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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

Musculoskeletal allografts – State of the art and future trends

Allograft bone was first transplanted over 125 years back by MacEwen in 1881. Bone and tissue banking has come a long way since then. Tissue banks all the world over strive to provide safe and sterile graft with minimal risk of disease transmission. The use of allografts in musculoskeletal surgery is on the rise and more than 5,00,000 musculoskeletal allografts are used annually in USA alone. Popular uses of the allograft bone have been in spinal fusions, bone cancers, fracture treatments, dental applications, and joint replacements. Using allograft tissue has the advantages of lack of donor site morbidity, decreased surgical time, smaller surgical incisions and avoidance of a second surgery to harvest autograft with attendant increased surgical time and blood loss. Disadvantages of allografts include their limited availability, high cost, fracture in case of massive structural bone allografts, and potential risk for disease transmission. Processing of the allografts can reduce the risk of disease transmission. Gamma irradiation or ethylene oxide can be employed to reduce the risk of disease transmission associated with the use of allografts. Both the techniques may also have a detrimental effect on the biomechanical as well as the biological properties of the graft.

Recent times have seen a change in the way the allografts are used. During the initial period of use, these tissues were removed from the donor and transplanted into the recipient without any manipulation. Advances were mainly confined to storage and surgical techniques. Current researchers aim to manipulate these grafts to make them more versatile.

Also, recent times have seen a lot of changes brought in by the advances in the material sciences and regenerative medicine. Allografts have been replaced by newer materials in some indications, porous metal use in revision acetabular surgery which has brought down the use of bulk allografts on the acetabular side considerably being a point in the case. However, bulk allografts on the femoral side have compared favorably with megaprostheses. Excellent to good results with good mid-term survival has been reported in the tumor surgery as well as revision hip replacements.[1,2] Moreover, the use of bulk allografts in the upper limb is also burgeoning, and the newer indications have been reported. Capanna et al.[3] reported 6 cases of scapular allograft reconstruction after total scapulectomy preserving the rotator cuff muscles. Authors reported good functional results at a mean follow-up of 5.5 years. Malignant tumors of the proximal humerus have been treated with allograft-prosthesis composite reconstruction. Black et al.[4] reported good early and intermediate results in 6 consecutive patients of malignant tumors of proximal humerus treated with allograft-prosthesis composite and followed up for a mean interval of 55 months. King et al.[5] reported proximal humerus reconstructions after resection of tumor with allograft-prosthetic composite reverse total shoulder arthroplasty. Authors reported promising functional outcomes with ostensibly less instability rates compared to hemiarthroplasty or total shoulder arthroplasty.

Morsellized bone allografts have stood their ground as biological materials to fill defects even in weight bearing situations. Even the availability of porous metal components and augments has not been able to undermine the role of morsellized allografts in filling up asperities and defects behind the implants.[6] While the role of morsellized allografts for the management of deficient bone stock, especially in contained and metaphyseal defects is undisputed, their sparse supply has been a concern. Synthetic bone graft substitutes, though readily available, vary in their resorption behavior and material properties. Bone marrow as an additive to allograft to enhance its osteogenetic potential and autologous grafts as extender have been used with moralized allografts. Recent times have seen attempts to use Bioglass BAG-S53P4 as additive to bone allograft. David et al.[7] demonstrated that allografts can be extended using bioglass without compromising the mechanical properties in vivo. An earlier study also demonstrated no negative effect of bone impaction grafting with bone and ceramic mixture.[8] Conversely, allografts can be used as extenders for autografts and have been successful in promoting and achieving a solid fusion mass in instrumented lumbar spine fusion.[9]

Manipulation of the allografts to improve their performance has also been on the agenda of the current researcher. Preclinical studies have shown that the osteoinductive capacity of allograft bone can be improved substantially by the addition of osteogenic proteins. The attempt to achieve the same has been made in the past by adding bone marrow or autologous bone grafts to the allograft.

In other scenarios also, attempts are rife to manipulate the allografts to enhance their biological properties and specially their healing potential. Massive bone defect repairs can typically be augmented using three strategies for manipulating the allografts[10] namely, (a) by engrafting mesenchymal stem cells (MSCs) onto a graft or a biosynthetic matrix to provide a viable osteoinductive scaffold material, (b) by introducing critical factor(s), for example, bone morphogenetic proteins (BMPs), in the form of bone-derived or recombinant proteins directly onto the graft, or, (c) by targeted delivery of therapeutic genes (using viral and nonviral vectors). Awad et al.[10] developed a murine femoral model in which recombinant, adeno-associated virus (rAAV) gene was transferred to achieve revitalization of the allograft. Allografts coated with rAAV expressing osteoinductive or the angiogenic factors combined with the osteoclastogenic factor receptor were shown to have remarkable osteogenic, angiogenic, and remodeling effects in healing allografts resembling the healing response of an autograft. These innovations in gene delivery hold great promise as therapeutic approaches in challenging indications.

Hoffman and Benoit[11] have reported an emerging idea to augment allografts with a tissue engineered periosteum consisting of biodegradable poly (ethylene glycol) hydrogels as a vehicle for mesenchymal stem cells (MSC) transplantation. This bioengineered periosteum will ostensibly revitalize the allografts and heal them akin to autografts.

Cartilage transplantation and tendon allograft techniques are becoming popular with increasingly improved outcomes. There has been a rise in the sports-related and activity-related knee injuries especially among the young and active population. Chondral defects have revealed themselves in the arthroscopic studies in over 60% of these patients increasing the risk of the early onset of osteoarthritis in the injured knee. Osteochondral allograft (OCA) transplantation (OAT) is now increasingly available and has proven to be highly effective in repairing chondral defects larger than 2 cm^2 and restoring mature, hyaline cartilage with innate structure, biology, and function.

Fresh-preserved donor OCAs are commercially available through tissue banks, but the tissue must be maintained at 4 °C after retrieval until a series of microbiological and immunological tests to screen for the transmissible infections are completed. These were historically transplanted fresh, stored in Ringer's solution, within 7 days of the death of the donor.

Bugbee et al.[12] in an excellent review of their work published recently reported on the development of OCA storage protocols to enhance the longevity and the supply of suitable donor tissue, analysis of the cartilage repair and remodeling in vivo through the establishment of an appropriate animal model, refined patient selection through identification of appropriate indications, and, improvement of surgical techniques for better outcomes. The two key constituents of the osteochondral allografts are the chondrocytes and the extra cellular matrix (ECM). Fresh OCA transplantation is done with the premise that the viable chondrocytes survive storage and subsequent transplantation. They are able to maintain their metabolic activity and sustain their surrounding matrix thus providing an intact structural and functional unit to replace diseased articular tissue. Chondrocyte viability in OCA; therefore, is critical to the osteochondral graft survivorship and clinical outcome. However, when stored at 4 °C, the number of chondrocytes falls linearly with storage time. An optimal storage time of less than 28 days from procurement for OCAs has been suggested in studies because a significant decline of cellularity, crucial to maintain matrix, occurs in the fresh-preserved OCAs between days 14 and 28 in storage. The possible explanation offered is that the storage of fresh OCA at 4 °C gradually causes a mismatch between the ATP supply and demand in chondrocytes, which eventually results in necrotic cell death.[12] Chondrocyte apoptosis is also believed to be a major cause of cell depletion in the allografts. Increasing chondrocyte death in fresh-preserved OCAs might release matrix-degrading proteases, including metalloproteinases, from ruptured lysosomes of necrotic chondrocytes leading to dissolution of ECM. Ding et al.[13] have shown that, compared with patients' diseased cartilage, OCA cartilage released significantly lower amounts (10.4-fold lower) of cartilage proteoglycan degrading metalloproteinases, especially MMP-3 (matrix metalloproteinase-3) and showed much lower MMP-3/TIMP-1 (tissue inhibitor of MMP-1) ratio. According to authors, this remarkable difference in metalloproteinase levels between OCA cartilage and patients' cartilage may suggest an intrinsically low expression of cartilage-damaging metalloproteinases in OCAs from young and healthy donors, or, higher expression of these metalloproteinases in the injured knee.

Bugbee et al.[12] have gone further to show that the chondrocyte viability after storage could be improved when additional nutrients (i.e., serum) were added to the media and the superficial zone was a target for decreased viability after 14 days; also, apoptotic response could be altered by adding a TNF inhibitor to tissue culture medium (TCM) thus improving chondrocyte viability during 4 °C storage for up to 28 days; and, 37 °C storage of OCA could support long-term (≥4 weeks) chondrocyte viability, especially at the articular surface, but additional anabolic stimuli or catabolic inhibitors to maintain matrix (e.g., glycosaminoglycan – GAG) content of the cartilage of OCAs may be needed as the cells may become quiescent during storage. Authors also conclusively proved that 4 °C stored grafts have lower chondrocyte viability at the time of OCA transplantation versus fresh grafts. Moreover, 4 °C stored grafts (with reduced cellularity at the cartilage surface) were shown to be less stiff and more susceptible to tissue degeneration after transplantation and associated surface and/or bone collapse.

The research by Bugbee et al. has led to the practice of the addition of the fetal bovine serum to the TCM to preserve chondrocyte viability during screening and processing and an increased supply of fresh OCA for more widespread use.

Other contributions by Bugbee et al. to the osteochondral grafting include the introduction of a comprehensive MRI scoring system for OCA validated with histopathologic, μCT, and biomechanical reference standards in an animal (adult goat) model of in vivo OCA repair. The method has immense potential to help standardize reporting of MR findings after OCA repair with variable treatment options, ranging from outstanding to poor repair. Authors also identified a novel use of proteoglycan-4 (PRG4) secretion as a biomarker of OCA health and performance. These developments will allow better prediction of the OCA outcomes and help devise strategies to provide more suitable tissue for transplantation, which in turn will help improve long-term repair efficacy. Furthermore, authors stressed revisiting the surgical technique in light of their findings that the impact insertion of OCA generates damaging loading impulses sufficient to cause chondrocyte death resembling apoptosis mediated by the activation of caspases, especially in the superficial zone.

Another development in the field of cartilage regeneration is the availability of an Off-the-shelf allograft cartilage implant *De Novo Natural Tissue Allograft* (Zimmer, St Louis, Missouri) which consists of minced human articular cartilage recovered from juvenile donor joints containing viable chondrocytes. Allograft cartilage pieces, molded after suspension in thrombi and fibrin can be used with fibrin glue to fit the cartilage defect bed as a graft. Successful outcome has been reported with its use[14] and the rationale provided lies in the higher proliferative capacity of the juvenile graft compared to the adult tissue.

Cryopreserved cartilage allografts, with pores to increase flexibility and enhance growth factor release, prepared with a novel tissue processing and preservation method have been used to augment marrow stimulation with improve results.[15]

Allografts are just not confined to the replacement of deficient bone and cartilage. Allografts can serve as biological substitutes that are used in the reconstruction of deficient ligaments, tendons, and menisci. Chaudhury et al.[14] have reported allograft replacement for absent native tissue to obtain stable anatomy and restoration of function. This is in contradistinction to the common notion that allografts are employed to reinforce weakened tissue.

Tendon allografts are being increasingly employed in the reconstructive procedures.[16] Fresh allograft tissue is highly immunogenic and therefore unsuitable for implantation. Processing of the allograft tissue by fresh-freezing, freeze-drying or cryo-preserving significantly reduces the immunogenicity of the tissue by killing fibroblasts within the tissue and allows their use even in immunologically incompatible hosts without provoking a significant immune response.

Most common allograft tissues used for tendon reconstruction are tendo Achilles and patellar tendon allografts. Other tissues also used include Fascia lata, rotator cuff, tibialis posterior, tibialis anterior, gracilis and semitendinosus grafts and these are also available commercially. Dermal allografts have been used for the rotator cuff reconstruction.

Secondary sterilization of the tendon allografts can be done using gamma irradiation or ethylene oxide. Both the methods lead to the compromise of the mechanical properties of the graft. The principle concerns regarding the use of ethylene oxide in tendon allografts include the concern about the persistent synovial effusion, reports of graft dissolution, and a poor clinical outcome.

The indications for the tendon allografts have been primarily in lower limb, most frequently for anterior cruciate ligament reconstruction, posterior cruciate ligament reconstruction, multi-ligament reconstruction, lateral ankle ligament for chronic ankle instability, hip abductor mechanism reconstruction, and, knee extensor mechanism reconstruction.[17] Though used less commonly in the upper limb, tendon allografts are now being considered for the management of elbow instability, triceps deficiency in patients following total elbow arthroplasty, reconstruction of the biceps tendon, and, rupture of the pectoralis major tendon. To summarize, tendon allografts are being increasingly used in reconstruction of the tendons and ligaments in a number of anatomical sites. However, major issues surrounding their procurement, processing and use must be understood and discussed with the patient including the risk of disease transmission.

Meniscal transplantation has been considered as a solution in patients with symptoms who have previously undergone meniscectomy and are known to potentially suffer from premature degenerative changes.[18] At present time there are few Level I or II studies reporting the results of meniscal transplantation. Most studies report on small study groups with limited follow-up and patient selection and description of patient factors varies greatly between the groups and data from different studies cannot be compared.

Four types of meniscal allografts are used – fresh, fresh-frozen, cryopreserved, and freeze-dried (lyophilized) graft. Out of these, cryopreserved and fresh-frozen allografts have been found to be most suitable. Matching of the allograft meniscal size with the host is absolutely crucial. Grafts are harvested and transplanted with bony plug attached separately to each horn (Medial meniscus) or both the horns (Lateral meniscus) for best results. Use of bony anchors is recommended to fix the graft. A lesser degree of degeneration in the knee prior to transplantation is associated with an improved outcome. In conclusion, the current literature suggests that meniscal allograft transplantation provides improvement of pain and function in the short and intermediate term in patients less than 40 years of age with knee pain, proven meniscal injury and a normally aligned, stable joint without severe degenerative changes. The effect of meniscal transplantation on the future joint degeneration is inconclusive.

How the technology stands to facilitate the practice of the bone banking? Wu et al.[19] in an article published this year reported improved matching accuracy and reduced allograft selection time by combining virtual bone bank and CAOS when using massive bone allografts for bone tumors. Authors scanned the massive allografts using CT scans and the data was stored in Digital Imaging and Communication in Medicine (DICOM) files. Then the images were segmented and 3D models were reconstructed and saved in Virtual Bone Bank System. Allografts were selected after a matching process based on the volume registration method. Thus, limb salvage surgery using massive allografts and 3D virtual bone bank system could be improved. The technique of 3D virtual bone banking allowed convenient management of the bank, easy and precise matching of allograft and reduced time required for allograft preparation including cutting and trimming.

The future of musculoskeletal banking remains mysterious. While expanding indications and advancing technologies promise a more widespread and easy application, other advances in technology may replace the need for allografts in certain indications. The advances in bioengineering will likely reduce the dependence on allografts in future. Synthetic scaffolds, manufactured with new technology of additive manufacturing, or 3D printing will be instrumental in achieving a clinically successful engineered tissue construct.[20] 3D printing allows the control of scaffold size, shape, geometry, pore size and mechanical properties. Furthermore, modern medical imaging and computer assisted design could be integrated to designs scaffolds individualized to a specific defect in a patient. Refinement of nanotechnology, biocompatible materials, growth factors, gene therapies, and bioreactors will lead to improved bioengineered musculoskeletal tissues leading to reduced demand for the allograft tissue. So let us wait together and see how the future trends unfold in this exciting arena!

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Meta Analysis

Arthroscopic rotator cuff repair with and without acromioplasty for rotator cuff tear: A meta-analysis of randomized controlled trial

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ABSTRACT

Introduction: Although acromioplasty is being widely performed with arthroscopic rotator cuff repair, it remains unknown whether it improves functional outcomes or decease retear rate. The aim of this meta-analysis is to compare the clinical outcome of arthroscopic rotator cuff repair with and without acromioplasty for the treatment of rotator cuff tear.
Methods: A search was performed in the MEDLINE, EMBASE, and Ovid databases. All randomized controlled trials that reported the outcome of arthroscopic rotator cuff repair with and without acromioplasty were included in the meta-analysis. The outcomes were American Shoulder and Elbow Surgeons (ASES) score, Constant score, UCLA score, and retear rate. We then analyzed the data using RevMan (version 5.1).
Results: The literature search identified a total of 5 studies with 447 patients that were included in the meta-analysis. There was no significant difference in the American shoulder and elbow surgeons, University of California-Los Angeles (UCLA), or constant scores between the acromioplasty and nonacromioplasty group.
Conclusion: Our meta-analysis does not demonstrate any difference in the functional outcome and retear rate of arthroscopic rotator cuff with or without acromioplasty.
Level of evidence: Level II. Therapeutic study.

1. Introduction

Rotator cuff tears are one of the most common shoulder injuries and can be a source of persistent pain, disability, and decreased range of motion (ROM) and strength.[1] Medium to large rotator cuff tears are treated with rotator cuff repair. Traditionally, acromioplasty have been routinely performed, as a part of the arthroscopic repair.[2] Acromioplasty is an effective surgical procedure in increasing the height of the subacromial space, and thus relieving the symptoms of impingement syndrome. The mechanical impingement is believed to contribute to abrasion of the supraspinatus tendon, eventually leading to its rupture.[3] Neer hypothesized that

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acromioplasty smoothens the area of contact over the supraspinatus tendon and decreases mechanical wear.[4] The effectiveness of acromioplasty, as an adjuvant procedure in rotator cuff repair, remains unknown, with some studies supporting this while others refuting any benefit.[5–7] Despite this, the incidence of acromioplasty with rotator cuff repair has significantly increased recently.[8,9]

Randomized controlled trials are considered to be the most reliable form of scientific evidence in the hierarchy of evidence because randomized controlled trials reduce spurious inferences of causality and bias. Our aim was to compare the functional outcome, revision rate of the two groups of patients treated for rotator cuff repair with and without acromioplasty by arthroscopic method. Our hypothesis was that both the groups were comparable, with no benefit of acromioplasty.

2. Methods

This meta-analysis was conducted according to the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analysis and the Cochrane Handbook for Systematic Reviews of Interventions.

2.1. *Literature search*

We searched the Cochrane Central Register of Controlled Trials (The Cochrane Library, 2013, Issue 9), PubMed (1946 to September 2013), and EMBASE (1980 to September 2013) databases. No language or publication restrictions were applied. Articles in languages other than English were translated with the help of medically knowledgeable speakers. The following keywords were used for the searches: Rotator cuff repair, cuff repair, rotator cuff, acromioplasty, and subacromial decompression. We checked the reference lists of published studies to identify additional trials. Furthermore, we searched the following journal contents in the past 3 years for randomized controlled trials: *Arthroscopy: The Journal of Arthroscopic and Related Surgery*, *The American Journal of Sports Medicine*, *The Journal of Bone and Joint Surgery*, *The Bone and Joint Journal*, *Clinical Orthopaedics and Related Research*, and the *Journal of Shoulder and Elbow Surgery*.

2.2. *Eligibility criteria*

We systematically reviewed the literature according to the following criteria: (1) a target population of rotator cuff tears requiring arthroscopic repair, (2) Level I and II randomized controlled trials evaluating surgical interventions, (3) studies comparing the outcomes of arthroscopic rotator cuff with and without acromioplasty. (4) One or more outcomes of interest postoperatively (e.g. retear rate, shoulder score, and complications).

2.3. *Selection of studies*

Two authors (SM and SK) independently scanned records retrieved by the searches to exclude irrelevant studies and to identify trials that met the eligibility criteria. They retrieved and independently reviewed full-text articles for the purpose of applying inclusion criteria. Differences in opinion between authors were resolved by discussion and consultation with the senior author (BC) (Fig. 1).

2.4. *Outcomes*

The primary outcome of interest was American shoulder and elbow surgeons (ASES score).[10] Secondary outcomes noted were Constant score,[11] University of California-Los Angeles (UCLA)score,[12] and retear rate.

2.5. *Assessment of heterogeneity and statistical methods*

We planned to consider both clinical heterogeneity (e.g. differences among patients, interventions, and outcomes) and statistical heterogeneity variation between trials in the underlying treatment effects being evaluated. To establish inconsistency in the study results, statistical heterogeneity between studies was formally tested with I^2.[13] The I^2 estimate

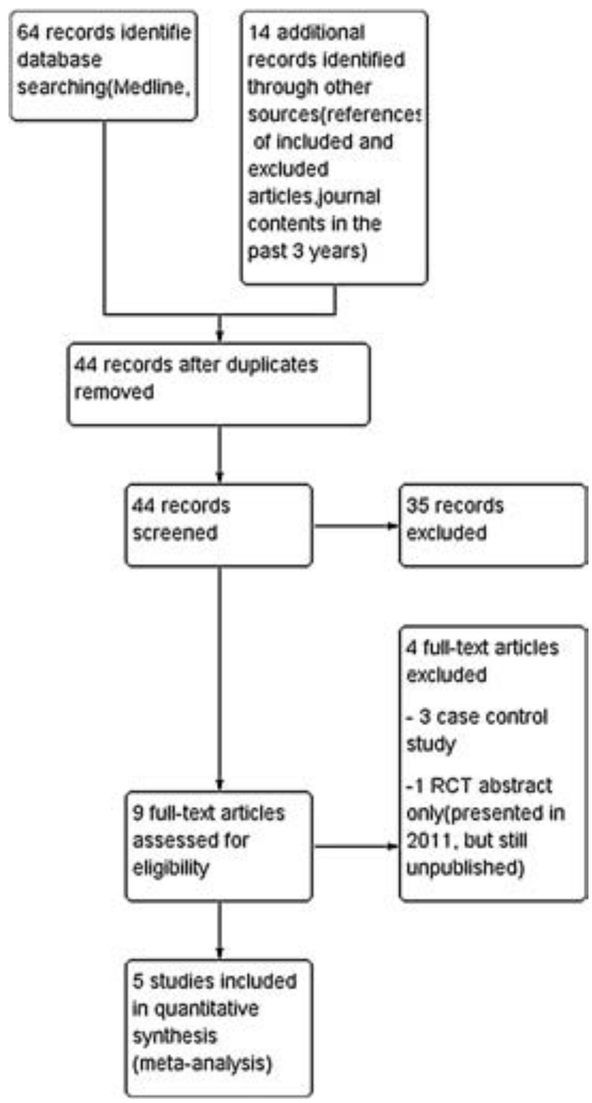

Fig. 1 – Search strategy results.

Table 1 – Study characteristics (ARCR-A: arthroscopic rotator cuff repair with acromioplasty, ARCR: arthroscopic rotator cuff repair without acromioplasty) Characteristics of included studies.

Author	Patients/age	Men (%)	Follow-up rate and length	Randomization (ARCR-A/ARCR)	Measured outcomes	Jadad score
Shin et al., 2012[18]	150 pts; mean age 56.8	44.6	120/150 (80%); 35 months	60/60	Constant, ASES, UCLA, pain VAS	2
MacDonald et al., 2011[15]	86 pts; mean age 56.8	65	68/86 (79%); 24 months	32/36	WORC, ASES	3
Abrams et al., 2014[17]	95 pts; mean age 58.8	67.3	95/114 (83%); 24 months	52/43	SST, ASES, Constant, UCLA, SF-12	3
Milano et al., 2007[16]	80 pts; mean age 60.4	54.9	71/80 (89%); 24 months	34/37	Constant, DASH, work-DASH	2
Gartsman and O'Connor, 2004[14]	93 pts; mean age 59.7	55	93/93 (100%); 15.6 months	47/46	ASES	2

examines the percentage of total variation across studies resulting from heterogeneity rather than chance. According to the Cochrane Handbook, heterogeneity is considered not important between 0% and 40%, moderate between 30% and 60%, substantial between 50% and 90%, and considerable between 75% and 100%. Therefore, an I^2 of less than 60% is accepted in this meta-analysis, and a fixed-effects model was used. Tests for significance were 2-tailed, and $P < 0.05$ was deemed to be significant.

Continuous data (ASES, UCLA, and constant score) were reported as standardized mean differences. Dichotomous data (retear) were reported as risk ratio by the use of a random or fixed-effect model. A fixed-effect model was applied when the included studies were assessed to be homogenous; a randomized effect model was applied when they are heterogeneous. The quality of studies was assessed by Jadad score.

3. Results

Hence, 5 randomized controlled trials involving 474 patients were included in this meta-analysis, with individuals ranging from 80 to 120 patients.[14–18] Of these 474 patients, 240 were randomly assigned to the group with acromioplasty and 234 patients were assigned to the group with acromioplasty. Table summarizes the characteristics of the included studies. Table 1 provides an overview of each study in this meta-analysis.

3.1. *Methodological quality*

Out of the five studies included, three were level I and two were level II. The overall methodological quality was high, and no studies were of low quality. The rate of loss to follow-up was considered to be acceptable (0% to 11%).

3.2. *ASES score*

Four studies used ASES score. The test for heterogeneity showed that there was no heterogeneity in this meta-analysis ($I^2 = 0\%$, $P = 0.39$). No significant difference was found in the fixed-effects model between the two groups (mean difference 1.92; 95%, CI, −0.85 to 4.70) (Fig. 2).

3.3. *Constant score*

Three studies used constant shoulder scores. The test for heterogeneity showed that there was no heterogeneity in this meta-analysis ($I^2 = 0\%$, $P = 0.50$). No significant difference was found in the fixed-effects model between the two groups (mean difference 3.12; 95% CI, −0.05 to 6.29, $P = 0.05$) (Fig. 3).

3.4. *University of California at Los Angeles score*

The University of California at Los Angeles (UCLA) shoulder score was reported in 2 studies. Fixed-effect analysis showed that the difference was not significant between the 2 groups (mean difference 0.70; 95% CI, −0.21 to 1.60; $P = 0.33$). No statistical heterogeneity was found in this meta-analysis ($I^2 = 0\%$; $P = 0.42$). No further analysis was possible (Fig. 4).

3.5. *Retear rate*

The retear rate was reported in two studies. Fixed-effect analysis showed no significant difference between the two groups (mean difference 0.20; 95% CI 0.04 to 1.18) (Fig. 5).

4. Discussion

Neer suggested that extrinsic impingement was the most common cause of chronic rotator cuff tear.[4] The usual

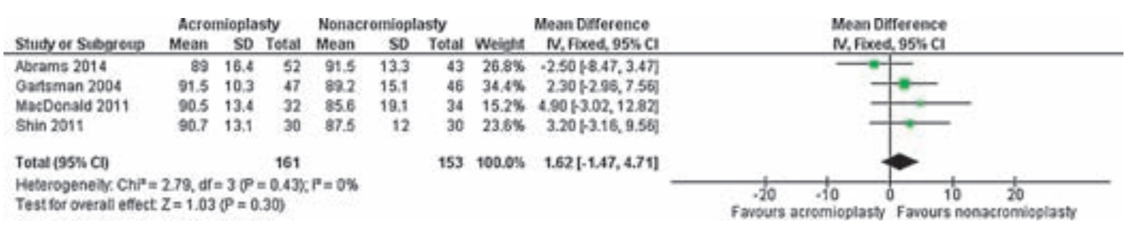

Fig. 2 – Forest plot for ASES score.

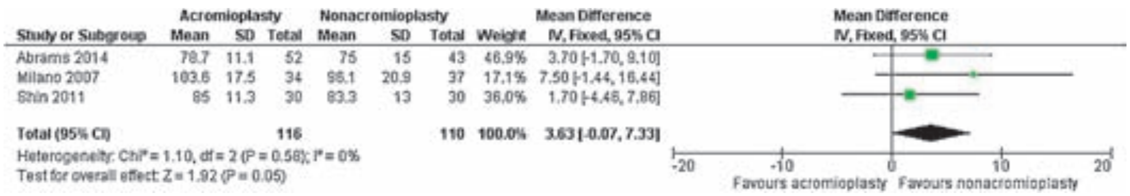

Fig. 3 – Forest plot for constant score.

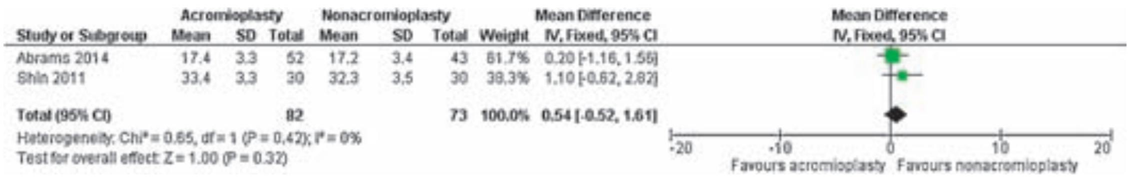

Fig. 4 – Forest plot for UCLA score.

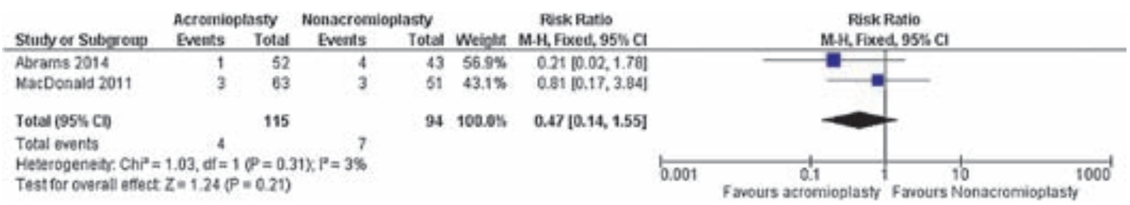

Fig. 5 – Forest plot for retear rate.

indication for acromioplasty is Neer stage II rotator cuff disease with subacromial pain or partial tear of the supraspinatus or infraspinatus tendons.[2] Subacromial decompression by acromioplasty is believed to result in relief of extrinsic, primary impingement on the rotator cuff tendons, a potential cause of extrinsic tendinopathy. However, many recent studies have shown that majority of the time rotator cuff tears are related to internal factors.[19] Some investigators have showed that the development of the acromial bony spur is a secondary degenerative change, implying that the majority of rotator cuff tears are initiated not by impingement but by an intrinsic degenerative tendinopathy. Hence, there should be no need for acromioplasty in rotator cuff repair.[20]

Several studies have shown good results after acromioplasty with rotator cuff repar.[21–23] However, recent studies have shown good clinical outcome even without acromioplasty.[24] Our meta-analysis pooled 5 randomized controlled trials showing that there were no significant differences in functional scores (ASES, UCLA, and constant scores) and retear rate for patients with rotator cuff tears from medium to large sizes. The main findings of the current study were that doing acromioplasty with rotator cuff repair does not improve functional outcomes, as measured by various shoulder scores. There is also no decrease in retear rate with acromioplasty. These results support our primary hypothesis.

Acromioplasty has been reported to have an impact on the healing rate of the tear. It leads to increase in local concentrations of growth and angiogenic factors, potentially leading to improved healing environment.[25,26] However, this is not supported by the recent literature.[27]

Only two out of the five studies included in this meta-analysis have reported retear rate. The retear rate was higher in the nonacromioplasty group but that was not significant. MacDonald et al. found a significantly higher number of patients in nonacromioplasty group requiring additional surgery. We did not evaluate the relation of the type of acromion with the outcome and retear rate. However, Shin and Macdonald et al. did not find any association between the functional outcomes and acromion type.[15,18] Henkus et al. reported that acromion morphology made no difference in the outcome of the patient. We showed that acromioplasty and rotator cuff debridement in patients with impingement syndrome and partial tears do not prevent the patient from having future tear.[28]

The disadvantages of doing acromioplasty are weakening of deltoid muscle, anterosuperior instability, and possibly formation of adhesion between exposed bone on under surface of the acromion and the underlying rotator cuff tendon, which in turn can limit smoothness, motion comfort, and range of motion.[29,30] Acromioplasty leads to increase in the cost to the patient due to the obvious increase in time and equipment costs associated with the procedure.

The American Academy of Orthopaedic Surgeons (AAOS) clinical practice guidelines for treatment of rotator cuff tears do not recommend routine acromioplasty during rotator cuff repair.[31] The academy statement is primarily based on the two randomized controlled trials available on this topic at that time. Based on our meta-analysis, we full endorse the academy statement. However, the long-term outcomes of performing or not performing acromioplasty with rotator cuff repair are still unknown. Large, well-designed RCT with long-term follow-up is required to clarify that.

This meta-analysis has several limitations. First, the number of target patients was small. All randomized controlled trials were of small size and each was performed at a single centre. Second, the variety of different outcome measures limited our ability to combine outcome scores and make more definitive conclusions. It may also have resulted in a decrease in our ability to identify a true difference when one actually existed. We analyzed ASES, UCLA, and Constant shoulder scores, but it is noteworthy that all of these scores involve comprehensive assessments, such as pain, function, strength, and range of motion. Third, the tear size and acromion type may affect the differences between the two groups. No adequate studies reported the outcomes of subgroups. Therefore, we did not perform the subgroup analysis based on the tear size to ensure the rationality and validity of this meta-analysis.

5. Conclusions

Our meta-analysis does not any demonstrate any difference in the functional outcome and retear rate of arthroscopic rotator cuff with or without acromioplasty. Large, well-designed trials are needed to further assess the long-term outcome of performing or not performing acromioplasty.

Conflicts of interest

All authors have none to declare.

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Original Article

Assessing the benefit of multidisciplinary assessment centre in a military population sustaining knee injury

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ABSTRACT

Objective: To evaluate the benefit of multidisciplinary assessment centres in the diagnosis of knee injury in military populations and assess the role of MRI as gold standard in the diagnosis of knee injury.

Design: Retrospective epidemiological study.

Setting: 122 servicemen attending the Multidisciplinary Injury Assessment Clinic (MIAC) at Redford Barracks, Edinburgh between January 2008 and January 2010.

Results: The most common of these injuries were to the medial meniscus (30.3%), osteochondral defects (28.7%) and anterior cruciate ligament (25.4%). 45.6% of patient sustained injury to more than one structure.23% of the 122 servicemen were deemed fully fit for military duty following treatment; 41 (34%) were classed as partially fit, with 31 (25.4%) deemed not medically fit at the end of period of assessment. The MIAC team were both more sensitive and specific at picking up all forms of structural knee injury with the exception of meniscal injuries, where the MIAC was more sensitive (0.76 vs. 0.74) but less specific (0.53 vs. 0.62). MRI was shown to have a sensitivity of between 0.68 and 0.96 when compared against arthroscopy. Its specificity was poorest for picking up osteochondral defects (0.39).

Discussion: The MIAC diagnosis of knee injuries was shown to be more effective than that of non-specalised GPs. MIAC also had a good degree of clinical accuracy when compared to MRI. MRI was shown to be an effective investigation, although not 100% sensitive and specific, and was poor at picking up osteochondral defects. It is recommended that the use of systems such as MIAC be expanded in the civilian community and be used in conjunction with MRI for maximal diagnostic efficiency.

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1. Introduction

Young active populations are at risk of knee injures owing to the stress they place on their joints during physical activity.[1,2] The most common injuries are those involving the anterior cruciate ligament, medial meniscus and medial collateral ligament.[3] The prognosis and recovery rates post-knee injury depend largely on the mechanism and nature of injury. Large epidemiological studies in Scandinavia have indicated that knee injury was the most common cause of disability following injuries in a variety of sports,[4] with many athletes struggling to return to pre-injury fitness.

Magnetic resonance imaging (MRI) is routinely used as the modality of choice for imaging of the knee, owing to its ability to identify soft tissue injuries[5] and is widely considered as a practical 'gold standard' test when used in associated with clinical assessment.[5] It is generally regarded as the investigation of choice in both civilian and military populations, particularly in patients with equivocal findings and risk of substantial injury.[6–9] The National Institute of Clinical Excellence (NICE) provide a knee assessment protocol that dictates when referral to emergency services and orthopaedic surgeon is recommended. In reality, these guidelines are often not fully adhered to. This is partly due to clinical symptoms often presenting equivocally and the subsequent burden on emergency departments this would place if all high index of suspicion injuries were referred on. In addition, waiting lists for orthopaedic referrals are often lengthy, preventing rapid assessment and diagnosis. Anecdotal evidence suggests that knee injuries in the UK are largely dealt with in the primary care setting with the majority of the remainder first presenting to the emergency department; there is no current epidemiological data highlighting what percentage of patients present to which services. Recent research indicated a mean delay from presentation to diagnosis of 22 months in patients with anterior cruciate ligament rupture presenting to sports injury clinics.[10] In addition, this same study found fewer than 10% of patients with anterior cruciate ligament rupture were given this diagnosis by referring doctors, with 30% having no formal diagnosis even after review with an orthopaedic consultant. Clearly any system that could improve these statistics by providing quick and efficient assessment and diagnosis would benefit both the patient and reduce strain on NHS services.

Military personnel are at risk of sustaining knee injuries due to the physical nature of their employment. As fitness is considered an integral aspect to military service, disability as a result of knee injury would have consequences for the individual's professional life in addition to affecting day-to day functioning and participation in sporting activities. Loss of full function could result in alteration of duties or discharge from medical service in severe cases.

As a result of this, the military operate a system whereby patients are streamlined to ensure there is minimum delay between initial presentation and diagnosis. Most patients initially present to their medical officer (MO) or general practitioner. Patients will either be treated at this level, or if it is felt warranted, referred on to Regional Rehabilitation Units (RRU). These units provide assessment, diagnosis and treatment via their Multidisciplinary Injury Assessment Clinic (MIAC).[11] These clinics are situated at 15 military bases across England, Scotland and Wales. The team working at these centres typically consists of an MO or general practitioner, physiotherapists and remedial instructors. These health professionals have specific sports medicine training for diagnosis and rehabilitation of sporting injuries. Each MIAC aims to see each patient within 20 days of referral to the clinic. The clinics have intensive physiotherapy programmes available as well as on site medical officers.[11] Each MIAC also has 'rapid access' to MRI scans, with a timeline of 10 days between referral and scan targeted. This service aims to minimize the waiting time between initial presentation and diagnosis, which, as research has shown, is one of the most significant[12] aspects for patients, both physically and psychosocially. If significant injury is suspected through clinical examination and MRI, the patient is booked in for arthroscopy. Arthroscopy can be both diagnostic and therapeutic. Although it too is neither fully sensitive nor specific as a stand alone diagnostic tool, it is often recognised as the gold standard test for diagnosis of internal derangement of the knee.[13]

We present the impact of a Multidisciplinary Injury Assessment Clinic in the diagnosis and subsequent treatment pathway of individuals presenting with knee injury in a military population. We provide valuable information on the outcomes of knee injuries in servicemen, which will help guide people treating servicemen and athletes around the world.

2. Methods

2.1. Population sampling

The sample group was military servicemen who presented to the Redford Barrack Multidisciplinary Injuries Assessment Centre (MIAC) to have MRI for knee pathology between January 2008 and January 2010 inclusive. In total this was a population of 182 servicemen from the Royal Navy, Royal Marines, British Army and Royal Air Force. Those who were seen but injury felt not sufficient enough to undergo further investigation with MRI were not included in the sample, unless later re-attending and undergoing investigation at that point.

Records of MIAC attendance to the Redford Barracks in Edinburgh were used to identify individuals who presented with injury severe enough to warrant MRI during the above time frame. Information was taken from initial GP referral letter, MIAC records, MRI scan reports and surgical notes.

Of the 182 patients, 60 of these patients were not included in the final data set. 50 of these were due to these patients having inadequate or absent initial referring GP letter, therefore data could not be assessed for these patients. The remaining 10 patients had incomplete MIAC notes or inadequate documentation of MRI results. This left 122 patients within the sample population.

2.2. Evaluation of clinical assessment

The mechanism of injury and suspected clinical diagnoses and by the initial referring GP, MIAC team, MRI and arthroscopy (if performed) were recorded. Due to the number of structural injuries that it is possible to sustain with knee trauma, only a select number of the most commonly occurring knee injuries were assessed. These were; meniscal injuries; anterior and posterior cruciate ligament injuries; collateral ligamentous injuries and osteochondral defects, which research has indicated clinicians are poor at diagnosing and detecting. For the GP referral and MIAC team, MRI was used as the gold standard against which the GP and MIAC team were compared. In order to assess the clinical accuracy of using MRI, those patients who underwent arthroscopy had their MRI results tests against their end arthroscopy findings.

Pathology was classified as a recognised rupture or tear, or injury to the ligament significant enough to cause notable inflammation of the surrounding tissues. In those individuals who sustained injury to more than one structure in the knee, this was recorded in both the incidence of each injury sustained and also in Figs. 2–4 in the results section showing the spread of multiple pathologies. For example, in an individual damaging both his lateral meniscus and anterior cruciate ligament, this would count as 2 individual injuries to calculate mechanism per individual pathology sustained, and would show as the intersection between lateral meniscus and ACL on the Venn diagram in Fig. 3.

These data were then used to calculate the sensitivity, specificity, positive predictive value and negative predictive value for each method of diagnosis (Table 1).

2.3. *Treatment and end outcome assessment*

Records were reviewed for information regarding treatment outcome for those individuals with substantial pathology. Treatment options were split into four main categories: arthroplasty (functioning as both diagnostic and therapeutic procedure); ACL/PCL surgical repair; menisectomy; and chondroplasty and microfracture for osteochondral defects. Owing to the nature of the MIAC system as outlined above, none of these surgeries was substantially delayed from presenting date to affect end outcome data. The online applet Euler3[9] was used for production of the Venn diagram relating to demographics of surgical intervention.

End outcome in all patients presenting was assessed by use of the military physical status system. All military divisions in

Table 1 – Prevalence of knee injury, mechanism of injury and end outcome in military personnel following treatment.

Characteristic	RAF	Navy	Army	Marine	Total
Diagnosis					
Meniscal	16 (13.1)	15 (12.3)	14 (11.5)	1 (0.8)	46 (37.7)
Medial	10 (8.2)	14 (11.5)	12 (9.8)	1 (0.8)	37 (30.3)
Lateral	9 (7.4)	1 (0.8)	3 (2.5)	0 (0)	13 (10.7)
ACL	14 (11.5)	8 (6.6)	8 (6.6)	1 (0.8)	31 (25.4)
PCL	2 (1.6)	3 (2.5)	2 (1.6)	1 (0.8)	8 (6.6)
OCD	13 (10.7)	9 (7.4)	11 (9.0)	2 (1.6)	35 (28.7)
MCL	2 (1.6)	3 (2.6)	0 (0)	1 (0.8)	6 (4.9)
LCL	0 (0)	0 (0)	1 (0.8)	0 (0)	1 (0.8)
Other[a]	3 (2.5)	2 (1.6)	4 (3.3)	0 (0)	9 (7.4)
End outcome					
Fully Fit	13 (10.7)	8 (6.6)	6 (4.9)	1 (0.8)	28 (23.0)
Partially Fit	13 (10.7)	11 (9.0)	11 (.0)	6 (4.9)	41 (33.6)
Unfit	12[d] (9.8)	7[e] (5.7)	10 (8.2)	2 (1.6)	31 (25.4)
Not documented	7 (5.7)	3 (2.6)	11 (9.0)	1 (0.8)	22 (18.0)
Mechanism					
Sporting	24 (19.7)	14 (11.5)	22 (18.0)	5 (4.1)	65 (53.3)
Football	13 (10.7)	10 (8.2)	7 (5.7)	2 (1.6)	32 (26.2)
Running	2 (1.6)	1 (0.8)	7 (5.7)	0 (0)	10 (8.2)
Rugby	3 (2.5)	1 (0.8)	4 (3.3)	1 (0.8)	9 (7.4)
Other[b]	6 (4.9)	2 (1.6)	4 (3.3)	2 (1.6)	14 (11.5)
Low Impact	8 (6.6)	6 (4.9)	6 (4.9)	2 (1.6)	22 (18.0)
Walking	2 (1.6)	0 (0)	3 (2.5)	1 (0.8)	6 (4.9)
Low impact fall	2 (1.6)	3 (2.5)	1 (0.8)	1 (0.8)	7 (5.7)
Other[c]	4 (3.3)	3 (2.5)	2 (1.6)	0 (0)	9 (7.4)
Military related	6 (4.9)	2 (1.6)	6 (4.9)	1 (0.8)	15 (12.3)
On exercise	3 (2.5)	0 (0)	5 (4.1)	0 (0)	8 (6.6)
Physical training	3 (2.5)	2 (1.6)	1 (0.8)	1 (0.8)	7 (5.7)
Unknown	6 (4.9)	6 (4.9)	3 (2.5)	1 (0.8)	16 (13.1)
Total					122

Data reported as *n* (%).

ACL = anterior cruciate ligament; PCL = posterior cruciate ligament; CD = osteochondral defect; MCL = medial collateral ligament; LCL = lateral collateral ligament.

[a]Others included substantial tendinosis, joint degeneration and chondromalacia patellae.

[b]Cricket, golf, cycling, hockey, kite surfing, skiing, squash, volleyball, martials arts.

[c]Load carrying, chronic damage, road traffic accident, fire fighting duty.

[d]Exited military.

[e]For medical reasons unrelated to knee injury.

the UK use the PULHHEEMS system to assess capacity to work. As part of this classifications system, overall physical capacity (P) is assessed. This 'P' grade is adjusted depending on the roles of the individual, the activities required within this role and their ability to be fit with the amendment of duties.[15] The P grades are as follows:

- P2: Medically fit for unrestricted service worldwide.
- P3: Medically fit for duty with minor employment limitations.
- P4: Medically fit for duty within the limitations of pregnancy.
- P7: Medically fit for duty with major employment limitations.
- P8: Medically unfit for service.

Records were read between May and June of 2010—this allowed a period of six months between the last patients presenting and their assessment of their clinical progress and end outcome. This time period left enough time for all patients to undergo satisfactory investigations and for the vast majority of patients to have reached a level of fitness which one can assume to be nearer their baseline level of fitness, regardless of whether or not they went on to have surgery. It is recognised that not all patients will reach their maximal fitness level in this time period. Information was gathered for all patients in general, for each individual injury and also for those who underwent some form of surgical intervention. The high number of multiple injuries and frequency of patients undergoing more than one surgical procedure made it difficult to individualise the end outcome assessments for patients. For example, many patients with meniscal injuries who went on to have menisectomy also underwent ACL repair. As a result, data was accrued for those who underwent any form of surgical procedure.

From this information, the overall benefit of the MIAC vs. conventional GP diagnostics was assessed.

Table 2 – Mechanism of injury according to pathologies sustained on MRI.

	Mechanism of Injury				
	High Impact	*Low Impact*	*Military Duty*	*Unknown*	*Total*
Lat men	11 (84.6)	1 (7.7)	1 (7.7)	0	13
Med men	18 (48.6)	5 (13.6)	5 (13.5)	9 (24.3)	37
ACL	25 (83.3)	2 (6.7)	1 (3.3)	2 (6.7)	30
PCL	6 (75)	2 (25)	0	0	8
OCD	22 (62.9)	4 (11.4)	2 (5.7)	7 (20)	35
MCL	5 (83.3)	1 (16.7)	0	0	6
LCL	0	1 (100)	0	0	1

Data reported as *n* (% of injury total).
Lat = lateral; med = medial; men = meniscal; ACL = anterior cruciate ligament; PCL = posterior cruciate ligament; OCD = osteochondral defect; MCL = medial collateral ligament; LCL = lateral collateral ligament.

3. Results

3.1. *Demographics*

A total of 182 servicemen were seen by the MIAC clinic and had MRI between January 2008 and 2010, with 122 being included in the final population sample Of these, 36.8% (45) were RAF servicemen, 31.1% (38) were army, 23.7% (29) were naval servicemen and 8.2%[10] were royal marines. 95% (116) of the population were male. 75.4% (92 of the 122) of the referrals on from MIAC were by physiotherapists working in the centre, with 23% being doctors and the remainder unknown.

3.2. *Incidence of knee injury on MRI*

79 of the 122 (64.7%) servicemen had evidence of significant pathology relating to cruciate ligaments, collateral ligaments, menisci and osteochondral defects on MRI. Of these, 24 (30.3%) were army servicemen, 4 (5.0%) were marines, 23 (29.1%) were naval and 28 (35.4%) were RAF. In this limited female population, it was not possible to discern any significant gender differences in injury sustained ($p = 0.57$).

Table 2 outlines the raw data for individuals with positive pathology on MRI regarding diagnosis, end outcome and mechanism of injury for each military sub population. Total percentage figures for diagnosis equate to greater than 100% due to the incidence of multiple separate pathologies occurring in one individual (see Fig. 3).

The most common pathologies are outlined in Fig. 1. The highest incidence of injury was related to the medial meniscus (30.3%), osteochondral defects (28.7%) and anterior cruciate ligament (25.4%). 36 of the 79 (45.6%) sustained injury to more than one structure. Of these, 58.3% (21) sustained 2 injuries, with 38.9%[14] sustaining 3 and 1 injuring three structures. The anterior cruciate ligament (24 of the 36) and medial meniscus (23 of the 36) were the two structures most commonly injured in those with multiple pathologies.

3.3. *Incidence of knee injury on arthroscopy*

A total of 55 servicemen (45% of the original sample) underwent arthroscopy following MRI. Of these, 49 (89%) had evidence of positive pathology on arthroscopy. The incidence of each pathology separately is shown in the graph below.

A total of 23 (41.8% of the 55 undergoing arthroscopy) patients were found to have on isolated pathology on arthroscopy, 12 (21.8%) had two separate pathologies, 12

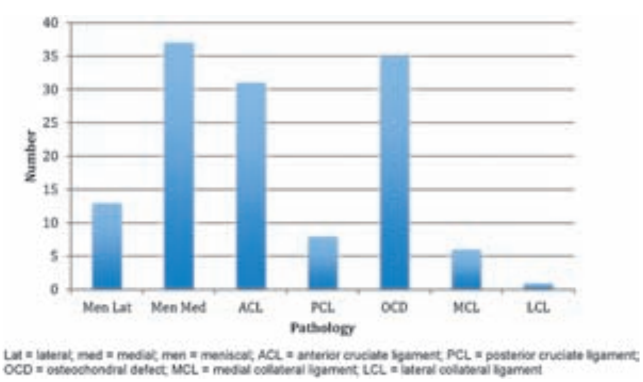

Fig. 1 – Bar graph demonstrating incidence of knee injury according to pathology as detected on MRI scan.

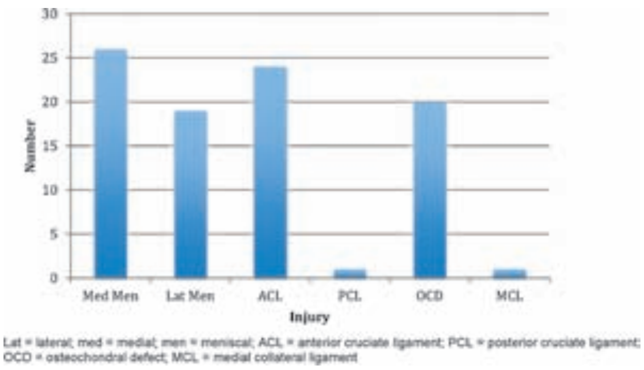

Fig. 2 – Bar graph demonstrating incidence of knee injury according to pathology as detected on arthroscopy.

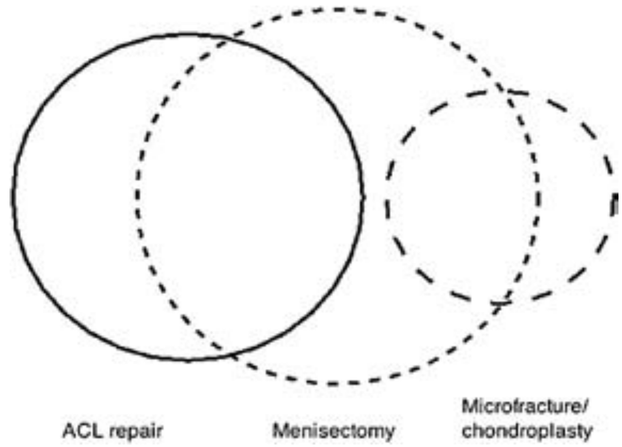

Fig. 4 – Venn diagram demonstrating the incidence of ACL repair, menisectomy and microfracture/chondroplasty.

patients (21.8%) had 3 separate pathologies, and a further 2 (3.6%) had 4 pathologies.

3.4. *Mechanism of Injury*

103 (86.9%) had a documented mechanism of injury recorded. Of these, 65 (53.3%) were performed during high impact sporting activity, with the remainder reporting low-level activity or chronic pain with no acute mechanism of injury. Of these, 15 (12.3%) were sustained whilst on exercise or military duty. Table 2 demonstrates the mechanism of injury sustained in each of those individuals who had confirmed pathology on MRI scan.

The mechanisms of injury for each specific injury type were sustained largely through high impact activities (as defined above), with the exception being that of the one lateral collateral ligament injury, which occurred through a low impact fall (see Fig. 3). Both medial meniscal injuries and osteochondral injuries had relatively fewer high impact injuries (48.6% and 62.9%, respectively), with all other injuries comprising 75% or greater high impact injury. These categories also had a substantially higher percentage of unknown mechanisms of injury (24.3% and 20%, respectively) *p* value = 0.098 (Fig. 5).

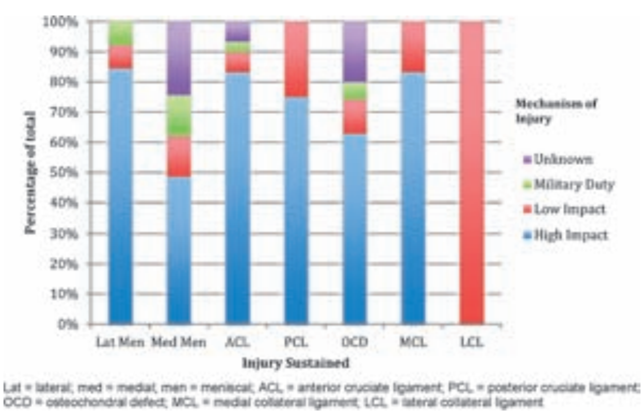

Fig. 3 – Stacked bar graph demonstrating mechanism of injury according to confirmed injury on MRI.

3.5. *Treatment*

A total of 49 patients (40.2% of the initial 122 in the sample population) underwent treatment other than simple arthroscopic measures. Of these, 12 (9.8%) underwent microfracture or chondroplasty for ostoechondral defects, 26 (21.3%) underwent ACL repair and 33 (27%) underwent menisectomy. The Venn diagram below shows the incidence overlap for each of these treatments.

3.6. *End outcome assessment*

28, or 23% of the 122 servicemen in the initial sample population were deemed fully fit for military duty following treatment; one of these was on the condition of fulfilling administrative duties only. 41 (34%) were classed as partially fit. Of the 31 (25.4%) deemed not medically fit, one was due to unrelated medical problems. One of the servicemen left the military between and attending and data correlation-the reasons for this departure were unknown.

Of the 79 servicemen with positive findings on MRI, 26 (32%) were fit for service at the end of the study period, 20 (26%) were partially fit and 18 (22%) were unfit, with 15 servicemen having no end point fitness assessment recorded. Of the servicemen with no pathology found on MRI, 1 (4%) was fully fit at the end of the study period, 15 (65%) were partially fit, 5 (22%) were unfit and 2 (9%) had no end outcome data. With the exclusion of those individuals with no outcome data, there was significant difference between those patients with no findings on MRI and with positive findings on MRI ($p = 0.0017$).

Table 3 highlights the end outcome for each individual injury on MRI finding. The surgery column for each includes individuals who underwent any form of surgery, accounting for those individuals with multiple pathologies. There was no statistical signficance between the injury sub groups and end outcome ($p = 0.79$). As can be seen, there was a decrease in the percentage of patients who were assessed as fully fit across all injury types when undergoing surgery compared to the injury population as a whole. With the exception of the PCL injured

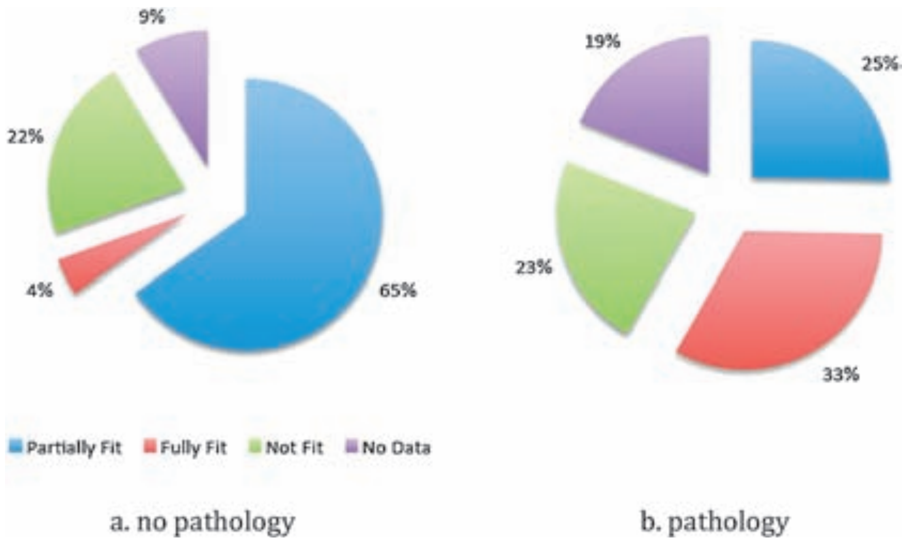

Fig. 5 – Pie chart showing the end outcome for servicemen attending MIAC with and without knee pathology on MRI.

Table 3 – End outcome data according to injury found on MRI.

	Meniscal		ACL		PCL		OCD		MCL	
	All	Surgery	All	Surgery	All	Surgery	All	Surgery	All	Surgery
Fully fit	17 (37.0)	11 (26.8)	9 (29.0)	7 (25.0)	2 (25.0)	0 (0)	11 (31.4)	8 (30.8)	2 (33.3)	0 (0)
Partially fit	10 (21.7)	10 (24.4)	7 (22.6)	8 (28.6)	2 (25.0)	0 (0)	8 (22.9)	8 (30.8)	0 (0)	0 (0)
Not Fit	11 (23.9)	12 (29.3)	12 (38.7)	9 (32.1)	2 (25.0)	2 (100)	7 (20.0)	7 (26.9)	3 (50.0)	3 (100)
No Data	8 (17.4)	8 (19.5)	3 (9.7)	4 (14.3)	2 (25.0)	0 (0)	9 (25.7)	3 (11.5)	1 (16.7)	0 (0)
Total	46	41	31	28	8	2	35	26	6	3

population ($p = 0.014$), there was no statistical significance between the population for each injury and those operated on ($p = 0.17, 0.21, 0.0014, 0.006, 0.0833$).

3.7. *Assessment of clinical evaluation*

Using the data collected from the findings of the GPs, the MIAC and MRI, the sensitivity, specificity, positive predictive value and negative predictive value were calculated to assess the ability of both GPs and MIAC in picking up pathology. This was calculated using MRI as a gold standard.

Table 4 outlines the findings for each individual pathology for both the GP and MIAC assessments.

As can be seen, the MIAC was consistently more sensitive than GP diagnosis in ascertaining pathology, and had a higher level of specificity and positive predictive value in all but the meniscal subpopulation. Significance was unable to be calculated owing to population sizes. The small population

Table 4 – End outcome assessment of GP diagnosis vs MIAC diagnosis in diagnosing knee pathology.

	N	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Meniscal	46				
GP		0.74	0.62	0.54	0.80
MIAC		0.76	0.53	0.50	0.79
ACL	31				
GP		0.45	0.85	0.50	0.82
MIAC		0.55	0.86	0.57	0.85
PCL	8				
GP		0.13	0.94	0.13	0.94
MIAC		0.28	0.96	0.38	0.96
MCL	6				
GP		0.33	0.83	0.09	0.96
MIAC		1	0.90	0.33	1
LCL	1				
GP		0	0.98	0	0.99
MIAC		1	0.99	0.5	1

Table 5 – End outcome assessment of MRI in diagnosis of knee pathology using arthroscopy as gold standard.

	N	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Medial men	26	0.96	0.71	0.77	0.94
Lateral men	19	0.53	0.93	0.83	0.76
ACL	24	0.88	0.88	0.88	0.88
PCL	1	1	0.96	0.33	1
OCD	20	0.39	0.68	0.41	0.66

sizes for PCL, MCL and LCL make data analysis difficult to interpret, but the MIAC scored higher in all functions in these groups, although both groups had a low positive predicative value for these injuries. The meniscal and ACL groups, the two most commonly occurring injuries, were relatively similarly matched in terms of diagnosis by both GP and MIAC. Recognition of osteochondral defects was unable to be ascertained as the GP did not list this as a primary diagnosis and so analysis could not be performed (Table 5).

3.8. *Assessment of MRI vs. arthroscopy*

As demonstrated above, 55 patients underwent arthroscopy during the study period. Documented below are the data analysing the performance of MRI in diagnosing knee pathology, using arthroscopy as a gold standard for those selected individuals who underwent arthroscopy.

As demonstrated, MRI had a specificity >0.65 for all pathologies, with the lowest being for osteochondral defects at 0.68 and the highest for lateral meniscal injuries at 0.93. Sensitivity figures varied to a greater extent between 0.39 for osteochondral defects to 0.96 for medial meniscal injuries. Positive predictive value also varied from 0.33 for PCL injuries to 0.88 for ACL. Negative predictive value was more consistently high, between 0.66 for OCD and 1 for PCL injuries. Figures cannot be accurately assessed for PCL injuries, as there was only one documented injury on arthroscopy.

4. Discussion

Individuals presenting with knee injury to MIAC were demographically representative of those within the general military population. 64.8% of individuals who present displayed positive findings on MRI. The highest incidence of injury occurred with meniscal injury, ACL injury and osteochondral defects, with a substantial percentage (45.6%) of individuals sustaining damage to more than one internal structure. These findings were consistent with previous research into the epidemiology of knee injury in active populations.[3,4] The majority of injuries (65.5%) were sustained through high impact sporting injuries or on military duty, with the remainder being low impact injury or unknown mechanisms. These fit with the higher incidence of knee injuries in athletes and active populations[3,4] and suggest a higher suspicion of index should be used for those undertaking such activities, although the not insubstantial proportion of low impact injuries (18%) raise the importance of clinical findings in diagnosing such injuries.

There was significant difference in end outcome between patients with and without pathology on MRI: of those without pathology, a significantly higher percentage were partially fit at the end of the study period, with significantly smaller percentage (4% vs. 33% in those with pathology) being documented as fit for active duty. There was no significant difference in those patients who underwent operative treatment and those without. These findings are in keeping with anecdotal evidence from the MIAC: those without pathology are less likely to have serious injury but may not benefit from targeted physiotherapy and operative treatment.

The MIAC was more sensitive than GP diagnosis in all but the meniscal subgroup (where the difference in sensitivity was just 0.02), suggesting it has a function in picking up knee injury in military populations. The two groups were well matched in terms of specificity, again with the exception of meniscal injuries where GP diagnosis was more specific. This may be that GPs more frequently see meniscal injuries and so are more comfortable making this as a diagnosis compared to pathologies with lower incidence such as collateral ligament damage and PCL injury. Significance could not be ascertained in this population owing to population size, which limits the statistical strength of these findings. These findings suggest that MIAC may play even more of a beneficial role in a civilian environment, where GPs may see a lower percentage of knee injuries when compared to their military counterparts. We would propose these centres to be related closely to general practice, with individuals specially trained in the diagnosis and management of musculoskeletal injuries, working in conjunction with both general practitioners and secondary care when appropriate. The drawback to this would be that the data above shows that MIAC has a specificity equal to that of GPs for most injuries, and a lower specificity for meniscal injuries. This lower specificity could lead to a higher percentage of negative MRIs being carried out.

Data analyzing the sensitivity and specificity of MRI vs. arthroscopy showed that, in general, MRI had both a strong positive and negative predictive value (>0.75) for all pathologies with the exception of osteochondral defects. Sensitivity and specificity were substantially lower (0.39 and 0.68, respectively) for these. Although it is recognised that there are limitations in using MRI as a gold standard with regards to knee injury,[6] our findings support the use of MRI as a diagnostic examination in conjunction with clinical examination.

In those individuals that then underwent arthroscopy ± surgery, the data showed that MRI still functioned well, with the exception of those patient with osteochondral defects: if symptoms are ongoing despite negative MRI findings or osteochondral defects are suspected, it may be beneficial for the patient to undergo arthroscopy to exclude osteochondral defects.

There were two main limitations to the study. The first relates to the time between the final patients attending MIAC and data collection, with a period of 6 months being allocated. Although the vast majority of patients had run through the MIAC process by this point, 3 patients had not been formally discharged from the MIAC service. It is also possible that some patients were still undergoing self-directed physiotherapy or physiotherapy through their GP. This could be improved on by performing follow-on analyses assessing whether end outcome varied substantially 1–2 years after initial diagnosis (although the incidence of non-related injury would also increase in this time).

The second limitation relates to the size of the population. In total 2 years of data were collected, with 122 servicemen being included in the initial population size. However, due to the number of separate pathologies these individuals presented with, the number in each sub-group was not substantial enough to perform statistical analysis, and thus significance could not be calculated. As the role of MIAC service has remained largely unchanged since the initial data collection, this could be remedied by performing a further data collection in order to provide numbers sufficient for statistical analysis.

5. Conclusion

These findings suggest that the MIAC plays an important role in the diagnosis and management of knee injuries in the military. By providing a cohesive combined multidisciplinary service, the majority of patients were deemed fully or partially fit once discharged. Further research should be carried out over a longer time period to allow for more complete statistical analysis and also with a longer follow up period. This data indicates that there could be a substantial role for the MIAC in a civilian population. This data also indicates that for the majority of individuals MRI remains an effective gold standard. The exception to this in the case of osteochondral defects, which are under-diagnosed by both clinical examination and MRI. When suspected, arthroscopy with the potential for operative treatment should be carried out. We therefore recommend the introduction of a model comparable to the MIAC in civilian populations.

Conflicts of interest

All authors have none to declare.

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Original Article

Double bundle medial patello-femoral ligament reconstruction for recurrent patellar dislocation – A modified technique and documentation of importance of arthroscopy

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ABSTRACT

Aim: Evaluation of outcome of double bundle MPFL reconstruction for recurrent patellar dislocation using semitendinosus tendon autograft passed through vertical tunnel in patella and to document the scope of arthroscopic assistance during the procedure.

Methods: The prospective case series study included 22 patients (17 females and 5 males) with recurrent lateral patellar dislocation. The average age was 29 years (15–55 years) and all underwent arthroscopy-assisted MPFL reconstruction using semitendinosus tendon autograft passed through vertical tunnel in patella.

Results: At an average follow-up of 30 months (17–43 months), none had apprehension or re-dislocation of patella postoperatively. Intraoperative arthroscopy was useful in the confirmation of patella tracking; removal of loose body (9 cases), performing chondroplasty (11 cases), simultaneous management of associated intra-articular pathology (4 cases) and careful tunnel placement for tendon graft. Radiologically, the congruence angle improved from pre-operative average of 13.41° (−9° to +53°) to 2.59° (−10° to +14°) and the lateral patellar tilt angle improved from 11.95° (2° to 21°) to 4.18° (0° to 9°) post-operatively. Functionally, the Kujala score improved from pre-operative average of 49.59 (42–76) to 92.18 (86–96), the Lysholm score from 62.13 (56–70) to 94.31 (90–100) and the Tegner activity scale from 2.31 (2–3) to 3.31 (3–4) post-operatively.

Conclusion: Double bundle MPFL reconstruction for recurrent patellar dislocation using looped semitendinosus tendon autograft passed through vertical tunnel in patella produces promising radiological and functional results. The study highlights the value of arthroscopic assistance during the procedure to improve the outcome.

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1. Introduction

Patellar instability is a painful disabling condition of the knee often characterised by repeated lateral subluxation or dislocation of the patella. Although many surgeries have been described, reconstruction of the medial patello-femoral ligament (MPFL) aims at correcting the primary pathology. Literature published by various authors has supported good outcome with MPFL reconstruction.[1–3] Kang et al.[4] explained functional double bundle configuration of MPFL paving the way for double bundle reconstruction. Initially, this was performed using 'Y' configuration of the graft with two transverse tunnels made in the patella for graft fixation.[5,6] Wang et al.[7] retrospectively reported good outcome with this type of double bundle reconstruction compared with single bundle reconstruction. Unfortunately, double bundle MPFL reconstruction performed with two transverse tunnels in patella places patella at high risk for fractures post-operatively.[8] We conducted a prospective case series study to radiologically and functionally evaluate the results of double bundle MPFL reconstruction for recurrent patellar dislocation using looped semitendinosus autograft passed through a vertical tunnel in patella and to document the scope of arthroscopic assistance during the procedure.

2. Materials and methods

A prospective case series study was done including 22 patients with recurrent lateral patellar dislocation operated between May 2010 and October 2012. The patients requiring combined osteotomy procedures (having TT–TG $>$ 20 mm, severe trochlear dysplasia and patella alta with Insall-Salvati ratio $>$ 1.4) were excluded from the study.[9] Approval for the study was obtained from the Institutional Review Board.

The study included 17 females and 5 males. The average age was 29 years (range 15–55 years). The premorbid Tegner activity scale in our patients was on an average 3.45 (range 3–5), since most of our patients were females, who were restricted to light labour activities only. Aetiology of primary episode was spontaneous in 5 patients and post-traumatic in 17 cases (accidental fall during daily activities in 9 cases, twisting injury of knee in 5 cases, fall from two wheelers in 2 cases and fall of weight over the knee in 1 case). Left knee was more commonly affected (left:right = 13:9). Generalised ligamentous hyperlaxity was noticed in 8 patients (including all the 5 cases with insidious onset). Patients commonly presented with anterior knee pain aggravated by climbing stairs or uphill, repeated episodes of patellar subluxation or dislocation with swelling and locking of the knee, feeling of giving way sensation of the knee during vigorous activities. The duration of symptoms ranged from 3 months to 31 years (average 60.22 months). The number of episodes of patellar dislocations among them ranged from 2 to 20 times (average 6 episodes).

Clinically all the patients had positive apprehension sign on attempted lateral displacement of patella. Retropatellar tenderness was present in 12 patients. Range of movement in the knee was painless and normal in 18 patients, and 4 patients had restriction of terminal 10° to 20° of movements. In the 4 patients with terminal movement restriction, two patients had synovial hypertrophy, one patient had associated ACL ganglion cyst, and the other had associated medial meniscal tear. The Q angle was measured with patient supine and knee flexed to 30°, wherein patella is centralised over trochlea. It was found to be on an average of 13.68° (range 8° to 18°) in our cases.

Radiological evaluation was done with lateral view and Merchant axial view taken with knee flexed to 30°. Insall-Salvati ratio (Patella tendon length/Patella height) was measured in the lateral radiograph, which was found to be an average of 1.13 (range 0.9–1.38) in our cases. In the Merchant axial radiograph, the sulcus angle, congruence angle and the patella inclination angle (lateral patellar tilt angle) were measured as per standard guidelines[10] (Fig. 1a). The sulcus angle was on an average 141.77° (range 136° to 150°). The congruence angle was on an average 13.41° (range −9° to +53° negative and positive variable denote medial or lateral subluxation of patella, respectively). The normal congruence angle being $-6°(\pm 11°)$, there were 18 outliers pre-operatively.

Magnetic resonance imaging of the knee was done in all the patients that revealed thinning of MPFL in 17 patients and complete tear in 5 patients. Cartilage defect over patella was noticed in 11 cases, and loose body within the knee joint was picked up in 4 cases. Trochlea dysplasia with shallow groove (Dejour type A) was seen in 4 cases. Patello-femoral arthritis was present pre-operatively in 6 cases. The tibial tuberosity and trochlear groove (TT–TG) distance was measured in axial sections which were on an average 14.12 mm (range 10–17 mm).

All the patients underwent arthroscopy-assisted double bundle MPFL reconstruction using looped semitendinosus autograft passed through vertical tunnel in patella and fixed to femoral condyle using interference Bioscrew. Surgery was performed by single surgeon (first author) in all the cases.

3. Surgical technique

Surgical procedure was performed under regional spinal anaesthesia and tourniquet control. All the patients underwent intraoperative arthroscopy of the knee joint and looked for patella subluxation/tilt with excess medial parapatellar opening, patella maltracking, intraarticular loose bodies and chondral injuries (Fig. 2). Any associated knee pathology including patellofemoral arthritis was also documented (Table 1).

Through a 3 cm incision extending vertically below the tibial tuberosity, semitendinosus tendon graft was harvested and prepared. Another vertical incision was made midway between medial border of patella and medial epicondyle. A tunnel was made in the medial third of patella parallel to its supero-medial border using a 4 mm cannulated drill over a guide wire placed under fluoroscopy assistance. The position of the tunnel was carefully planned so as to avoid any rim fracture of patella or penetration into the knee joint, which was confirmed arthroscopically. The margins of entry and exit holes were smoothened by nibbling the margin so as to prevent any graft impingement. The tendon graft was then passed through the tunnel in patella creating a double bundle configuration (Fig. 3a). The ends of the tendon graft were then passed deep to medial retinaculum (between 2nd and 3rd

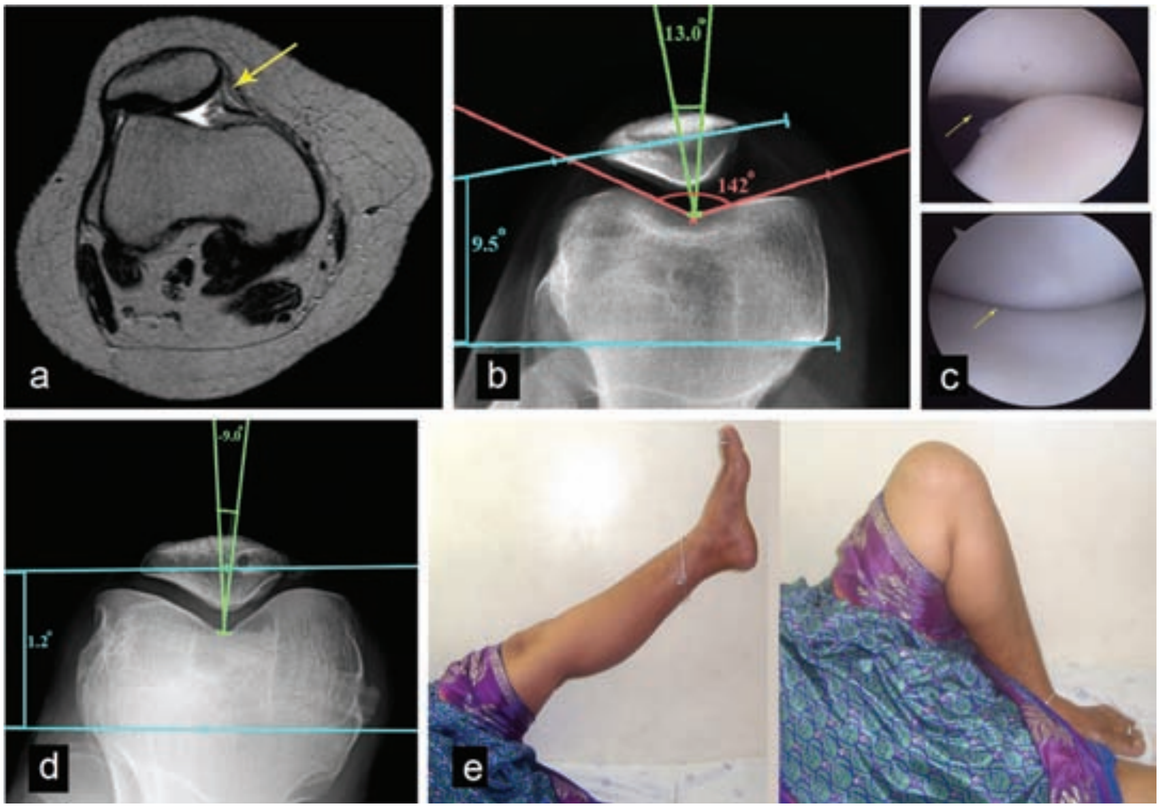

Fig. 1 – (a–e): Case example of a 38-year-old female with recurrent dislocation of patella. (a) Pre-operative MRI shows MPFL tear. (b) Pre-operative radiograph shows lateral subluxation with tilting of patella. (c) Intraoperative arthroscopy confirms abnormal patellar tracking which is restored to normal after MPFL reconstruction. (d) Post-operative radiograph shows restoration of normal patellar alignment. (e) Post-operative regain in full range of movements in the knee.

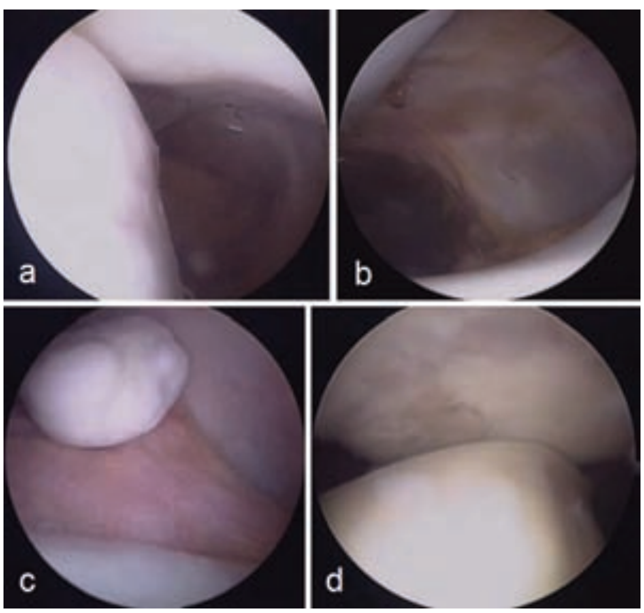

Fig. 2 – (a–d) Intraoperative abnormal arthroscopic findings. (a) Lateral subluxation of patella. (b) Patellar tilt with abnormal opening in the medial parapatellar space. (c) Loose body within the knee joint as a result of osteochondral injury. (d) Chondral damage in patella due to recurrent dislocation.

fascial layers of Warren) towards the medial epicondyle, and the ends were sutured together. A guide pin was placed horizontally parallel to the joint line at the isometric point of attachment of MPFL between medial epicondyle and adductor tubercle. Its position was confirmed by intraoperative fluoroscopy (1 mm anterior to the posterior cortex extension line, 2.5 mm distal to the posterior origin of the medial femoral condyle on a lateral radiograph with both posterior condyles projected in the same plane).[11] Arthroscopic evaluation also noted any violation of intercondylar notch by the guide pin. After confirming the position, a femoral tunnel of 7–8 mm diameter (corresponding to the size of combined and sutured tendon ends) was drilled over the guide wire, and tendon ends were passed through the tunnel mediolaterally using beath pin. The graft length and tension required were confirmed by arthroscopic visualisation of patellar position, tilt and tracking. After its confirmation, the graft was fixed at the aperture of the femoral tunnel using bio-absorbable interference screw of (2 mm larger than the tunnel size) with knee in 45° of flexion (Fig. 3b). Finally after fixation, the patella tracking was reconfirmed and documented arthroscopically (Fig. 1b).

Post-operatively, knee was splinted in knee immobiliser until wound healing. Isometric quadriceps exercises were started immediately and patient was mobilised full weight bearing on first post-operative day. Passive knee mobilisation was started after 10th day and active assisted knee mobilisation

Table 1 – Intra-articular pathological findings noted in scout arthroscopy of the knee joint.

Sl. no	Pathological findings	Number of cases (Total = 22)
1	Patella subluxation	15
2	Patella tilt with medial opening	7
3	Intra-articular loose body	9 (4 were not picked up in MRI)
4	Cartilage defects	11
5	Medial meniscal tear	1
6	Synovial hypertrophy	2
7	ACL ganglion cyst	1

was allowed after 6 weeks aiming for full range of movements within 12 weeks. Quadriceps strengthening exercises were started post-operatively after 3 months. Activities like running and squatting were permitted only after 6 months. Radiological re-assessment of congruence angle and patellar tilt was done by Merchant axial view (Fig. 1c). Functional assessment was done using Kujala score, Lysholm knee score and Tegner activity scale. Statistical analysis of results was done using Minitab-10.

4. Results

With an average follow-up of 30 months (range 17–43 months), none of our patients had apprehension or recurrence of dislocation of the patella post-operatively and all resumed their premorbid Tegner activity level.

Intraoperative findings noted in scout arthroscopy of the knee joint are summarised in Table 1. In addition, arthroscopy was also useful in removal of loose bodies within knee, evaluation for joint penetration of patellar and femoral bone tunnels, assessing the tension in graft required before fixation and confirmation of patella tracking. None of our patients required lateral retinacular release.

Post-operative radiological assessment was done after 6 months since surgery, and the functional assessment were done at their last follow-up. Radiologically, the congruence angle improved from pre-operative average of 13.41° (range −9° to +53°) to 2.59° (range −10° to +14°). There were only 6 outliers beyond the normal range post-operatively. The lateral patellar tilt angle improved from 11.95° (range 2° to 21°) to 4.18° (range 0° to 9°) (Table 2). Functionally, the Kujala score improved from pre-operative average of 49.59 (range 42–76) to 92.18 (range 86–96); the Lysholm score improved from an average of 62.13 (range 56–70) to 94.31 (range 90–100), and the Tegner activity scale improved from an average of 2.31 (range 2–3) pre-operatively to 3.31 (range 3–4) post-operatively at the final follow-up. Pre-operative and post-operative radiological alignment and functional scores were analysed statistically by paired t-test and were found to be significant at $p < 0.001$ (Table 2).

Active and passive movements of the knee were regained to full range in 19 (86.4%) patients within 3 months. Three patients had terminal restriction of the knee movements. One among them had associated deep vein thrombosis post-operatively and her movements improved with physiotherapy and the other two patients regained full movements after manipulation of the knee under anaesthesia and arthrolysis, respectively. Anterior knee pain was persistent in 3 cases (13.6%), for all of whom had documented patello-femoral joint arthritis pre-operatively. However, the pain was mild to moderate and tolerable without any functional limitation.

Table 2 – Radiological and functional results.

	Pre-operative mean	Post-operative mean	95% CI for mean difference	p-Value
Congruence angle	13.41	2.59	−6.62, −15.01	<0.001
Lateral patellar tilt angle	11.95	4.18	−6.05, −9.48	<0.001
Functional outcome				
Kujala score	49.59	92.18	46.24, 38.94	<0.001
Lysholm score	62.14	94.32	34.89, 29.47	<0.001
Tegner activity scale	2.31	3.31	1.13, 0.86	<0.001

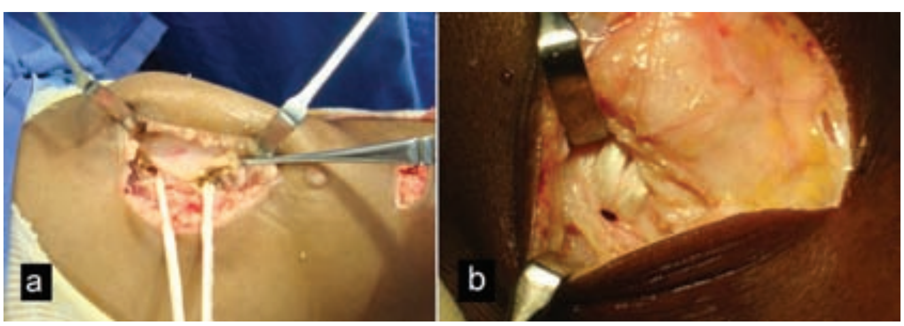

Fig. 3 – Surgical technique. (a) Semitendinosus tendon graft looped through the patellar tunnel. (b) Tendon graft passed through the femoral tunnel and fixed using bioscrew.

One patient had numbness over the medial aspect of the leg and symptoms improved gradually within 6 months. None of our patients had surgical site wound healing problem or patellar fracture post-operatively.

5. Discussion

The main factors contributing for patellar stability are articular geometry, muscular action and passive soft tissue restraints.[12] MPFL is a static stabiliser that acts as a checker in preventing lateral patellar dislocation and contributes to 40–80% of total medial restraining force.[3,13,14] Further, from full extension to approximately 20°–30° of knee flexion, patella has no bony guidance; forcing the MPFL complex to bear the load of restraint against the literalising vector of the quadriceps muscle.[15] Anatomically, MPFL is a 10–30 mm wide condensation of medial patellar retinaculum extending from proximal 2/3 of medial border of patella to adductor tubercle of femur.[16] Functionally, it has two bundles: a superior-oblique bundle, which is a dynamic restraint and an inferior straight bundle which is a static restraint.[4]

Surgical methods for recurrent patellar dislocation such as proximal realignment procedures, distal realignment procedures, lateral release and medial plication all intend to realign the extensor mechanism; however they do not tackle the primary pathology – 'medial soft tissue laxity'.[14] In majority of cases with patella instability, MPFL is disrupted and hence several authors have recommended MPFL reconstruction for high success rate (83–93%).[1,17] Non-operative treatment for first time patellar dislocation has a re-dislocation rate of 14–44%.[18] MPFL repair in recurrent dislocation has high failure rate camp with 28% recurrence of dislocation.[19]

Numerous reconstruction techniques have been described to restore medial restraint of patella; including various tendon sources (gracilis, semitendinosus, partial patellar tendon, allograft, synthetic tendon) and various fixation methods (transverse or vertical patella drill holes, single/double bundle reconstruction, anatomic/isometric point fixation, sutures, anchors, interference screws).[16]

Double bundled MPFL reconstruction is more anatomical, as it reproduces cyclical tightening and slackening pattern with movements and has functional advantage with rotational stability of patella when compared to single bundle reconstruction.[7,12] Double bundle MPFL reconstruction with single vertical tunnel does not require fixation of graft to the patella and also avoids the risk of patella fracture seen when reconstruction is performed with two transverse tunnels are placed in patella.[8]

Additional procedures such as medialisation of tibial tuberosity, distal transfer of tibial tuberosity or trochleoplasty were not performed in our cases. Mild trochlear dysplasia does not compromise the outcome of MPFL reconstruction as reported by Steiner et al.[20] and is confirmed in our study with 4 cases of Dejour Type A trochlear dysplasia.

In our study, patellar instability was seen commonly in females (77%) similar to that found in other studies. The onset was commonly post-traumatic (77%) suggesting high rate of recurrence after previous dislocation since MPFL has poor capacity to heal resulting in increased laxity and patellar instability.

Position of femoral fixation is crucial and requires radiological confirmation.[21] Another important aspect of tendon reconstruction is adequate tension of the graft – any small alteration in length and position of fixation significantly affects the outcome.[5] A lax MPFL reconstruction produces persistent instability and an over tight MPFL produces extension lag (when tight in extension) or loss of flexion (when tight in flexion).[22] In our study, we fixed the tendon graft to the femur with knee in 45° of flexion to avoid any chondral overload during knee flexion. Fernandez et al.[13] and Yoo et al.[23] have suggested fixation of the graft with knee in 30° of flexion.

Radiological improvement after double bundle MPFL reconstruction has been studied by Han et al.[12] with dual transverse tunnel in patella and reported improvement of congruence angle from 12.2° to −2.4° and lateral patellar tilt from 11.4° to 8.4°. Our series with reconstruction using vertical patellar tunnel showed better improvement of patellar tilt from 11.95° to 4.18° and also the average congruence angle in our cases improved from 13.41° to 2.59° post-operatively.

Functional improvement seen in our cases was better compared to other series of single bundle reconstruction[2,14,17] and comparable to other series of double bundle reconstruction.[8,24,25] In a similar retrospective study done by Matthews and Schranz,[16] either gracilis or semitendinosus graft was used and the post-operative Kujala score was 87 with 20% knee stiffness due to less aggressive mobilisation in initial cases with poor femoral fixation as revealed by the author. Compared to it, our study used only semitendinosus graft for better strength along with stable fixation for aggressive mobilisation yielding good results with average post-operative Kujala score of 92.18 with 13.6% knee stiffness.

Osteochondral fractures with loose body within the knee joint were present in 41% of cases; of which, only 22.7% were picked up by MRI suggesting need for routine intraoperative arthroscopic evaluation. Intraoperative arthroscopy of the knee has been performed in few studies during MPFL reconstruction.[2,8,12,17,19] We stress the importance of routine arthroscopic assistance in these cases for it helps in – diagnostic evaluation for associated injuries and patellofemoral cartilage integrity; confirmation of diagnosis as shown by medial parapatellar opening, patellar tilt, subluxation and maltracking; removal of intra-articular osteochondral loose bodies; management of any associated knee pathology (like meniscal tears, synovial hypertrophy, ACL ganglion cyst as seen in our cases). It also helps in performing chondroplasty, microfracture or lateral retinacular release in selected cases; evaluation for joint penetration caused by tunnels placed in patella and femoral condyle; confirmation of isometric fixation and to assess the adequate tensioning of the tendon graft before fixation and to finally confirm patellar tracking.

A limitation of our study is mid-term follow-up in small series of selective patients. Further randomised controlled trials are needed to establish the differences in outcome with various techniques of MPFL reconstruction.

6. Conclusion

Double bundle MPFL reconstruction for recurrent patellar dislocation using looped semitendinosus tendon autograft passed through vertical tunnel in patella produces promising radiological and functional results. The study highlights the value of arthroscopic assistance during the procedure to improve the outcome.

Conflicts of interest

All authors have none to declare.

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