with a normal ESR and CRP. Comparison of MR images showed reduction in both, the size of Baker's cyst and associated synovial hypertrophy (Fig. 6).

3. Discussion

Knee joint is the third most common site for osteoarticular tuberculosis accounting for around 10% of skeletal tubercular lesions.[8] Most commonly it presents in form of diffuse swelling, with progressive loss of movements, Sometimes it may present late in form of multiple discharging sinuses and triple deformity of knee.[8] Although rare, occurrence of Baker's cyst with knee joint tuberculosis has also been described.[3–7]

Baker's cyst is defined as collection of fluid in gastrocnemius–semimembranosus bursa of knee and it usually results from anatomical defect at the bursa–joint interface, compounded by pathologies causing knee effusion.[2,9] Causes of knee effusion are commonly non-infectious, secondary to

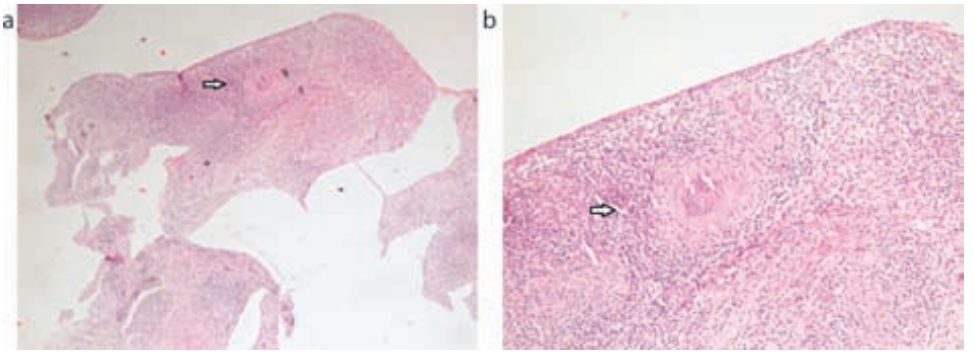

Fig. 5 – (a) Low power microscopic histopathological section (H&E 40×) showing a granuloma (arrow). (b) High power microscopic histopathological section (H&E 400×) showing an epithelioid cell granuloma (arrow), caseous necrosis, and Langhans giant cell.

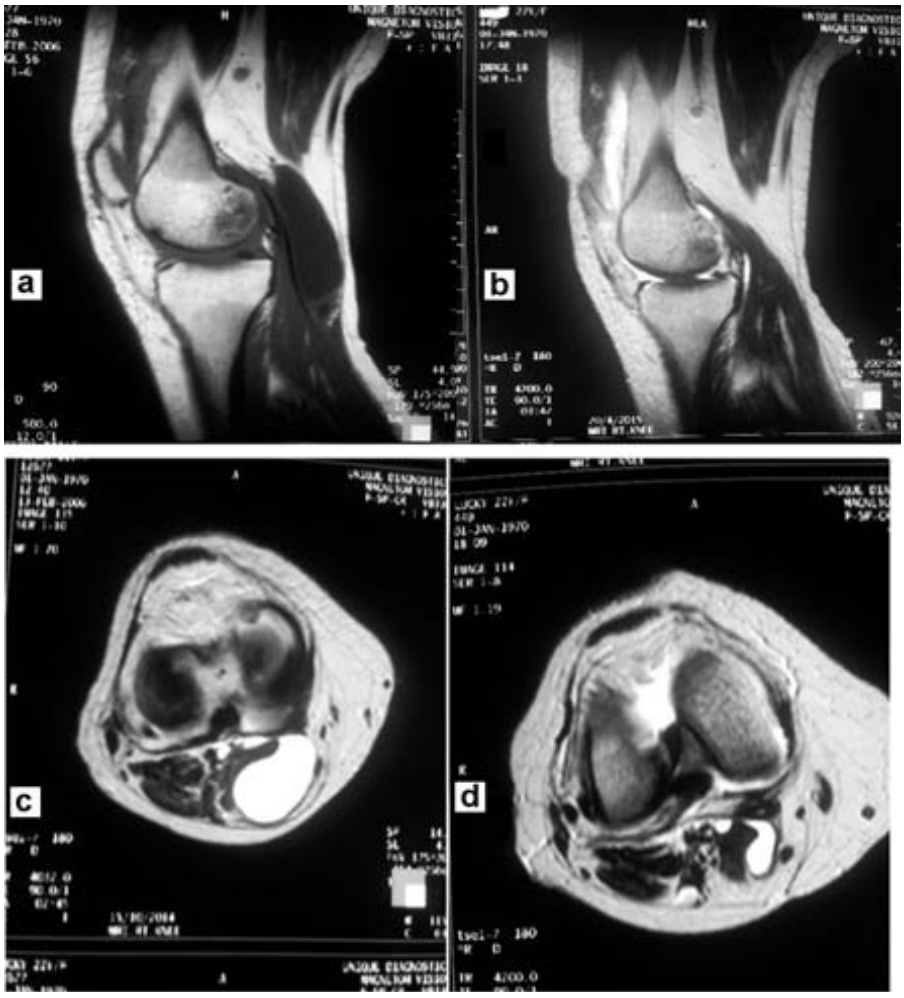

Fig. 6 – Comparison of pre- and post-operative MR images showing marked reduction in the size of cyst in both sagittal (a and b) and axial (c and d) sections.

meniscal tear, chondral lesions, osteoarthritis, seronegative/seropositive spondylo-arthropathies, and pyrophosphate arthropathy.[6] Although uncommon, infective etiology also results in Baker's cyst. Labropoulos et al.[2] in a causation analysis study of Baker's cyst confirmed the rare occurrence of tubercular etiology.

Baker's cyst by itself has no specific radiographic features, but features of causative pathology can be seen on radiographs at times. In our case, we did not find anything significant on plain radiograph of knee. Although osteoarticular tuberculosis has classical radiological features, described as the Phemister triad consisting of juxta-articular osteoporosis, peripheral osseous erosions, and narrowing of joint space, but in the early stages, radiographic features are usually nonspecific.[8] Slow growth pattern of *Mycobacterium tuberculosis* and the deficiency of proteolytic enzymes explain the preservation of joint space in early stages.[10] Early changes are better picked up on MR imaging which shows articular affection and synovial thickening, as seen in our case.[11]

Definitive diagnosis is established either by demonstration of presence of *M. tuberculosis* (*acid fast bacilli*) or by classical histopathological (HPE) features of tuberculosis,[8,10] skeletal tuberculosis is classically paucibacillary; therefore, Ziehl–Nielsen test as well as Lowenstein Jensen culture results may be negative at times.[10] PCR for *Mycobacterium* and histopathological examination of synovial tissue remain highly specific in establishing the diagnosis.[12]

We observed that our case had absence of constitutional symptoms while results of ESR and CRP were positive. Analysis of joint fluid for Gram and AFB staining was non-conclusive but synovial tissue histopathology revealed epithelioid cells and Langhans giant cells.

The patient hailing from endemic zone with corroborative hematology and confirmatory features on histopathology clinched the diagnosis for us.

Chemotherapy remains the cornerstone of treatment; although there is no consensus on the duration of treatment, it is preferable to follow the regimen for 12–18 months in cases of bone and joint tuberculosis to prevent relapse.[8,13] We observed complete resolution of symptoms at 3 months of therapy, but ATT was continued till 1 year as per institutional protocol.

4. Conclusion

Our case had presentation as a classical Baker's cyst with associated medial meniscal tear. The characteristic synovial hypertrophy drew our attention to the unusual causes of Baker's cyst. This case highlights the importance of maintaining a high index of suspicion for tubercular pathology in endemic areas. Also, it underscores the importance of the routine histopathological examination of excised tissue, which conclusively contributed to the establishment of diagnosis.

Conflicts of interest

The authors have none to declare.

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Case report

An unusual case of a massive intra-articular angiolipoma of the knee – Case report and review of literature

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ABSTRACT

We report a case of a 59-year-old woman who presented with new onset knee pain after starting an exercise program. Clinical examination pointed to a possible lateral meniscal tear. This was confirmed radiologically, but an intra-articular mass suspected to be a lipoma was also found on MRI. Excision biopsy was done and diagnosis was confirmed histologically. To the best of our knowledge, this is the case with the largest intra-articular knee angiolipoma reported till date. The differentiation between this type of mass and other more common encountered conditions, like lipoma arborescens and Hoffa's syndrome, is discussed.

1. Case report

A 59-year-old woman presented with left knee pain over lateral side of the joint and with anterior swelling. She had noticed the swelling 4 months previously after undertaking a new exercise class. Initially, she had mild discomfort over the lateral aspect of the knee, which was aggravated by squatting and was treated with physiotherapy and stretching exercises as possible iliotibial band syndrome. On examination, she had a normal gait. A swelling was present in the region of the suprapatellar pouch. It was soft in consistency and nontender. Tenderness was elicited on palpation of the lateral joint line space and rotatory test forlateral meniscal tear was positive. The range of movement was from 0° to 140° and was equal to the other knee. The ipsilateral hip and spine were clinically within normal limits. MRI scan showed a large swelling in the suprapatellar pouch with minimal peripheral enhancement. The axial T1 and T2 fat suppressed images have been shown in Figs. 1 and 2. It also showed a longitudinal tear in the posterior horn of the lateral meniscus and chondromalacia of the patella. Arthroscopic partial lateral meniscectomy was performed. Considering the size of the swelling in the suprapatellar pouch, an open excision biopsy was performed. The gross specimen and histopathology slide are shown in Figs. 3 and 4. The swelling had dimensions of 11 cm × 8 cm × 3.7 cm and weighed 122 g.

2. Diagnosis

The MRI findings were consistent with a benign lipoma in the suprapatellar pouch. The histopathology showed encapsulated mature adipose tissue with some interspersed small caliber capillaries containing fibrin thrombi consistent with an angiolipoma. There was no evidence of atypia or malignancy. The patient had an uneventful recovery and there has been no recurrence at 1 year.

3. Discussion

The knee is the most common synovial joint in which intra-articular synovial lipomas (IASL) have been reported.[2–4] They have also been seen in the hip and the lumbar spine.[5,6] To the best of our knowledge, our case represents the largest IASL reported in literature.[7] Although they have been reported to occur in patients as young as 8 years[8] and in adolescents,[2,9] the majority of cases have been reported to occur above the age of 40 years. IASLs have been reported to arise from different parts of the knee joint, including the suprapatellar pouch, infrapatellar fat pad, lateral recess, medial gutter, retropatellar region, intercondylar notch between the ACL and PCL, posteromedial recess, and anteromedially.[2,7,8,12,13] They usually arise de novo without any preceding pathology, but have been reported in association with rheumatoid arthritis and osteoarthritis.[1,14]

An IASL commonly presents as a painless mass. In our case, the lipoma had probably been growing over many years, but was noticed by the patient only after she sustained the lateral meniscus tear and experienced some discomfort. Increased discomfort in a

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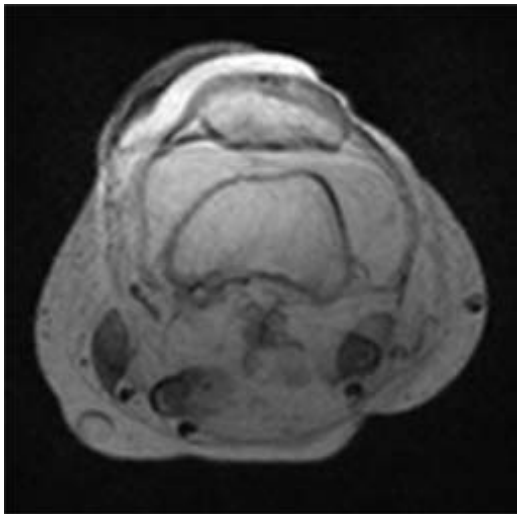

Fig. 1. T1-weighted axial MRI.

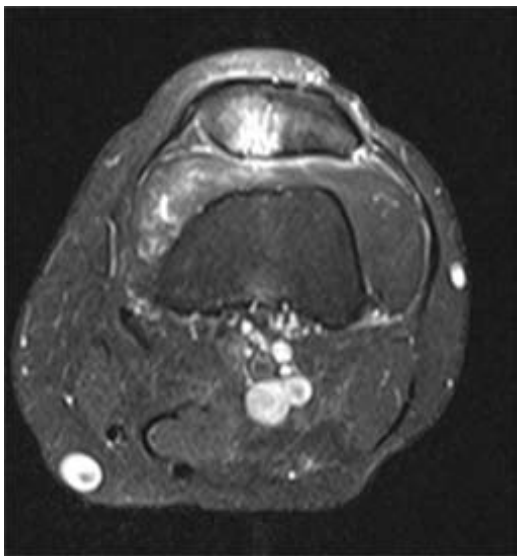

Fig. 2. T2-weighted fat suppressed axial MRI.

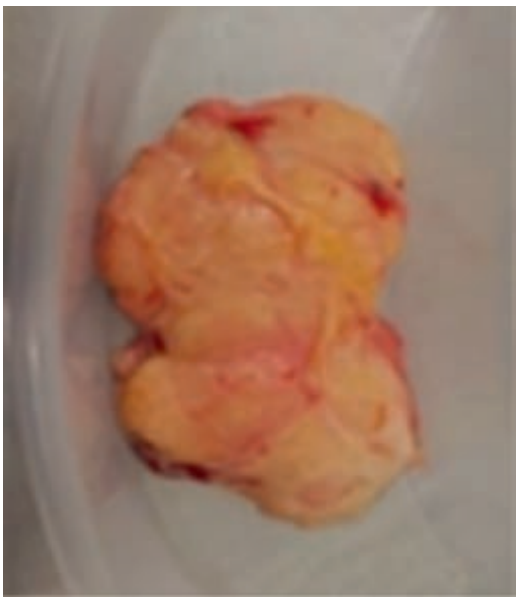

Fig. 3. Gross specimen.

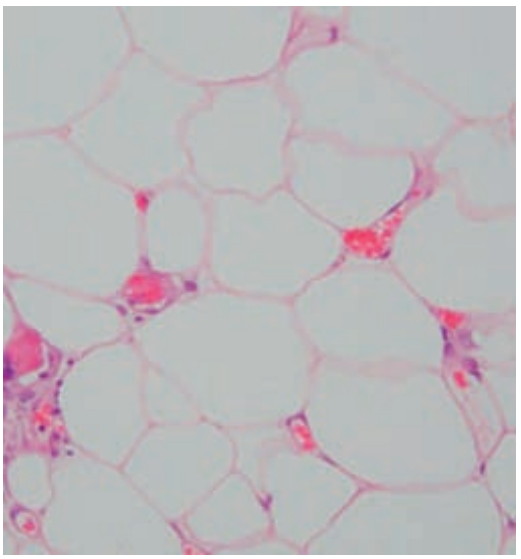

Fig. 4. Histopathology.

lipoma can also indicate sarcomatous change but there was no evidence of this in this case. IASLs may produce symptoms due to the mass effect causing reduced range of motion, locking, or snapping.[2,12] Patellar dislocation has been described to have been caused by an IASL in the lateral gutter.[11] IASLs can present with pain due to strangulation.[10] They have been reported to have been presented as loose bodies in the knee, which were later confirmed to be IASLs by histological examination.[1]

IASLs appear as yellowish, smooth masses on gross examination, with a short or pedunculated stalk. Histologically, they contain mature adipocytes.[7] They are well encapsulated and fibrous septa may be present dividing the mass into lobules.[4] Ostochondral metaplasia has been reported in IASLs in two cases.[15,16] They may be covered with synovium partially or completely. MRI scans show high signal intensity on T1 and T2 images and suppressed signal in fat suppression sequences. Fibrous septa may show low signal intensity.[2] In contrast, IASLs can show low signal intensity in T1 and T2 images in the presence of mucoid degeneration.[4]

IASL need to be differentiated from lipoma arborescens (LA) and Hoffa's syndrome. LA is a villous lipomatous proliferation of the synovial membrane occurring in association with trauma, diabetes mellitus, osteoarthritis, and rheumatoid arthritis.[17] It presents with recurrent knee swelling. It consists of frond-like villi arising from the synovium with subsynovial fat hypertrophy. Histologically, there is mononuclear inflammatory cell infiltration. MRI shows high T1 and T2 signal. LA is managed with synovectomy. Hoffa's disease is characterized by fibrosis in the infrapatellar fat pad, hypertrophy, and impingement.[18] It is differentiated from IASL by low signal intensity in T1 and T2 images. However, high signal intensity may be seen on the T2 image in the presence of hemorrhage. IASLs are slow growing tumors with reports of progression over many years. The natural history is poorly understood. Excision of these tumors can be performed successfully by both open and arthroscopic methods, depending on the size of the lipoma as seen on MRI. No case of recurrence has been reported after arthroscopic excision.[7]

4. Conclusion

IASL is a rare tumor occurring in diarthrodial joints with a variety of presenting symptoms. It can grow to a large size and cause mass effects. It can be differentiated from other similar conditions based on the MRI appearance. It can be managed with

open or arthroscopic excision and should be considered in the differential diagnosis of knee swelling and pain.

Conflicts of interest

The authors have none to declare.

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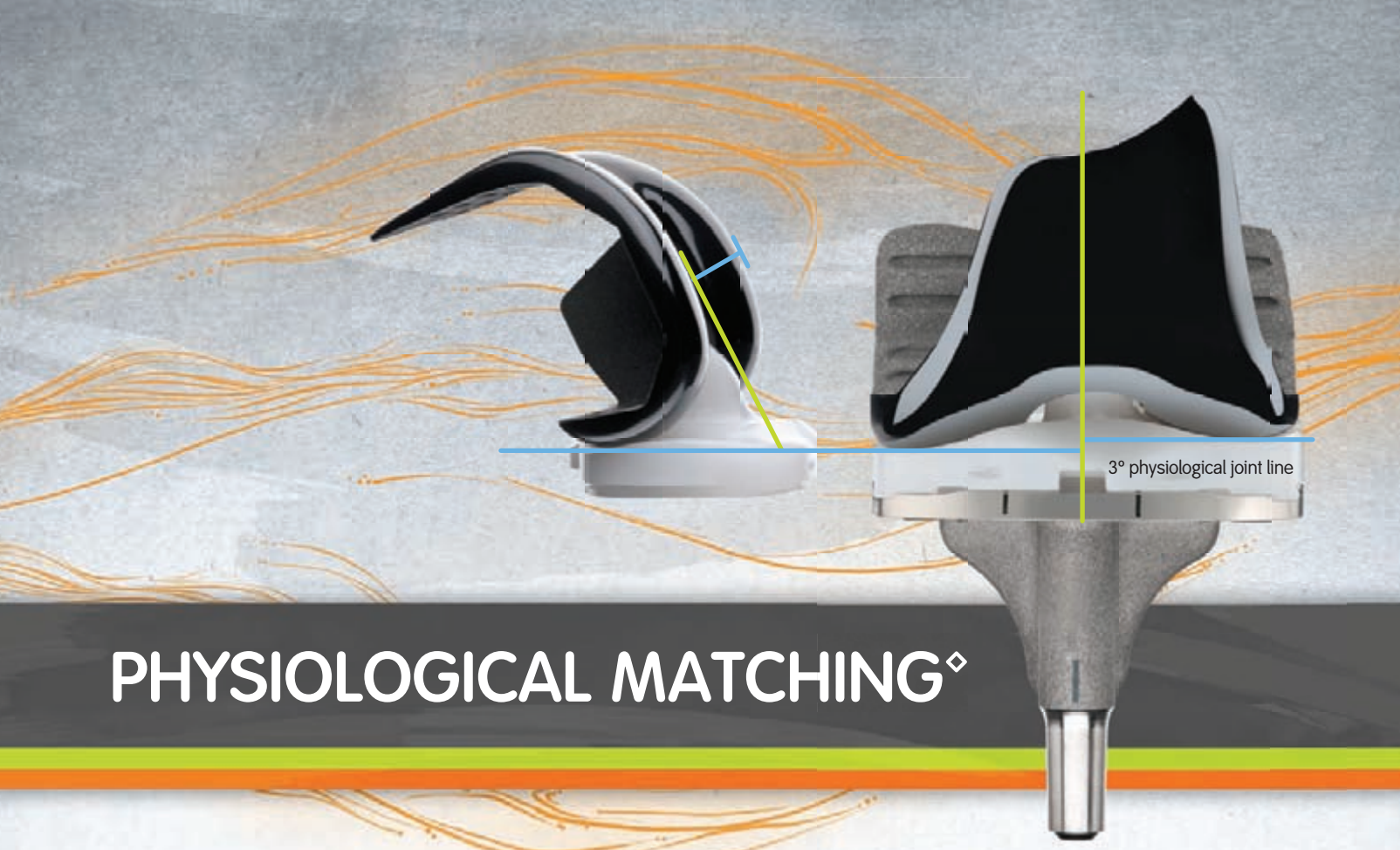

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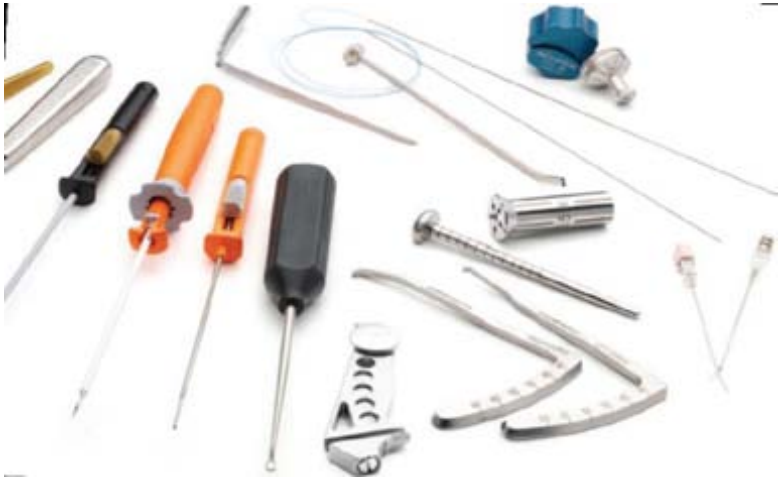

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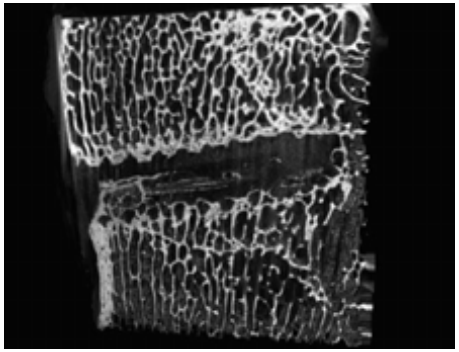
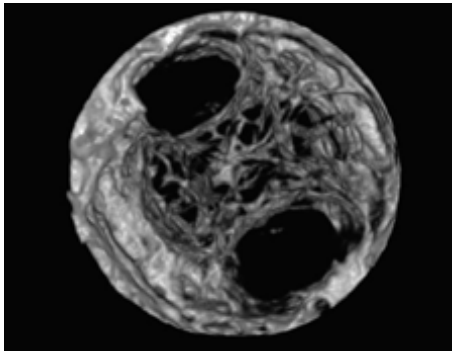
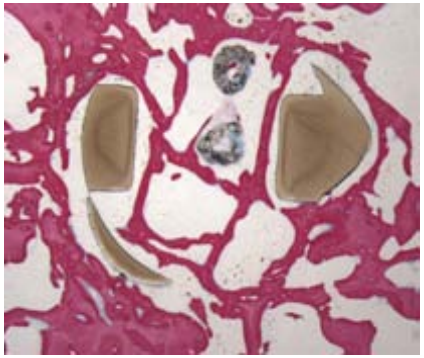
HEALICOIL PK Suture Anchor: Bone-fill at 12 weeks in a pre-clinical ovine study.







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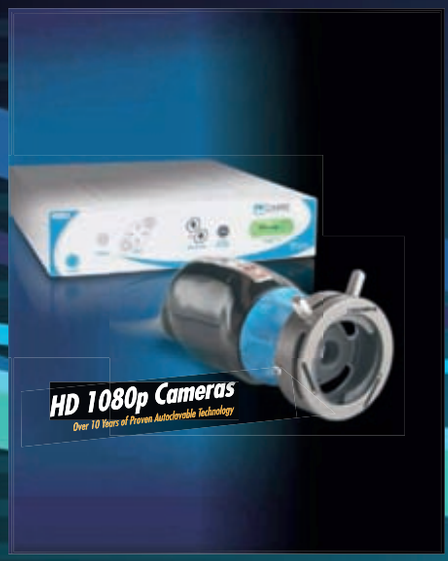

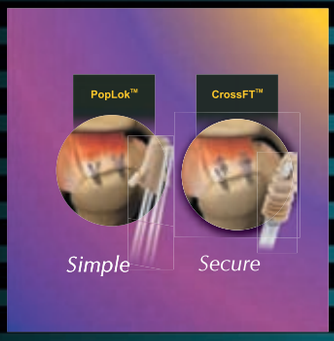

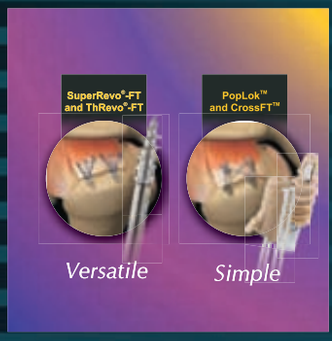

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1. The interested candidates are encouraged to look at the University website link. The programme is aimed at motivated candidates who wish to come to UK to obtain 2 years of clinical experience, specialist surgical training and a MCh degree from Wrightington Hospital and Edge Hill University.
2. Initial application should be via email. Just send updated CV, photo along with 2 satisfactory recommendation letters from current/recent trainer to ISKSAA president at isksaafellowships@gmail.com. This will serve as an initial screening to judge eligibility. The last date for applications is **31st October 2016.**
3. The interviews are slated for 23rd November during ISKSAA GLOBAL SUMMIT 2016 in Delhi and 25th November 2016 in Chennai with a team coming from the UK.
4. **Having cleared the IELTS exam** before the interviews will be of advantage for final selections.
5. The Clinical posts would start in August 2017 although if candidates were to be interested for Aug 2018 and August 2019 start, they could still apply.
6. The MCh course is at the Edge Hill University and although most of the payment for the course can be made along the way in installments over the 2 years, there would be an initial Commitment of £17,500 to be made to secure the place before the formalities with Royal colleges and GMC are commenced at this End. The salary scales are detailed with the information sheet as well.
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