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Knee & Shoulder Arthroscopy And Arthroplasty ISKSAA

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ISKSAA International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

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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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Original Articles

Case Reports

ISKSAA International Society for Knowledge for Surgeons on Arthroscopy and Arthroplasty

Wrightington, Wigan and Leigh NHS NHS Foundation Trust

Edge Hill University

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3. **Having cleared the IELTS exam** before the interviews will be of advantage for final selections .
4. The Clinical posts would start in July 2021 although if candidates were to be interested for August 2022 start, they could still apply.
5. The MCh course is at the Edge Hill University and although most of the payment for the course can be made along the way in installments over the 2 years, there would be an initial Commitment of £8,000 to be made to secure the place before the formalities with Royal colleges and GMC are commenced at this End. The salary scales are detailed with the information sheet as well.
6. There will be two posts per year as the "Wrightington - ISKSAA MCh Fellowship". There would be an **assured Wrightington placement** during the 2-year UK rotation via this stream . **Only ISKSAA Life Members can apply for these posts** .
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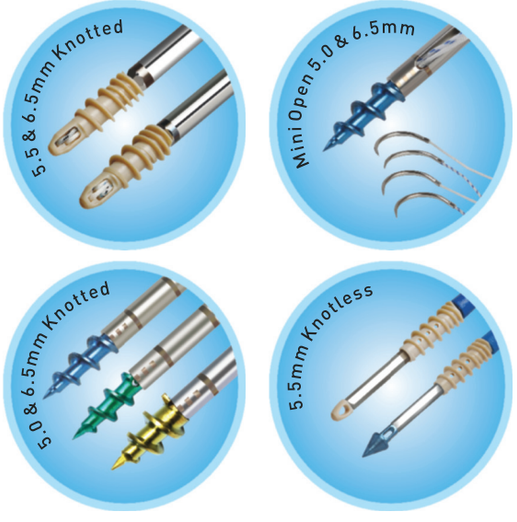
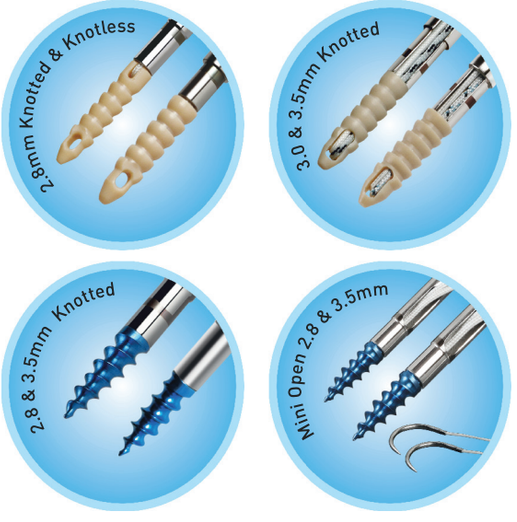


Suture Anchors for Slap & Bankart Repair



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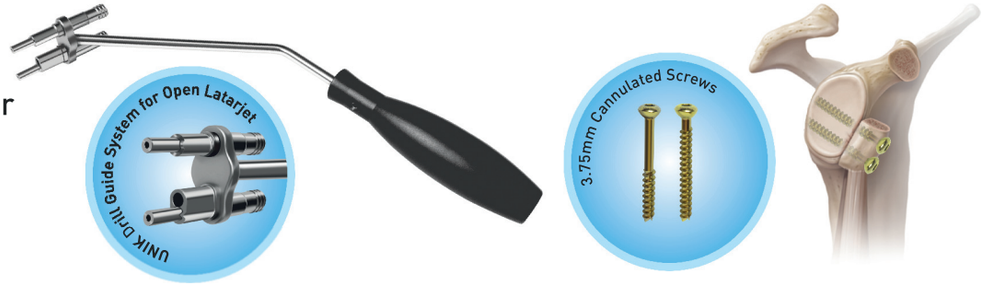

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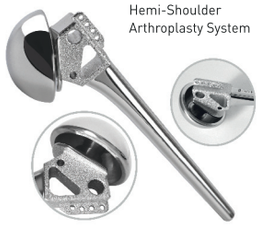

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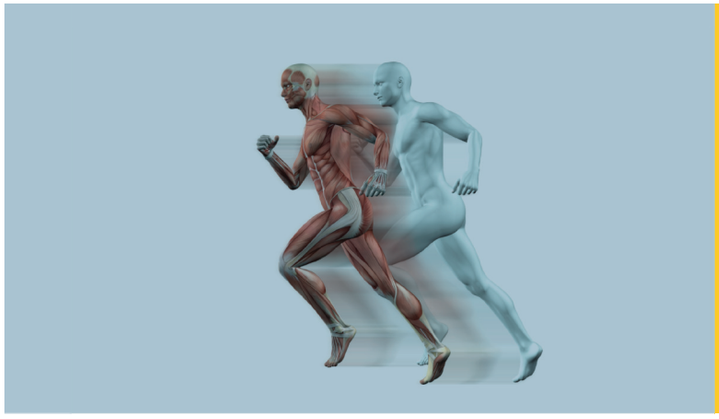

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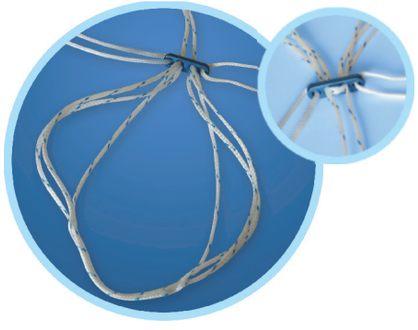

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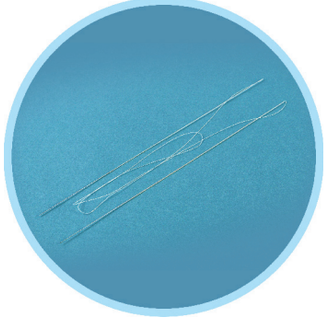

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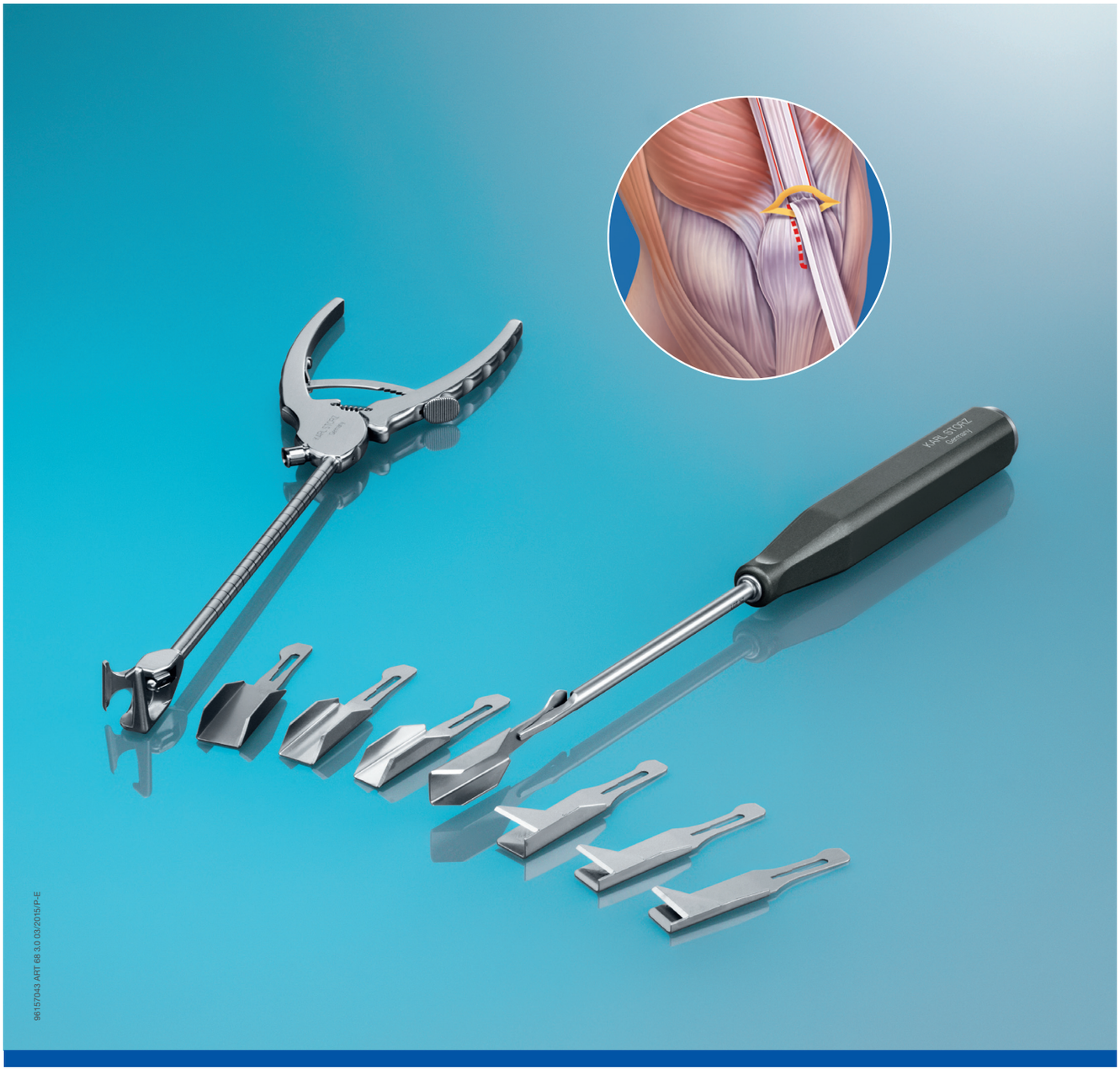

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Functional outcomes of trans-tendon repair vs. tear completion and repair for partial thickness rotator cuff tears: A metaanalysis

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ABSTRACT

Purpose: Surgical treatment for partial rotator cuff tears may include debridement of the tear, subacromial decompression or repair of the tear. Repair of the tear can be either in-situ repair, or completion of the tear followed by repair. Though it is agreed that surgical repair is required for tears more than 50% of the thickness of rotator cuff, there is no consensus on ideal surgical treatment of these cases. This systematic review and meta-analysis was carried out to compare functional outcomes following these two different surgical treatments of PTRC tears.

Methods: Search of electronic databases Google Scholar, PubMed, Ovid, and the Cochrane Register of Controlled Trials for published randomised controlled trials (RCTs) was undertaken. Search was done using a pre-designed search strategy. Critical appraisal of eligible studies was done for methodological quality using Cochrane Collaboration's tool. Functional scores used for meta-analysis were visual analogue scale for pain, Constant Score and American Shoulder and Elbow Surgeons shoulder score.

Results: Four studies reporting total 282 repairs were eligible to be included in the meta-analysis. No statistically significant difference was found between the two groups in terms of Constant Score and American Shoulder and Elbow Surgeons shoulder score. Results were significantly better in the trans-tendon repair groups in terms of re-tear rates. There was no significant difference in functional outcome scores between the two groups.

Conclusion: Tran-tendon repair technique may offer some benefits over tear completion and repair in terms of re-tear rates. Both techniques of surgical repair have shown equivalent functional outcomes at follow up. Current literature is insufficient to show superiority of one technique over the other.

1. Introduction

Partial thickness rotator cuff (PTRC) tears are more common than full thickness tears.[1,2] They may be difficult to diagnose on clinical examination as findings are often non-specific.[3,4] With the advent of magnetic resonance imaging and shoulder arthroscopy more and more PTRC tears are being identified and treated. Available evidence suggests that high grade PTRC tears (involving more than 50% of the tendon width) have better outcomes when treated with repair rather than debridement or subacromial decompression alone.[5,6] Options for repair of the tear are an in-situ repair, in which the torn portion of the tendon is approximated to the footprint leaving the intact portion attached, or completion of the tear followed by repair. It is not known that which of these two options is better for such tears. This systematic review and metaanalysis aims to compare functional outcomes following in-situ repair and completion of the tear followed by repair for PTRC tears. There are no existing systematic reviews of randomised controlled trials comparing these two techniques.

2. Material and methods

2.1. Review protocol

The 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (www.prisma-statement.org)

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were used to carry out this systematic review and meta-analysis.

2.2. Literature search

We searched Google Scholar, PubMed, Ovid, and the Cochrane Register of Controlled Trials for all published literature from January 2001 to 1st May 2018 using the following key words: "shoulder", "partial rotator cuff tears", "PASTA", "articular-sided rotator cuff tear", "incomplete rotator cuff tear", "arthroscopic" and "repair". These key words were combined in the search filed using appropriate Boolean operator 'AND'/'OR'.

2.3. Inclusion criteria

The eligibility criteria for inclusion the study in this systematic review were-

1. Randomised controlled trials
2. Partial (>50%) thickness tears of the supraspinatus tendon
3. Subjects belonging to either sex, any age and any country of origin
4. Functional outcome measures in terms of mean and standard deviation

2.4. Exclusion criteria

1. Tendon tears other than supraspinatus
2. Studies including full thickness tears
3. Studies managing tears conservatively
4. Associated injuries to shoulder
5. Cadaveric/biomechanical studies
6. Case reports, review articles

2.5. Study selection

Titles and abstracts of studies in the search results were assessed for possible inclusion in the systematic review by matching them against the inclusion and exclusion criteria. Full texts were retrieved for the studies that were shortlisted or in case of any ambiguity in the abstract. Two authors (TG & ST) carried out literature search individually and any discrepancy in results was resolved by mutual consensus. If there were two or more studies assessing the same functional outcome, they were considered for meta-analysis. References of all included studies were searched for any other potential study that could be included.

2.6. Data collection

Data was extracted on study design, patient demographics, tear characteristics, surgical procedure, and clinical outcomes using Microsoft Excel (2007).

2.7. Assessment of methodological quality

Two authors assessed methodological quality of the selected studies independently. Cochrane Collaboration's tool for assessing risk of bias was used for the assessment of bias in the included studies.[7]

2.8. Synthesis of results

Pooled outcomes data for the meta-analysis were analysed. Review Manager, Version 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration; Copenhagen, Denmark) was used for all analyses.

3. Results

3.1. Literature search results

Initial search yielded 1318 titles of which 970 studies were on humans and in English language. The PRISMA flow diagram for this search is shown in Fig. 1. Four studies were included in the systematic review.[8–11]

3.2. The characteristics of included studies

All included studies had reported level of evidence and all were level-2 studies. The details of the methodological quality of the included studies are listed in Fig. 2.

3.3. Functional scores

Four studies (282 rotator cuff repairs) compared functional outcomes between trans-tendon repair and tear completion with repair.[8–11] Results of comparison of functional outcome scores of various studies are summarised in Table 1. Details of surgical procedures, re-tear rates and complications are summarised in Table 2. One study[8] had expressed results in terms of difference in mean between the preoperative value and value at last follow up. Three studies had reported values before the surgery and at the last follow up.[9–11] Standard deviations of preoperative scores were not available for one of these studies[11] and it could not be pooled for analysis using difference in means. Thus, metaanalysis for functional scores (VAS and Constant Score) was done twice, once comparing difference in mean pre-operative score and the value at last follow up and second time comparing mean scores at final follow up between the two groups. Standard error of difference in means was calculated using formula, Standard Error (SE) = $\sqrt{S1^2/N1 + S2^2/N2}$.

3.4. VAS scores

Metaanalysis comparing difference in mean pre-operative VAS score and the value at last follow up was carried out for two studies[8,9] using fixed effect model (I2 = 0%; P = .33). Significant difference was found between the two groups (mean difference, 0.32; 95% CI, 0.15 to 0.49; P = .0003) (Fig. 3A).

Two studies were included in the metaanalysis using fixed effect model (I2 = 0%; P = .77) comparing mean VAS score at last follow up.[9,11] Significant difference was found between the two groups (mean difference, −0.1; 95% CI, −0.18 to −0.03; P = .007) (Fig. 3B).

3.5. Constant Scores

Metaanalysis comparing difference in mean pre-operative Constant score and the value at last follow up was carried out for three studies using random effect model (I2 = 86%; P = .0009).[8–10] No significant difference was found between the two groups (mean difference, −0.39; 95% CI, −2.11 to 1.33; P = .66) (Fig. 3C).

Three studies were included in the metaanalysis using random effect model (I2 = 80%; P = .0008) comparing mean Constant score

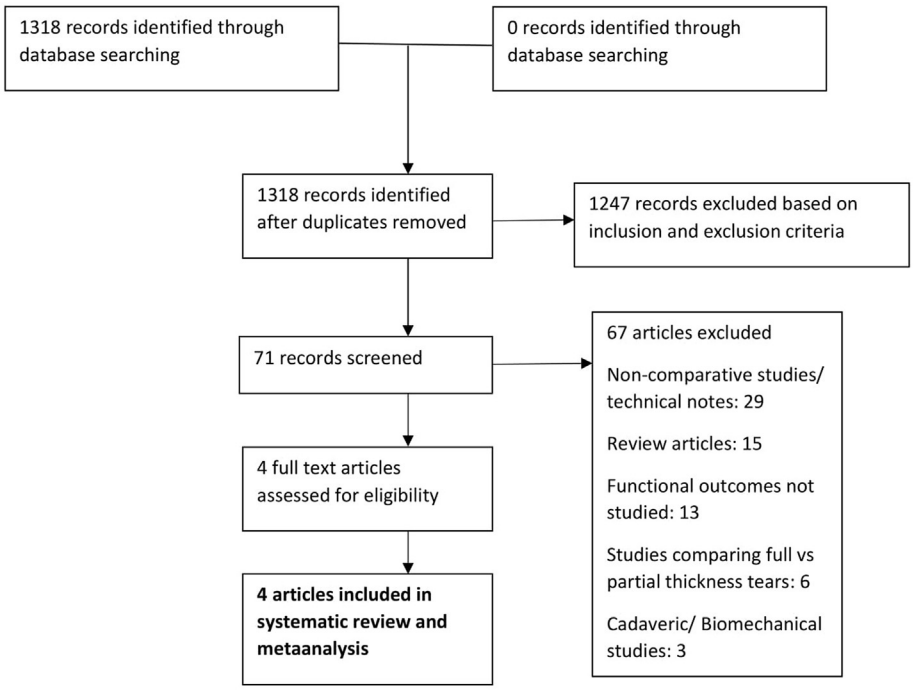

Fig. 1. PRISMA Flowchart describing the process of study selection and exclusion.

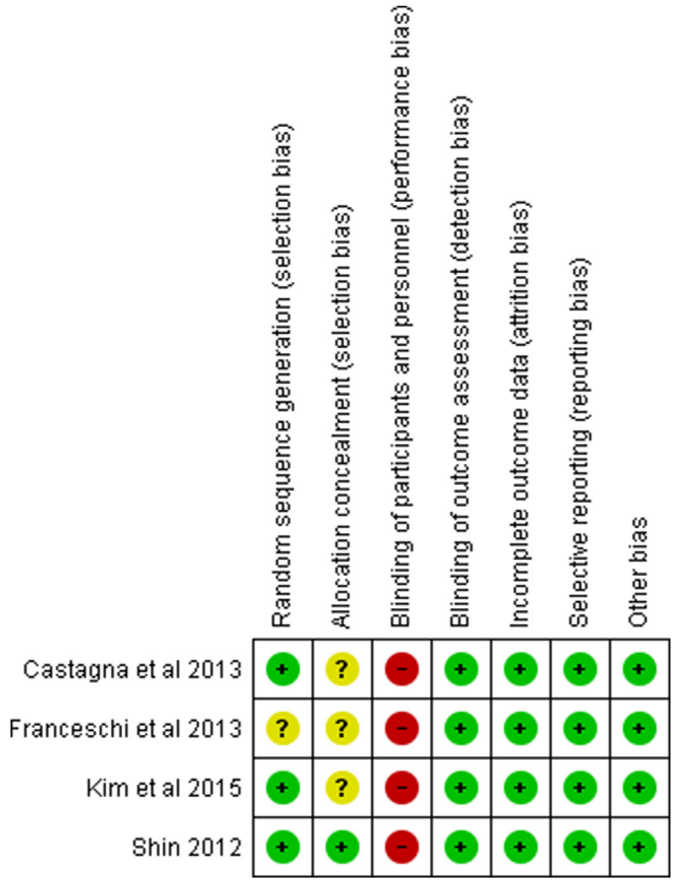

Fig. 2. Risk of bias graph for the studies included in meta-analysis.

at last follow up.[9–11] No significant difference was found between the two groups (mean difference, 1.79; 95% CI, −1.06 to 4.65; P = .22) (Fig. 3D).

3.6. American Shoulder and Elbow Surgeons (ASES) shoulder score

Three studies were included in the metaanalysis using random-effects model (I2 = 82%; P = .003) to compare mean ASES score at last follow up.[9–11] No significant difference was found between the two groups (mean difference, −0.27; 95% CI, −4.92 to 4.39; P = .91) (Fig. 3E).

3.7. Range of motion

Two studies were included in the metaanalysis using fixed-effects model (I2 = 0%; P = .97) to compare mean external rotation at last follow up.[9,10]No significant difference was found between the two groups (mean difference, −1.39; 95% CI, −3.19 to 0.42; P = .13) (Fig. 3F).

Two studies were included in the metaanalysis using random-effects model (I2 = 57%; P = .13) comparing mean forward flexion at last follow up.[9,10] No significant difference was found between the two groups (mean difference, −0.97; 95% CI, −5.28 to 3.34; P = .66) (Fig. 3G).

3.8. Re-tear rates

Two studies were included in the metaanalysis using random-effects model (I2 = 0%; P = .92) comparing re-tear rates between two groups.[9,11] Significant difference was found between the two groups (odds ratio, 0.21; 95% CI, 0.05 to 0.93; P = .04) (Fig. 3H).

3.9. Sensitivity analysis

Sensitivity analysis showed that results of ASES scores were significantly better in favour of tear completion and repair group if the study by Kim et al.[11] was excluded. No other findings were noted on sensitivity analysis.

Table 1
Comparison of functional outcome scores in studies included in systematic review.

Author, Year	Sample size Table 1: Comparison of functional outcome scores in studies included in systematic review	Outcome Scores & Range of Motion	GROUP I (Transtendon Technique)			GROUP II (Tear Completion Repair)			Statistically significant intergroup difference at Final follow up
			Preoperative	Final Follow-up	Statistical difference (Preop to Final follow up)	Preoperative	Final Follow-up	Statistical Difference (Preop to Final follow up)	
Shin 2012	48	Pain score (VAS)	5.5 ± 0.6	1.4 ± 0.4	Yes	5.3 ± 0.5	1.1 ± 0.2	Yes	No
		ASES score	50.8 ± 4.3	89.1 ± 2.1	p < .001	49.2 ± 4.2	86.2 ± 3.2	p < .001	
		Constant score	54.8 ± 2.6	84.8 ± 2.7	p < .001	59.0 ± 3.9	87.1 ± 2.4	p < .001	
		Forward Flexion	141.8 ± 5.6	167.8 ± 5	p = .010	136.7 ± 6.3	170.4 + 3.2	p = .003	
		External Rotation	49.7 ± 5.4	65.2 ± 4.4	p = .007	46.1 ± 4.8	66.6 ± 2.0	Yes	
		Internal Rotation (spinal level)	L3	L1/T12	p = .013	L3	L1/T12	Yes	
Franceschi et al., 2013	60	ASES score	45.6 ± 8.1 (29–71)	91 ± 6.6 (74–100)	p = .0001	47 ± 10.6 (25–72)	90 ± 7.9 (71–100)	p = .0001	No
		Constant Murley score	48 ± 8.2 (30–72)	92 ± 7.1 (72–100)	p = .0001	47 ± 8.6 (29–63)	91 ± 7.3 (72–100)	p = .0001	
		Forward Flexion	132.8 ± 13 (95–162)	171 ± 10.4 (150–190)	p = .0001	129.2 ± 18.2 (90–160)	169 ± 10.9 (145–190)	p = .0001	
		External Rotation	45.6 ± 14.5 (15–70)	59.8 ± 9.6 (45–80)	p = .0001	50.3 ± 12.7 (20–75)	61.1 + 10.2 (40–85)	p = .001	
		Internal Rotation (spinal level)	a level between L3-S1	23 ptsT8; 7 pts T9; 2 pts T10		a level between L3-S1	21 pts T8; 5 pts T9; 2 pts T10		
Castagna et al., 2013	74	Pain score (VAS)		Increase by a mean of 3.4 (SD 1.2)	p < .0001		Increase by a mean of 3.6 (SD 1.7)	p < .0001	No
		Constant score		Increase by a mean of 25.1 (SD 5.8)	p < .0001		Increase by a mean of 29 (SD 6.2)	p < .0001	
Kim et al., 2015	100	Pain score	5.9	2.6 + 2.2	p = .001	7	1.9 ± 1.6	p = .001	No
		ASES score	55	80.6 ± 15.6	p < .001	49	87.1 ± 9.9	p < .001	
		Constant score	59	71.1 ± 4.1	p < .001	59.9	71.1 ± 6.1	p < .001	
		SS score	55	79.2 ± 21.4	p = .001	56	88.2 ± 13.4	p = .001	
		KSS	50.5	70.5 ± 28.2	p < .001	48	80.7 ± 25.8	p < .001	

SD, Standard Deviation; VAS, visual analogue scale; ASES, American Shoulder Elbow Society; SS, Simple Shoulder; KSS, Korean Shoulder Score; T, Thoracic vertebra; L, Lumbar vertebra.

Table 2
Comparison of included studies for type of procedure, re-tear rates and complications.

Author, Year, Journal	Type of index procedure	Additional procedures done (if any)	Functional outcome score used	Retear rates	Complications
Shin 2012	Simple knot tying (Group I), Trans-osseous equivalent (Group II)	Debridement for Subscapularis partial tears 8 (GrI), 10 (GrII), Acromioplasty as needed Acromioplasty 4 (GrI), 7 (GrII)	ASES score, Constant shoulder score, Pain score (VAS)	Group I:0, Group II: 2	Post op Adhesive capsulitis 3(Group I), 2 (Group II)
Franceschi et al., 2013	Simple knot tying (Group I), Trans-osseous equivalent (Group II)	Acromioplasty for Osteophytes and Hook shaped acromion	ASES score, Constant shoulder score	Group I:1, Group II: 1	Post op Adhesive capsulitis 3(Group I), 3(Group II)
Castagna et al., 2013	Simple knot tying (Group I), Trans-osseous equivalent (Group II)	NA	Constant shoulder score, Pain score (VAS)	NA	NA
Kim et al., 2015	Trans osseous (Suture Bridge) technique for both groups	Acromioplasty as needed	ASES score, Constant shoulder score, SS, KSS,Pain score (VAS)	Group I:2, Group II: 7	NA

NA- information not available.

4. Discussion

PTRC tears have poor spontaneous healing due to hypovascularity in the region of tear and continuous tensile forces acting in the region.[12,13] Progression to full thickness tears may occur in 28% of patients conservatively managed patients in 1 year.[14] Clinical signs and symptoms of PTRC tears are non-specific and may mimic those of impingement and rotator cuff tendinitis.[4,5] Since PTRC tears may also be present in asymptomatic people and its management remains controversial, an initial conservative approach is preferred.[15] Surgical treatment is indicated in patients not responding to conservative treatment. Debridement alone, without cuff repair had also been used in treatment of PTRC tears, but repair of the cuff tissue is preferred to restore anatomy and prevent tear progression.[16,17]

There is no consensus on technique of treatment of these PTRC

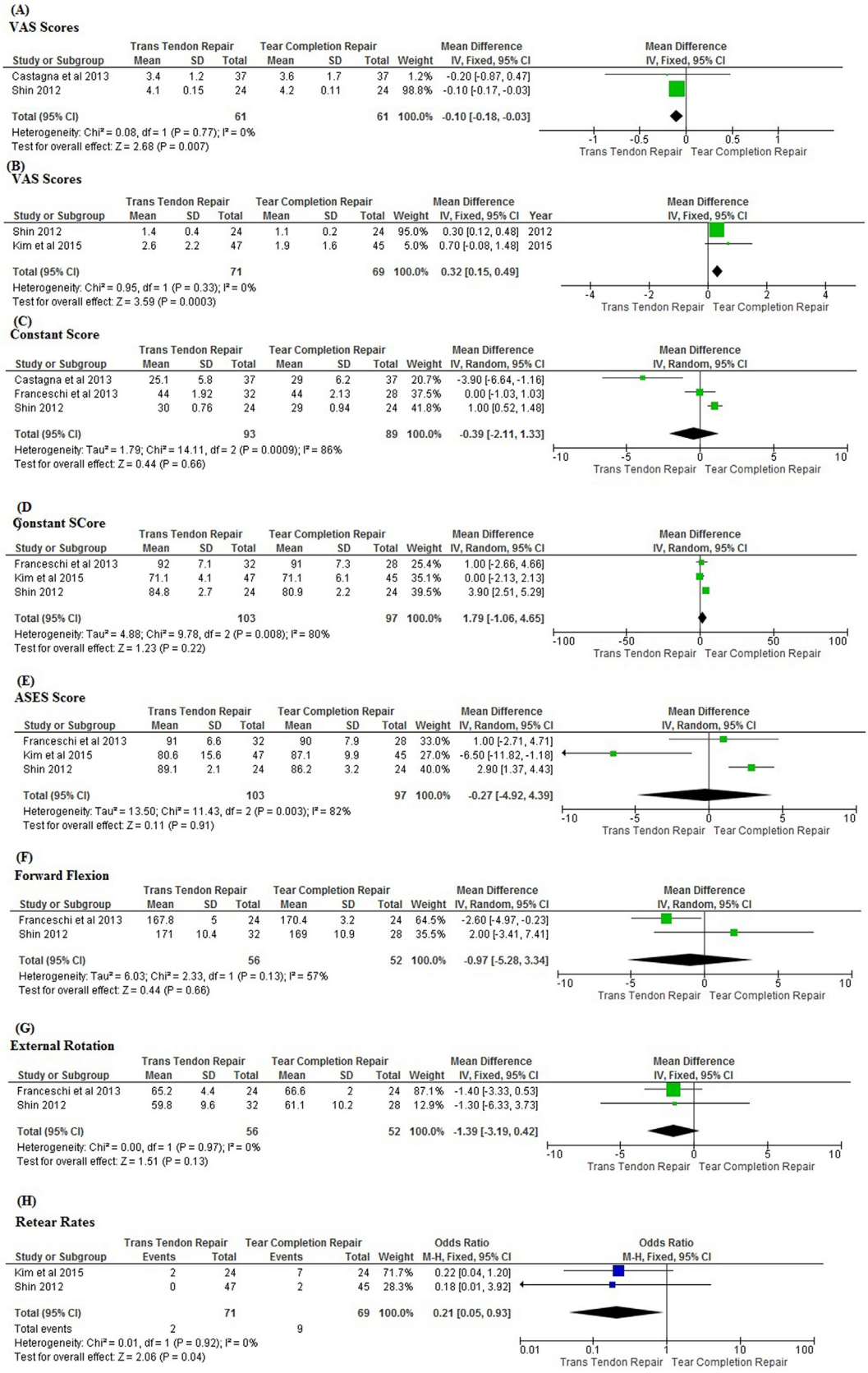

Fig. 3. Forest Plots for the outcomes (A) difference in mean pre-operative VAS score and the value at last follow up (B) mean VAS score at last follow up (C) difference in mean pre-operative Constant score and the value at last follow up (D) mean Constant score at last follow up (E) ASES score (F) Forward Flexion (G) External rotation (H) Re-tear rates.

tears. Studies comparing outcomes between different surgical techniques are few and there is no metaanalysis of these outcomes. This metaanalysis showed that trans-tendon technique results in better pain scores at final follow-up compared to tear completion and repair. There was no difference between the functional outcome scores (Constant Score and ASES) or range of motion at final follow up between the two techniques. Re-tear rates were significantly less in the trans-tendon group.

PTRC tears may also occur in patients engaged in overhead sports. Only Franceschi et al. had reported comparative return to sports in both the groups.[10] In trans-tendon repair group 75% of the patients could return to original sports whereas in tear completion and repair group 67% patients could return to original sports. This difference was not statistically significant.

There are many non-comparative studies reporting outcomes after either transtendon repair or tear completion and repair, and there are systematic reviews of these studies.[18,19] But these systematic reviews are of poor quality as they have combined studies of diverse methodological qualities and inclusion criteria had not been explicit. Literature search in these reviews also appear to be incomplete as some studies satisfying inclusion criteria have also missed. This is the first systematic review combined with meta-analysis of RCTs comparing the two techniques. Katthagen et al.[18] conducted a systematic review (Level IV) on PTRC tears. They included total 19 studies of which 11 were Level IV, 5 were Level III and 3 were Level II. These were studies with different objectives and methodologies. Only two studies were included in quantitative synthesis. Ono et al.[19] included only there studies in their meta-analysis. They had a good methodology and their results did not show a difference between two techniques in terms of functional outcome scores, range of motion, retear rates or complications.

This meta-analysis has some limitations. Firstly, there is relative lack of literature on this comparison resulting in a limited data for this metaanalysis. Another limitation of this study is that both articular and bursal side tears were included. Duration of follow up of participants is variable in the studies and the total numbers are relatively small. None of the studies included a comparison with a control group where either no surgical treatment or only decompression was carried out. Studies were also heterogeneous in terms of surgical technique used. Kim et al. used suture bridge repair in both the groups whereas others had used simple knot tying for trans-tendon repair and suture bridge repair for tear completion and repair. Sub-acromial decompression was also varyingly used in these studies.

5. Conclusion

Tran-tendon repair technique may offer some benefits over tear completion and repair in terms of re-tear rates. Both techniques of surgical repair have shown equivalent functional outcomes at follow up. Current literature is insufficient to confirm superiority of one technique over the other. More high quality randomised controlled trials are needed for making a stronger conclusion on this topic.

Declaration of competing interest

None.

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Research paper

Medium term outcomes of all-suture soft anchors in arthroscopic shoulder stabilisation

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ABSTRACT

Background: There are few studies reporting the outcomes from arthroscopic shoulder stabilisation using all-suture soft anchors. The aim of this study was to assess the clinical outcomes and failure rate for arthroscopic shoulder stabilisation using these anchors.
Methods: A retrospective cohort analysis of a consecutive series of patients in a single unit undergoing arthroscopic shoulder stabilisation using JuggerKnot all-suture soft anchors by four consultant shoulder surgeons was performed. Exclusion criteria were revision procedures, engaging Hill-Sachs lesions and glenoid bone loss greater than 20%. The primary outcome measure was failure (dislocation or subluxation as perceived by the patient with subsequent revision surgery). The secondary outcome measure was function as assessed by the Oxford Shoulder Instability Score (OSIS).
Results: 67 patients with a mean age at the time of surgery of 32.6 years (range 15–55 years) met the inclusion criteria. Median follow up was 34.5 months (minimum 13 months). No patient experienced a postoperative dislocation. However, three patients experienced painful subluxations; two underwent revision arthroscopic stabilisation and one required open stabilisation due to glenoid bone loss. Consequently, failure rate was 4.5%. Mean post-operative OSIS was 39/48 (n = 49).
Conclusion: This series supports the use of all-suture soft anchors in arthroscopic shoulder stabilisation. The failure rate compares favourably with that previously reported in literature for conventional anchors.
Level of evidence: Level IV: Case series with no comparison group.

1. Introduction

Arthroscopic stabilisation techniques have evolved since the use of metallic screws and staples[1] which cause interference with computed tomography (CT) and magnetic resonance imaging (MRI)[2] and carry the risk of loosening and migration towards the articular surface[3] causing chondral damage.[2,4] The gold standard therefore became the suture anchor,[5] including non-resorbable polymer anchors such as the polyether ether ketone (PEEK) anchor and biocomposite anchors composed of bioabsorbable polymers such as poly (L-lactide) and osteoconductive calcium.[6] Bioabsorbable anchors however have been associated with early degeneration resulting in the anchor becoming a loose body[7] as well as osteolysis and articular destruction.[8]

Novel all-suture soft suture anchors were developed to avoid these risks with the benefit of removal of less bone during tunnel drilling and occupying less volume.[9] Evidence supports the use of a higher number of suture anchors leading to a stronger repair with less than three anchor points significantly risking recurrent instability following arthroscopic anterior labral repair.[10,11] A strong bone conserving anchor is therefore ideal given the risks of an increased number of anchors on a limited available bony surface area, especially in revision cases which carry a higher risk of failure of fixation, glenoid fracture and bone loss. One such anchor is the suture soft "JuggerKnot" anchor (Biomet, Warsaw, IN, USA), which was introduced in 2009. Recent biomechanical studies have demonstrated similar load-to-failure characteristics for the all-suture soft suture anchors compared with more traditional anchors.[9,12,13]

Despite favourable biomechanical evidence, the clinical efficacy of all-suture soft anchors is unknown.[14,15] Few clinical outcome

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studies have been reported and patient numbers have been small and the duration of follow-up limited.[16,17]

The aim of this retrospective cohort study was to assess the failure rate (dislocation, instability symptoms and revision surgery) and the clinical outcome of arthroscopic labral repair using the all-suture soft JuggerKnot anchor at a minimum of 12 months follow-up.

2. Methods

2.1. Study design and study population

A retrospective cohort study was performed. Inclusion criteria were all patients from a single unit undergoing arthroscopic shoulder stabilisation for primary traumatic instability using JuggerKnot Soft Anchors (Biomet, Warsaw, IN, USA) since their introduction to the unit from October 2011 to October 2017. Patients were identified using a prospectively collected database containing diagnosis and procedural information both from clinic and the operating theatre from 2001 onwards. Information was entered onto the database on a case-by-case basis by a data entry team using case notes and theatre logs. The database was searched and case notes were requested for retrospective analysis and extraction of outcome data. Patients were informed about the study via mail and invited to return a survey questionnaire. If no reply was received then patients were contacted by telephone.

Exclusion criteria were revision procedures, engaging Hill-Sachs lesion on arthroscopy and significant glenoid bone loss (greater than 20%) at the time of procedure. Those undergoing an associated rotator cuff repair at the time of surgery were also excluded.

All patients had completed a minimum of 6 months of non-surgical treatment comprising of supervised outpatient physiotherapy. The decision to proceed to surgical stabilisation was based on pain and instability symptoms as well as number of dislocations and risk of recurrence. All procedures were performed by a fellowship trained consultant shoulder surgeon or senior trainee under direct consultant supervision.

2.2. Surgical procedure

Regional or general anaesthetic was used. Patients were placed in a beach chair position with extremity draping and the arm left free. A standard posterior arthroscopic viewing portal was first established and a dry arthroscopy of the glenohumeral joint was performed to assess for the presence of a Hill-Sachs lesion and if this was an on track or engaging lesion. Glenoid bone loss was then assessed to determine if arthroscopic stabilisation was appropriate (less than 20% bone loss). Anterior portals were then created within the rotator interval and two arthroscopic cannulae inserted. The labrum was prepared using a radiofrequency ablationtool radiofrequency tool and rasp to release all portions of the capsulolabral complex from the scapula neck and achieve a bleeding bone surface. The full width of the labrum was reattached to the debrided glenoid neck using all suture anchors (JuggerKnot, Biomet, Inc. Warsaw, IN, USA). The anchors were positioned at 5, 4 and 3 o'clock; when an additional anchor was needed, the 2 o'clock position was used. The technique of implanting the all-suture anchor involved drilling a 12 mm deep pilot hole with a 1.4 mm Kirschner-wire on the face of the glenoid and introducing the all-suture soft anchor loaded with a single Max-braid suture through a guide. Sutures were passed through the labrum and the inferior glenohumeral ligament was reformed and tensioned with sliding locking knots tied and laid carefully behind the labrum, shifting the capsulolabral complex superiorly and recreating the labral bumper. Patients were placed in a broad arm sling for 4 weeks and discharged the same day.

2.3. Rehabilitation protocol

All patients were visited by a physiotherapist on the ward prior to discharge. They were instructed to wear a broad arm sling continuously for the first four weeks with the exceptions of washing, dressing, eating and performing specific exercises. These include active elbow, wrist & hand movements, pendular shoulder movements and active assisted shoulder movements within a safe zone (typically 90° flexion/abduction and 30° external rotation unless specified otherwise in the individual post-operative plan). Patients attended the outpatient physiotherapy clinic within two weeks to re-iterate the instructions, assess for complications and reassure. The sling was discarded at four weeks with progression to full range active movements as pain allowed but avoiding aggressive stretching especially into external rotation. Low load isotonic strengthening was commenced along with low load weightbearing proprioception exercises. By six weeks the aim was to commence the Derby Shoulder Instability Rehabilitation Programme as detailed by Bateman et al.[18] Higher level athletes aimed to complete the programme whereas patients with lower physical demand continued until an accepted level of function was achieved. Contact sport was restricted until six months post-surgery.

2.4. Follow-up

Patients had clinical follow-up with the treating surgeon until a minimum of 12 months following surgery. Patients were asked if their shoulder felt stable and if they had any further episodes of dislocation or perceived subluxation. Shoulder function was assessed using the Oxford Shoulder Instability Score (OSIS).[19,20] The OSIS is a 12-item patient-reported measure of shoulder dislocation and subluxation with scores ranging from excellent 0 to 48, with 48 being the best outcome. It is condition specific and validated for measuring surgical outcomes for patients presenting with instability of the shoulder and has a minimum clinically important difference of 4.5 points.[21,22] Patients returned an OSIS independently at each clinic attendance without assistance from the treating surgeon.

No institutional review board or ethical approval was required for this study as data was prospectively collected as part of normal practice and service evaluation in our department with retrospective analysis performed.

2.5. Statistical analysis

Descriptive statistical analysis was performed using Statistical Package for the Social Sciences (SPSS Statistics for Mac, version 23.0; SPSS, Inc., Chicago, IL, USA).[23] Pearson's correlation analysis was performed to compare the number of preoperative dislocations and postoperative OSIS; $p < 0.05$ was considered statistically significant.

3. Results

67 patients met our inclusion criteria (Fig. 1). The mean age at the time of surgery was 32.6 years (SD 9.5, range 15–53). The median number of previous dislocations of the treated shoulder was 2 (IQR2, range 1–8).

Labral repairs were anterior in 63 cases, posterior in 2 cases and combined anterior and posterior in 2 cases. 13 patients also underwent simultaneous superior labral repair. The mean number of anchors used was 3.1 (SD1.1, range 1–5).

The duration of clinical follow up was a median 34.5 months

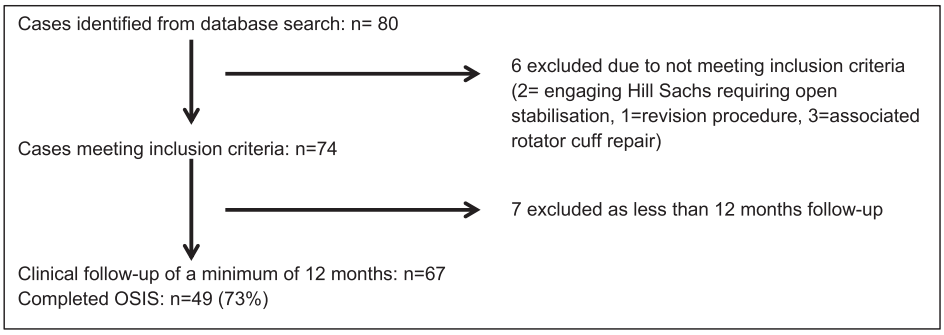

Fig. 1. Patient flowchart.

(IQR 37, range 13–84). The mean postoperative OSIS was 39.0 (SD9.2). Insufficient data was available from preoperative clinical records therefore no comparative analysis of preoperative functional scores was performed. There was no significant correlation between the number of dislocations before surgery and OSIS (Pearson's $R = 0.56$, $P = 0.74$).

There were three failures (4.5% of cases); none due to dislocation. One 21-year-old male patient treated with arthroscopic stabilisation following a traumatic dislocation experienced subluxation episodes six months following surgery and was treated with an open stabilisation due to CT proven glenoid bone loss. One 20-year-old male patient returned to boxing one year after arthroscopic stabilisation for a traumatic dislocation; arthroscopic assessment revealed intact suture anchors however the anterior labrum had torn through the sutures. Repeat arthroscopic stabilisation using JuggerKnot anchors was successful. One 28-year-old male patient had perceived instability 1 year following arthroscopic stabilisation for atraumatic instability. MRI was equivocal and a diagnostic arthroscopy revealed a deficient anterior labrum that was treated with revision arthroscopic stabilisation using JuggerKnot anchors successfully.

6 patients had a postoperative MRI, including the three failures. Two of these cases symptoms did not require revision surgery and improved with physiotherapy alone; one patient experiencing pain attributed to scapulothoracic dyskinesia and one patient following subsequent trauma. Tunnel widening or adjacent cysts were not identified in any cases.

One patient death occurred in the follow up period. This fatality was not related to their procedure.

4. Discussion

The aim of this retrospective cohort study was to assess the clinical outcome and failure rate of arthroscopic labral repair using the all-suture soft JuggerKnot anchor at a minimum of 12 months follow-up. We found at a median 34.5 months a mean OSIS of 39.0/48. There were 3 failures (4.5%).

Few studies have reported the clinical outcomes from labral repair using all-suture soft anchors. A recent prospective study of 30 patients using the JuggerKnot anchor by Tompane et al. monitoring for glenoid reactions using CT scanning found increased tunnel volumes at 6 and 12 months; however, this is of unclear significance as there were no episodes of recurrent instability during study period.[24] Agrawal et al. studied a series of 18 patients treated for circumferential labral tears and found at a mean 2-years follow-up improved Constant-Murley shoulder scores and Flexilevel shoulder function scores with one failure due to further trauma in a competitive athlete at 3 years and no instances of subchondral cyst formation or tunnel expansion.[16] Willemot et al. studied a series of 20 patients treated with the JuggerKnot anchor with minimum 12-month follow-up (mean 19 months) and found satisfactory Western Ontario Shoulder Instability (WOSI) Index and Disabilities of the Arm Shoulder and Hand and Constant-Murley scores and no cases of subluxation or dislocation.[17] There were some bone reactions but these were few and low grade on MRI. These studies all had small numbers and short follow-up duration however. Tunnel widening or adjacent cysts were not identified in any cases in this study, although it was not routine to perform postoperative cross sectional imaging in our unit.

Functional outcome was found to be similar to that from traditional anchors with a mean OSIS of 39.0 (SD9.2). A recent prospective study by Blonna et al. of 30 patients undergoing arthroscopic Bankart repair at minimum 2-year follow-up using bioabsorbable suture anchors reported an OSIS of 41 and a revision rate of 4.9%.[25]

Survival was good (95.5% at 1 year), although longer follow-up is required to compare directly to more traditional anchors. Vermeulen et al. studied a series of 147 patients treated with absorbable polylactic acid knotless anchors at a mean 6.3 years found 5-year survival of 79% and good long term results as assessed using the WOSI index.[26] The authors found no complications, although other authors have found rare complications such as chondral injury,[27] disintegration[28] and osteolysis around anchors.[29] There are no such long-term studies of all-suture soft suture anchors although biomechanical studies have shown similar load-to-failure performance to other anchor designs.[9,12,13] With a smaller footprint on the bony surface and the ability to place anchors as close as 2 mm from one another without reducing strength to failure,[30] all-suture soft anchors provide an ideal solution to offer more fixation points which is known to lead to a stronger repair.[10,11]

Limitations of this study included the lack of preoperative outcome scores for comparative analysis. This was because a preoperative OSIS was not available for a significant proportion of patients, therefore we accept this limitation and report a full consecutive series of patients and avoid a potential source of selection bias. 18 patients (27%) declined to return postoperative OSIS questionnaires; however, all patients completed a minimum clinical follow-up of 12 months. It was not routine practice in our unit to perform postoperative MRI imaging if the patient was asymptomatic therefore we cannot comment on labral healing or bone reactions.

Strengths of this study include that this is the largest study reporting clinical outcomes data from patients treated using all-suture soft anchors with minimum 12-months follow-up and is a multi-surgeon consecutive series.

The low failure rate and good clinical outcomes reported support the ongoing use of all-suture soft anchors. Further long-term studies are required to determine clinical outcome as compared

to more traditional suture anchors.

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Research paper

Clinical and cost comparison of manipulation under anaesthetic and steroid injection for frozen shoulder (stage II) with arthroscopic interval release

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ABSTRACT

Background: Manipulation under anaesthetic and Steroid Injection (MUA) is a traditional treatment for frozen shoulder (FS). Some clinicians believe arthroscopic release is superior. This study evaluates the clinical outcome of MUA for primary unilateral stage II FS and compared costs to interval release (IR).
Methods: 115 cases were retrospectively reviewed. Pre- and postoperative ranges of movement (ROM) were measured and compared to the other shoulder. Demographic data, symptom length, stated cause and diabetic status (11) were collected. Postoperative course was charted to discharge.
Results: Final ROM matched the normal side for flexion and abduction with significant improvement of external rotation (6.5° (SD 8.9°)) and internal rotation (1.3 vertebra/10 (SD1.6)). No pre-existing factors investigated influenced the results. 3 failures (2.6%), had repeat MUA (2) or IR (1). 73 were discharged on first post-op visit (63.5%). 27 (23%) had mild shoulder impingement that resolved with steroid injection, 3 (2.6%) with impingement required SAD, 9 (7.8%) with mild residual stiffness, which settled spontaneously. There were no complications.
MUA took 16 min, generated income £1600 with cost £831. IR took 66 min, income £4163, cost £2931.
Conclusion: MUA for FS is safe, successful (97%) obtaining near normal movement (94%). It is a cost effective first line treatment for patients, hospital and NHS. Symptomatic shoulder impingement is common postoperatively and should be sought and treated.

1. Introduction

No consensus currently exists on the best treatment modality for frozen shoulder (FS) and a wide range of methods are suggested including wait and watch policy, analgesics, physiotherapy, steroid injections, distension arthrogram, manipulations under anaesthetic or arthroscopic interval release. This is partly due to incomplete information on the natural history of the condition and the difficulty in defining the stage of the disease.

Manipulation under Anaesthetic and Steroid injection (MUA) combined with physiotherapy is still a commonly used traditional treatment for stage 2 Frozen Shoulder[1,2] although authors suggest that interval release could give better clinical result and faster relief of symptoms[3] and carries less risk of damage to shoulder structures.[4] However, a recent review by Hsu et al.[5] and a recent Health Technology assessment (HTA) report[6] did not find evidence to indicate that arthroscopic capsular release was better than MUA.

Many patients benefit greatly from MUA but certain groups many perform worse than others. The suggested reasons are mechanism of onset (trauma, after surgery)[7,8] and underlying conditions like diabetes.[7,9] As the condition can naturally resolve over time, time since onset of symptoms may be important and Flannery found early intervention provided better results.[2]

Costing treatment is increasingly important and forms part of the assessment of the overall benefit of one treatment versus another. Whilst there have been some cost comparisons of physiotherapy after distension arthrogram,[10] there are no available economic analyses for the treatment of frozen shoulder.

This study was performed to 1) Evaluate the clinical outcome of MUA for stage 2 frozen shoulders, looking at pain relief, range of movement, complications and the factors that could affect the

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results; 2) To compare the costs of MUA and interval release.

2. Method

Consecutive patients presenting to our unit from 1999 to 2010 with a primary unilateral Stage 2 frozen shoulder who had failed other conservative measures including steroid injections and physiotherapy and were requesting further treatment were included. Stage 2 frozen shoulder was defined as a restriction of range of movement globally with normal radiographs[11] with pain mainly at the end of range of movement and/or at night. Exclusions were bilateral frozen shoulders, post fracture stiffness, post dislocation, post-surgical decompression and cuff repairs and those patients with clinical weakness of the rotator cuff with suspicion of a cuff tear. We also excluded patients who received a distension arthrogram, as they are performed by the radiologists, and are few in our hospital and there was no ability to generate a cost per case from the hospital data and so were excluded from this study.

Patients with a Stage 2 frozen shoulder were offered the opportunity to wait for natural resolution or be considered for an MUA and steroid injection. The authors also use interval release but for cases that fail to improve with MUA or offers it in cases of secondary frozen shoulder (Fractures, dislocations or after cuff repairs).

Patients were assessed in outpatients to confirm a clinical diagnosis of Stage II frozen shoulder (a clinically globally stiff shoulder, normal cuff power and normal X-rays). Patients were booked for surgery around 2 weeks later. The range of movement was recorded: flexion, abduction and external rotation recorded in degrees but internal rotation was classified by the position of the back of the hand on the spine and graded as in the Constant score (0–10 in 2 grade increments).

All patients had MUA under a short general anaesthetic with a gentle manipulation to break the adhesions till a full range of movement is obtained. Movements performed in sequence while stabilising the scapula were: flexion abduction, adduction, external rotation at 0° of abduction of the arm and internal rotation with the arm at 90° of abduction. All patients received physiotherapy input with exercises, instituted on the day of operation and were discharged home the same day. They saw a physiotherapist in outpatients 2 days later and thereafter as required. First outpatient appointment was at 2 months postoperatively. Ranges of movement in all planes were measured at each visit and recorded in the notes. The clinical course of the patients was monitored looking at recovery of range of movement and alleviation of symptoms. Complications were noted. Range of movement at discharge was recorded unless the MUA had failed when the need for secondary procedure was determined.

This series was considered as service review no ethic board approval was required. Data was collected independently by an independent researcher retrospectively from the notes. The data was entered in a secure Microsoft access (Microsoft Corp., Redmond, WA, USA) database. The initial and final range of movements were compared to the normal side and analysed by paired t testing. Other factors influencing outcome were considered, such as time from onset of symptoms, mechanism of onset of symptoms, diabetes and magnitude of initial stiffness. To assist examination of these factors which might influence the success of the procedure and the recovery, the preoperative range of movement was combined into a global range of movement score. Flexion, abduction and internal rotation were scored 0–10 in increments of 2 as in the Constant score. For external rotation, the same 0–10 score was used with 0 -<15° = 0, 15°-<30° = 2, with 10 as ≥ 75. A global score was then calculated and the above factors were correlated to the global final range of movement achieved.

To compare the costs of MUA vs interval release, all cases of MUA and interval release performed under the senior author's care in the 2010–2011 financial year were costed. As, costs change with time, only patients from the year 2010–2011 were included in cost analysis. PLICS (Patient level information costing system) costs management system became available in that year. It is a patient level financial system which costs each aspect of an individual patient's treatment using locally generated reference costs for the operation but factoring in individual costs as to time in theatre, time on the ward and investigations performed. It includes costs for management, buildings and facilities. As a comparison, we also costed the two procedures from bottom up i.e. by itemising staff and materials used and adding in hospital costs (building/administrative staff etc.) according to an agreed hospital based formula (Table 1). The time for each case was measured using ORMIS (the theatre data management system) which records the times as the patient moves through the theatre (e.g. start of anaesthetic, start and end of surgery). We recorded the total time per case as the time from the start of anaesthetic time to the time the patient left theatre (the anaesthetic and surgical time). Although the groups were non-randomly assigned there was no reason to believe that the operating time would be affected by this.

Operations in the UK are coded into treatment groups (HRGs) according to complexity and the treatment group determines the income that the hospital receives for the procedure. HRG codes are a broad code including other procedures but an operation will code to one of two codes according to whether the patient had other comorbidities or not. MUA was coded as HRG code HB44B or C (minor arm procedure category 2 non-trauma with(B) or without(C) comorbidities). Arthroscopic interval release was coded as HRG code HB42B or C (intermediate arm procedure category 2 with(B) or without(C) co morbidities).

Only in-hospital physiotherapy costs were included. Outpatient physiotherapy was performed close to the patient's home which could lie outside the catchment area of the main hospital, in one of 6 community hospitals which were part of different trust. In addition, in the year in question the physiotherapy costs were apportioned on a proportional basis, not necessarily related to the cost of the patient's treatment. As the outpatient physiotherapy costs are the same for both treatment methods, this would not invalidate the comparison.

3. Results

We treated 135 patients with primary frozen shoulder between 1999 and 2010. Complete notes were available for 115 patients as 15 patients did not return for their first follow up and 5 sets of notes were considered incomplete. There were 58 males and 57 female patients. The mean age was 54 (range 41–58) years of whom 11 (10%) patients were diabetic. Median duration of symptoms before assessment was 7 months (range 2–18 months) with a late peak at 12 months.

The pre- and postoperative range of movements are shown in Fig. 1, compared to the range of movement on the other side. Preoperatively the range of movement in all directions was significantly reduced compared to the normal side. Postoperatively the figures show that flexion and abduction returned to the same as the other side at discharge. Flexion improved from a mean of 126° (SD 24°) to 172° (SD 10°). Abduction improved from a mean of 118° (SD 43°) to 177° (SD 10°). External rotation returned to an average of 6.5° (SD 8.9°) short of the normal (other side) from 28° (SD 18) to 59° (SD 16°); $p < 0.0001$ compared to other side. Internal rotation scored out of 10 taken from the Constant Score returned to 1.3 (SD 1.6) (about one vertebra) below normal. It improved from 3.7 (SD 2.7) to 7.5 (SD 1.6), $p < 0.0001$ compared to other side. Overall the global range of movement returned to 94% of the other side. Initial

Table 1
Bottom up costings for MUA and Interval release.

	MUA (16 min) cost in £	Interval Release (66 min) cost in £
Consultant Theatre time	35.4	146.03
Junior Theatre Time	15.9	65.59
Anaesthetist	35.41	146.03
ODP	6.24	25.74
Nurse	5.04	–
Scrub nurse	–	20.79
Circulating Nurse	–	13.06
Assistant	–	65.59
40 mg Kenalog	7.97	–
one vial marcain (10 ml of 0.5%)	1.35	–
green needle	0.05	–
10 ml syringe	0.07	–
plaster	0.11	–
small shoulder set with scope and dilatation probes		17.93
VAPR side effect probe		162.00
tubing with arthroscopy pump		26.96
ward costs	131.49	262.99
corporate over heads	20.6	67.59
central overheads	21.76	71.41
facilities	20.74	68.06
overheads	8.92	29.28
management	10.42	34.2
TOTAL COST	321.47	1223.25

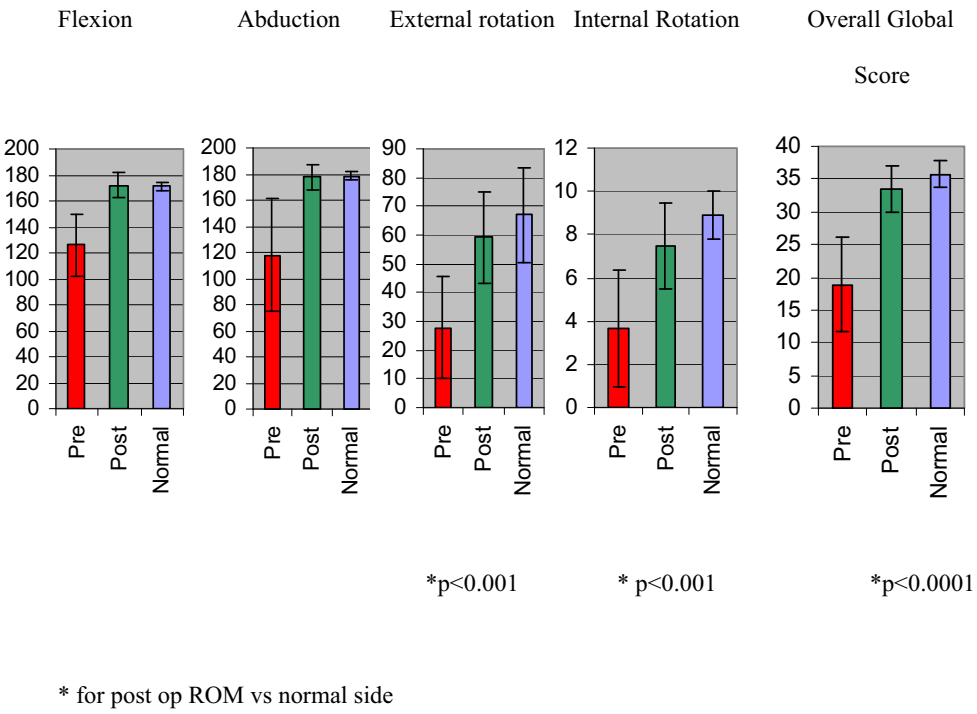

Fig. 1. Pre- and post-operative range of movements compared to other side.

score (pre-surgery) was 33.4 (SD 3.6), final score 35.7 (SD 2), $p < 0.0001$ (compared to normal side).

There was a wide distribution of the initial stiffness (measured using the global range of movement score) (Fig. 2) but there was no association between the range of postoperative movement (measured by the global movement score compared to the other side) and the initial score (Correlation coefficient 0.11).

73 (63%) patients were discharged at the first visit as they had significant improvement in the range of motion, no residual symptoms and were back to normal activities. At follow-up, 30 (26%) patients showed residual shoulder impingement which settled in 90% of cases with one steroid injection into the subacromial space and were subsequently discharged. 3 (2.5%) patients needed shoulder arthroscopy and subacromial decompression for the continuing symptoms. 7.8% (9 patients) had residual stiffness but it resolved after 3–4 months postoperatively before discharge. 3 (2.5%) patients developed stiffness again 2 months post-operatively and required further manipulation (1) and interval release (2).Table 2

None of other factors (length of symptoms prior to presentation, initial attributed cause and diabetes) were correlated to the improvement in range of movement. Correlation coefficient (r^2) for

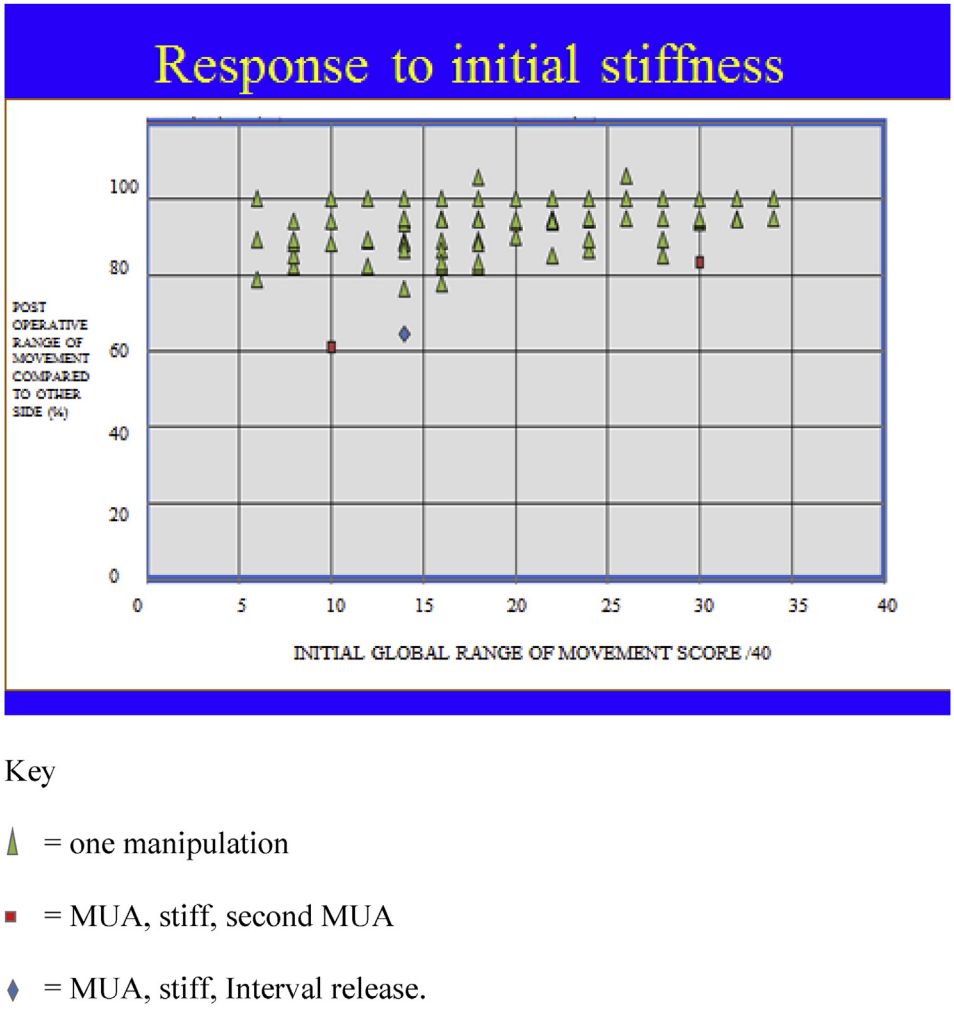

Fig. 2. Initial stiffness with response to treatment.

length of symptoms was 0.0045. There was no difference in the mean global range of motion score postoperatively based on initial attributed cause Table 3. Mean global range of motion score at outcome was 33.4 (SD 3.7) for the 104 non-diabetic patients was 32.7 (SD 2.7) for the 11 diabetic patients. (*t*-test: $p = 0.54$) There were no significant complications.

3.1. Cost per case (income and expenditure) (Table 4)

In 2010–2011, there were 12 cases who had an MUA. Of these 10 were HB44B (with co-morbidities) and 2 were HB44C (without co-morbidities). HB44B is routinely a day case procedure. However, 2 cases stayed overnight attracting an income of £2412 but costs of £2271 and £3665. Similarly, for HB44C both patients had no comorbidities but for other reasons (e.g. social) they also stayed overnight attracting an income of £2199 but costs of £2699 and £3415. This is not the normal course, so were excluded from the analysis of cost for calculation of single code but were included in the overall view to give a cost for managing a service as some patients may require an overnight bed. For the day case MUAs the income was £1600 for HB44B (day case). PLICS costings were £831 (SD £106).

For interval release, there were 17 cases (in the year 2010–11) of whom 12 were categorised as HB42B (with comorbidities) and 5 were HB42C (without comorbidities). PLICS costings were £2931(SD £187) for HB42B and £2800(SD £132) for HB42C. Income for HB42B was £4163 and for HB42C was £3682. Figures in Table 4 are shown with individual costs and then combined to give an average for the department.

As PLICS costings are determined by department reference costs, bottom up costings were also performed for the two procedures (Table 1). These were constructed by including an

Table 2
Clinical outcome of patients treated with MUA.

Result	Number (%)
At 2 m free of pain, full ROM happy back to normal activities, discharged	73 (63.5%)
At 2 m mild pain, clinically impingement syndrome, treated by steroid injection, 9/10 then pain free, 1/10 needed SAD	30 (26%)
At 2 m a bit stiff, settled by 3–4 months ready for discharge	9 (7.8%)
At 2 m – failed range of movement treated by MUA (2), interval release (1)	3 (2.6%)

Table 3
Mean global outcome score for initial attributed cause.

Initial attributed cause	Number of patients	Mean Global range of movement score (measured out of 40) (SD)
Nothing	61	33.2 (3.9)
Fall	18	32.7 (3.1)
Overuse	3	34.7 (1.1)
Forced activity	33	33.9 (3.4)

Table 4
Cost per case PLICS data and bottom up costings and ORMIS times.

Average cost per case 2010–11 PLICS data						Cost per case bottom up data (£) (see Table 1)	Time per case (ORMIS data)
	Code	Cost £(SD)	Income £	Profit £ (SD)	No of cases		Mean time per case (min) (SD)
MUA	HB44B	£831 (106)	1600	769 (106)	8	£321.47	16 (4.6)
	All cases	£1326 (742)	1835 (353)	508 (415)	12		
Interval release	HB42B	£2931 (187)	4163	1232 (187)	12	£1223.25	66 (12)
	HB42C	£2800 (132)	3682	882 (132)	5		
	All cases	£2893 (179)	4021	1128 (235)	17		

Key:
PLICS – Patient level costings.
Bottom up data – cost of treatment calculated from all equipment used, theatre and staff time and including an accepted cost for overheads.
ORMIS – Theatre information management system.

allowance for staff time in theatre, the equipment used, ward costs and an assessment for corporate and central overheads, facilities and management. Bottom up costs were considerably lower than the PLICS generated costs which does raise questions about how the PLICS data is generated. However, in both cases the interval release was more expensive by a similar proportion (3.8× for bottom up costs and 3.5× for PLICS costs) so the costing mechanisms are consistent.

3.2. Time in theatre (Table 4)

The total time required to perform an interval release (anaesthetic and surgical time) was 66 (SD 12) minutes compared to 16 (SD 5) minutes. Each MUA performed (in place of an interval release) saves the NHS around £2186 (based on income data). Although the profit per MUA is less than for an interval release, because 4.1 MUAs can be done in the same time as an interval release, the hospital makes a bigger profit if MUAs are performed. (£899.5 using PLICS data for all cases, £2249 using bottom up costs).

4. Discussion

In this series, the range of movement was restored in 97% of patients to 94% of the movement of the other side with any losses being in internal and external rotation and being of one vertebra and 6° respectively. 7.8% needed to wait an additional 2 months before symptoms of stiffness had settled-when the final assessment was made. This agrees with Reichmaster's study[12] where recovery was near complete though 8% had a repeat MUA and Theodorides study.[13]

For pain relief, had success been recorded as no pain at 2 months the success rate would have been 69.8% comparable with some other studies of FS treatment (Farrell(MUA),[14] Segemuller (arthroscopic release)[15]). However, in this study, the cause of the residual pain was found in 25.6% of the patients to be mild subacromial impingement (SAI) which was uncovered by treatment of the frozen shoulder. In 9/10 cases this settled with steroid injection, leaving only 3 (2.6%) requiring subacromial decompression (SAD). Only one smaller study[1] mentioned shoulder impingement as a cause of ongoing shoulder pain. This may be a cause of symptoms in patients (22%) in the series by Theodorides.[13] The trigger for frozen shoulder is unknown, some believe that any painful shoulder condition can trigger it and it is reasonable to assume that a predisposed patient with impingement syndrome may develop a subsequent frozen shoulder. In a full blown frozen shoulder, it may not be possible to assess for shoulder impingement because of the stiffness and this impingement may only be recognised when the range of movement is fully restored. Using a scoring system alone will, in patients with a low score, not identify a clinical condition, which may be treatable.

Most studies do not separate out range of movement and pain, many have chosen to use an outcome score relying on function and pain (Oxford) or a mixture of function, pain and range of movement (Constant) but do not explore the reasons for continued symptoms nor make any effort to correct these. Satisfaction rates of 90%[2] and 94%[1] have been quoted and yet in Dodenhoff study[1] he noted 59% had mild disability and 28% moderate disability after procedure. Disability and satisfaction do not necessarily assess the same thing. Dodenhoff's study[1] used the Constant score to assess outcome but did not investigate why some patients might have a lower score but did note one patient went on to have a subacromial decompression. Farrell[14] found 18/19 had no further surgery but 6/19 were troubled by night pain and at rest.

A recent study[13] using the Oxford scoring system (OSS) to study MUA for frozen shoulder found a significant improvement in the OSS in the short term (4 weeks) which was maintained in the long term (3.6 years). However, at 4 weeks the steroid injection may still be masking residual pain which was not considered. Even at 4 weeks, 22% had residual symptoms as recorded by the OSS. Although the authors state that patients were offered further treatment if symptomatic, further management is not clear, nor if they were excluded from further follow up. It is possible that these patients may have had mild impingement syndrome.

Compared to other methods of treating frozen shoulder, the outcome of this study is similar. Distension arthrogram (DA) studies have reported good results though the outcome can be unpredictable.[16] Ng[16] in a RCT of MUA vs DA although overall there was no difference in the two groups they commented that the abduction was less for the DA group. Ibrahim[17] in a case series commented that DA could do well at reducing pain but found that 1/3 needed manipulation to get the movement back however these were largely in the diabetic population. In contrast Quraishi[18] in an RCT of

DA vs MUA found that the DA patients did better at 6 months than the MUA patients. However, his DA patients had a worse range of initial movement. The Constant score was used which has ceiling effects, their result may be the consequence of this factor. Also, the patients who had an MUA regained their range of movement faster (by 2 months) whereas the DA patients were still regaining theirs. This slower recovery make DA less acceptable, as speed of recovery is important to patients.

Compared to arthroscopic interval release the outcome is like Watson's study[19] where the quoted ROM was within 10% of the other side in 5.5 weeks. Segmuller[15] quoted satisfaction rates of 88% with 78% normal flexion/abduction and external rotation but 50% lacking internal rotation with a constant score of 87%. Berghs[3] found that all ranges of movement improved to near normal with an age adjusted constant score of 91%. Kivimacki[20] in his RCT of MUA plus exercises or just exercises found at 1 year there was no difference in shoulder pain or function but range of movement was in favour of the manipulated group. Although getting rid of pain especially at night is important to patients, being able to move it to reach is also important and MUA provides that.

The clinical complications of MUA have been described (e.g. fracture, dislocation).[21] In this study, no clinical complications were noted in agreement with the study by Theodorides.[13] In a study by Loew[4] arthroscopically acute lesions were found in addition to capsular rupture after MUA in 12/30 joints (anterior labral tears, SLAP, SGHL and subscapularis tears) but not by another.[7] This has been cited as a reason for not doing MUA. However, Loews[4] study had no follow up. In this study, as in recent study,[13] there were no sequelae attributable to untoward lesions, so if they exist (accepting the variation in study reports) they do not cause any long-term consequences as these lesions would have caused clinical post-operative problems which would not have settled.

Some papers have suggested some subgroups do less well with MUA. Diabetics have been thought to have a more resistant and severe form of the disease. Certainly, Massoud[9] in a series of diabetics treated by MUA or arthroscopic release found equal satisfaction rates for NIDDM and IDDM but the NIDDM patients were more likely to require interval release. Others recorded that diabetics did worse with DA. Ibrahim[17] recorded that although overall 1/3 of patients needed an MUA for stiffness overall of the diabetics it was 4/5. In this series, no outcome differences for diabetics were detected, but their number was small so may not have been large enough to pick up small differences. However, another larger study also found no overall outcome difference in OSS for diabetics but commented on a small but significant reduction in external rotation.[13]

Similarly, this study agrees with Theodorides[13] that initial stiffness does not affect the result. Neither does length of symptoms,[13] in contrast to the only other study to examine this which found those with symptoms for less than 9 months did better than those 9–40 months.[2] Only one paper has commented on the outcome of MUA for frozen shoulder secondary to trauma or surgery[8] where outcome was worse than a group with primary frozen shoulder. However, included were patients with trauma including fractures and after surgery, following open cuff repair or fracture fixation. These patients with secondary stiffness after this type of surgery are very different to those with a primary frozen shoulder. The pathology is dense diffuse scarring which does not break easily in contrast to the isolated capsular contracture of a primary frozen shoulder. These excluded were excluded from this series and would have received an interval release.

In times of financial austerity costing of treatment is important, but difficult as alluded to in the recent HTA report. Part of the problem is constructing the "overhead" costs (the costs of the buildings, non-clinical staff, etc.). In this study, the bottom up and PLICS costings constructed are different but the ratio of costs is similar. The HTA report in the absence of any other figures, used NHS reference costs to cost the treatment for MUA. These are constructed as an average across all trusts and do not necessarily represent local costs. Although the HTA report came up with different figures and included a cost for physiotherapy, the same trend is present (they quote MUA £1446, interval release £2204) and because more MUAs can be done in the same time, the profit to the hospital is greater for the MUA. The HTA report attempted to assess QALYS (Quality adjusted life years) but found the information available was poor.

In assessing the cost of operations one can consider costs to the NHS community, the time in theatre and the effect on the hospital profits. In this study from the figures, MUA costs less than arthroscopic release with a saving to the NHS of £2186 per case (from PLICS figures). An MUA takes 4.1 times shorter time than an arthroscopic interval release, so in the same time in theatre 4.1 more patients can be treated. Finally using the costings although the profit per case is less for MUA, because more of them can be done in the same time the overall profit per hour of theatre time is greater of £899.5 using PLICS data, £2249 using bottom up costs for all cases.

This study has limitations. This series is a one surgeon series. However, it is a consecutive series and the results can be applied generally. Although the measurements were recorded by the author the notes review and data entry was conducted independently to reduce selection bias. There can be differences in selection criteria between studies but the selection criteria used in this study are consistent with other studies. We have not included patients after fracture, cuff tear, instability, or after surgery. Arthroscopic interval release is reserved for cases not suitable for MUA or for failed MUA cases. A pain diary in the first 8 weeks could uncover more information. A scoring system might have allowed more comparisons with other studies. To assess the outcome compared to other treatment methods a randomised controlled trial will be useful. Tracking NHS costs is difficult and as this study shows bottom up and top down costings are not similar however costing ratio is identical, so a comparative assessment between treatments can be made. Better costing methods would help understand the costs of NHS care. Physiotherapy costs were excluded as not all patients are treated in the trust and in the year where the data was taken from the costs were done on a proportional basis not individual. However, as the HTA report indicated the physiotherapy regimes are the same for the two operations so should not affect the result.

Range of movement and pain may improve with treatment; however, they do not always improve together.[1] Studies looking at manipulation under anaesthetic with steroid injection have often used a scoring system based on a combination of pain and stiffness without separating them (Constant score)[1,2] or have used a patient reported functional score (Oxford score).[13] These scores are useful for comparisons between groups and can be administered remotely (Oxford score). However, neither fully assess the normality of range of movement, nor look specifically at the reason for continued pain, that could be treatable. Scores can be subject to ceiling effects e.g. Oxford score.[22] Most studies do not investigate the cause for continuing symptoms and just record the outcome post-operatively.[2,13,14] Only two studies have looked at the final clinical outcome and only one series noted that one patient needed a sub acromial decompression[1] and another a patient developed a late onset cuff tear which caused impingement syndrome.[12] No studies have looked at impingement syndrome after frozen shoulder.

5. Conclusion

Manipulation under anaesthetic and steroid injection is safe and minimally invasive. The results of this consecutive retrospective series show that 97% of patients will regain their range of movement to within 94% of the other side with the 6% difference to be found in minor losses of internal and external rotation. 26% will have minor impingement uncovered once their range of movement is regained and of those 90% will settle with a subacromial injection leaving just 2.6% needing arthroscopic decompression. Of all treated 2.6% could stiffen up again and may need further treatment for the stiff shoulder. These results are apparent at 2 months though some (7.8%) need another 2 months to fully settle. The results are unaffected by initial range of movement, length of symptoms (once all are in stage 2), mechanism of acquiring frozen shoulder or diabetes.

MUA and steroid injection is successful for 97% of patients, costs less than arthroscopic interval release, takes a shorter time and doesn't instrument the shoulder. This allows more patients to be treated in the same time, with lower cost to the NHS and similar outcome. Our results do not support the trend for arthroscopic release as the primary surgical treatment for uncomplicated frozen shoulder (instead of MUA) considering both cost and clinical outcome of MUA.

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Declaration of competing interest

The Authors declare that there is no conflict of interest.

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Research paper

Does graft choice influence the outcome of MPFL reconstruction in patients with patellofemoral instability and increased TT-TG distance?

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ABSTRACT

A systematic review of the literature was conducted to determine the effect of graft choice on patient outcomes in patients undergoing a medial patellofemoral ligament (MPFL) reconstruction with concomitant tibial tubercle transfer (TTT). Utilizing the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) and QUORUM (Quality of Reporting of Meta-Analyses) protocol, a systematic search identified and analyzed the published literature pertaining to MPFL reconstruction with TTT. The literature search yielded eight eligible studies with a total of 183 knees treated with a MPFL reconstruction with TTT procedure involving either a gracilis autograft, a semitendinosus autograft, or a medial retinaculum autograft. The eight studies varied on the outcome measures reported, but the outcome measures most consistently used and assessed in this systematic review included the complication rate, postoperative instability rate, Kujala score, Lysholm score, International Knee Documentation Committee functional evaluation form, and the Tegner activity scale. Our study found that patients undergoing MPFL reconstruction with TTT resulted in good overall patient outcomes. No statistical difference was found between the graft choices on any of the outcome measures. While MPFL reconstruction with TTT resulted in low to moderate complication rates and low postoperative patellofemoral instability rates, one potential explanation for the postoperative instability and knee stiffness observed may derive from graft choice. Future research may consider addressing the effect of graft choice on improperly tensioned grafts and overmedialized TTTs.

1. Introduction

Patellofemoral instability represents a debilitating condition that occurs primarily in active, young patients with an increased prevalence in the female sex.[1–3] Patellofemoral instability can manifest either from a traumatic event inducing a lateral patellar dislocation, or from an atraumatic event if the patient possesses an underlying atypical anatomy, such as trochlear dysplasia, patellar dysplasia, patella alta, increased tibial tubercle-trochlear groove (TT-TG) distance, increased Q-angle, and ligamentous laxity. Many structures of both soft tissue and bony composition guide proper patellofemoral articulation throughout the full knee range of motion. Of these structures, the medial patellofemoral ligament (MPFL) serves as the primary passive soft tissue restraint to lateral patellar subluxation/dislocation in 0°-30° of knee flexion.[4,5]

As a structure traversing from the depression between the medial epicondyle and the adductor tubercle of the femur to the superomedial aspect of the patella, a MPFL lesion is found in 90–100% of all lateral patellar dislocations.[6–9] In fact, a MPFL lesion has been described as the "essential lesion" of a lateral patellar dislocation.[4] Thus, the reconstruction of the MPFL represents a standard surgical procedure to restore the stability of the patellofemoral joint after nonoperative treatment has failed for recurrent lateral patellar subluxation/dislocation events.

While a MPFL lesion represents the primary soft tissue lesion in recurrent patellofemoral instability, it is important to consider if any other factors are contributing to the patellofemoral instability. One important anatomical feature that can contribute to

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patellofemoral instability is the TT-TG distance, which indicates the degree of lateralization the tibial tubercle resides at relative to the trochlear groove. A marked lateralization of the tibial tubercle increases the lateral quadriceps force vectors on the patella, which in turn predisposes the patella to undergo subluxation or dislocation in knee flexion.[10] The current notion defines a normal TT-TG distance as less than 13 mm, an abnormal TT-TG distance as greater than 15 mm, and a pathologic TT-TG distance as greater than 20mm.[10–13]

Patients presenting with recurrent patellofemoral instability and an increased TT-TG distance likely will require a multifaceted treatment to address all of the underlying pathologies at play.[14] A common approach involves initial nonoperative treatment, but if this fails, a surgical intervention involving a MPFL reconstruction with concomitant tibial tubercle transfer (TTT) to medialize the tibial tubercle will ensue. A lateral release or lateral reticular lengthening procedure may also be performed if the lateral retinaculum is found to be excessively tight.[15]

MPFL reconstruction with TTT represents a multifaceted procedure with overall favorable results.[16,19] The incidence of postoperative patellar instability, reoperation, and complication rates reside at low to moderate levels, and the majority of patients demonstrate significant improvement in their condition after surgery. That being said, there remains a small patient population who do not achieve optimal results, experiencing postoperative complications and postoperative instability.[16,31,32,36,37] A critical review of the literature may help determine the possible reasons for suboptimal outcomes of MPFL reconstruction with TTT.

Previous systematic reviews have been conducted on the efficacy of MPFL reconstruction with TTT, but they did not assess the outcome measures by graft type.[16,19] The common grafts utilized for MPFL reconstruction include a gracilis tendon, semitendinosus tendon, partial quadriceps tendon, partial patellar tendon, partial adductor tendon, and medial retinaculum that can either be autograft or allograft in nature.[17] The use of synthetic grafts has also been reported.[18] Current research has discovered that certain types of MPFL reconstruction grafts may lead to improvement in patient outcome.[52] This systematic review will examine the impact of graft choice used for MPFL reconstruction in patients with recurrent patellofemoral instability treated with MPFL reconstruction with TTT.

2. Methods

Two independent authors performed a literature search on June 30, 2018 in concordance with the PRISMA and QUORUM protocol.[27,28] The searched databases included MEDLINE/PubMed, SportDiscus, CINAHL (Cumulative Index to Nursing and Allied Health Literature), and Cochrane Central Register of Controlled Trials with the search query listed in Table 1. To be included in the review, the study was required to: 1) report outcome measures following a primary MPFL reconstruction with TTT (anteriorization, medialization, distalization, or any combination of these techniques), 2) state the graft utilized, 3) involve no prior surgery addressing patellofemoral realignment in the ipsilateral knee, and 4) be written in the English language. Studies reporting on additional topics besides MPFL reconstruction with TTT were included if the data regarding MPFL reconstruction with TTT could be extracted from the published work. Patients receiving an additional lateral release or lateral reticular lengthening procedure were also included. Finally, if the studies met the inclusion criteria, the sample size for each specific graft had to reach a total sample size of 20 or more, or else the studies involving that specific graft were excluded due to the paucity of data.

Exclusion criteria for this systematic review were as follows: review articles, case reports, editorials, surgical techniques, epidemiological reports, anatomical studies, biomechanical studies, radiological studies, articles without MPFL reconstruction with TTT ± lateral release, articles involving patients with prior patellofemoral realignment surgery, and articles in which the outcome data on patients receiving MPFL reconstruction with concomitant TTT ± lateral release was not discernible. Studies reporting on the efficacy of MPFL reconstruction in isolation or with TTT ± lateral release with additional procedures, such as trochleoplasty, were excluded.

Articles which did not clearly meet the inclusion or exclusion criteria were presented to the senior author to reach a final consensus on their eligibility.

3. Results

3.1. Article selection

A total of 236 studies were generated from the searched databases after the removal of duplicate studies. On assessment of the abstracts, 197 articles were removed due an inability to meet the inclusion criteria based on the information provided in the abstract. The most common reasons for exclusion were that the studies were review articles, concerned procedures not involving MPFL reconstruction with TTT ± lateral release, or were not written in English. After a full-text assessment of the remaining 39 studies, a total of 8 studies met the inclusion criteria. A further search of the references of the included studies did not yield any additional articles (Fig. 1).

Of the 8 eligible studies, the surgeon graft choices included a gracilis autograft, semitendinosus autograft, and medial retinaculum autograft. The semitendinosus autograft was the most frequently utilized graft amongst the included studies (6/8). It should be noted that Allen et al.[31] reported on one patient who met the inclusion criteria receiving a quadriceps autograft; however, due to the single case report, this data was excluded.

The included studies reported the efficacy of their procedures on a wide array of outcome measures, which included: Tegner activity scale,[40,43] Kujala score,[39] International Knee Documentation Committee (IKDC) functional evaluation form,[40,42] Knee Injury and Osteoarthritis Outcome Score (KOOS),[40] Lysholm score,[40,46] Lille clinical score,[41] visual analog scale (VAS),[44] Turba score,[45] return to sport (RTS), range of motion (ROM), subjective assessment, reoperation rate, postoperative dislocation rate, patellar instability rate, apprehension sign rate,[47] and complication rate (Table 2).

3.2. Patient demographics

A total of 172 patients (183 knees) underwent MPFL reconstruction with TTT. Of these 172 patients receiving the surgical

Table 1
The search query utilized to discover articles in MEDLINE/PubMed, SportDiscus, CINAHL, and Cochrane Central Register of Controlled Trials.

Search Query
((("medial patellofemoral ligament") AND (tubercle OR tuberosity OR fulkerson OR Elmslie-Trillat OR osteotomy OR tubercleplasty)) OR (("mpfl") AND (tubercle OR tuberosity OR Fulkerson OR Elmslie-Trillat OR osteotomy OR tubercleplasty)))

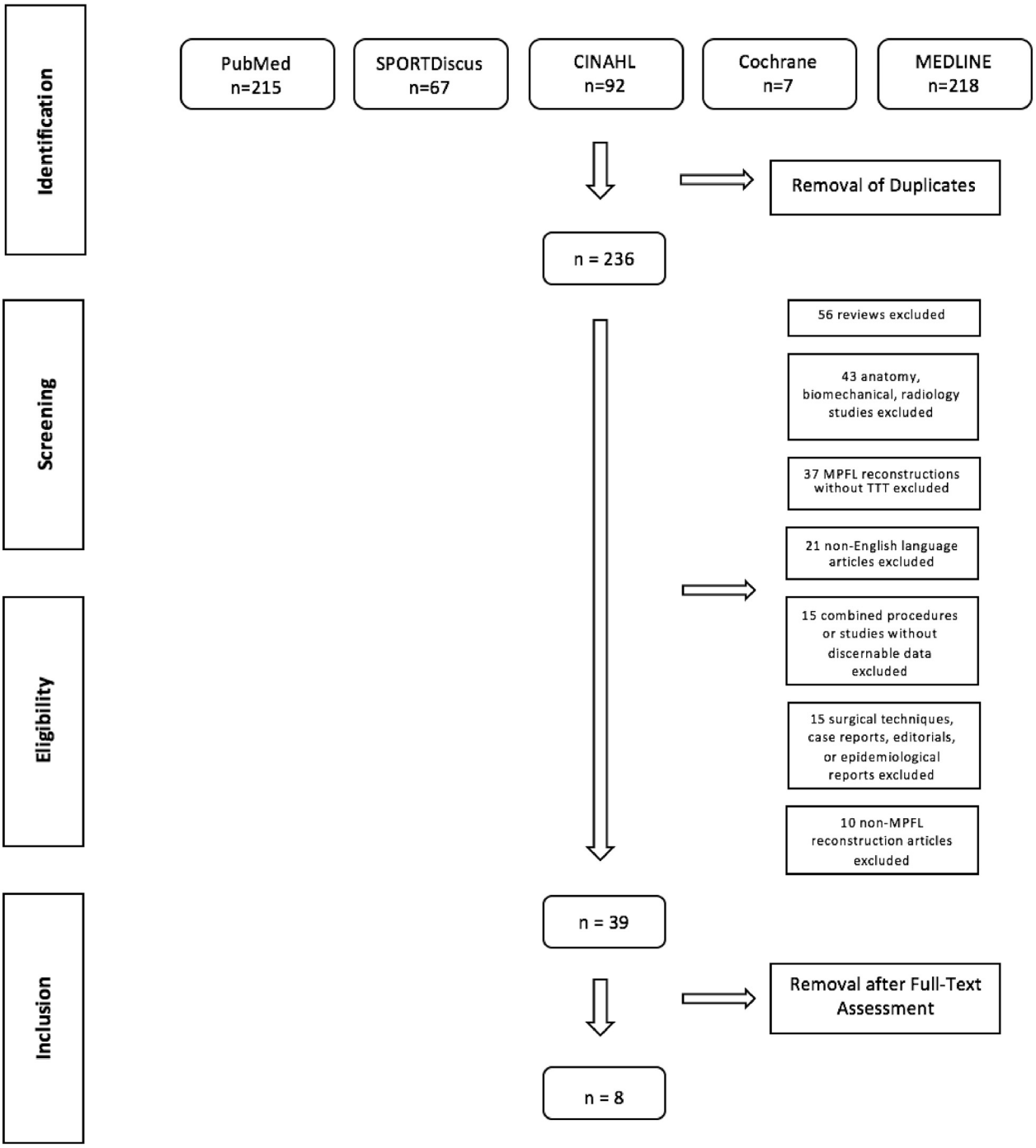

Fig. 1. The flow chart demonstrating the identification, screening, eligibility, and inclusion process.

procedure, 111 patients were of the female sex (64.5%), 55 patients were of the male sex (31.2%), and the sex of the remaining 6 patients could not be determined from the studies (3.5%). The average patient age was approximately 23.9 years, which ranged from 12 to 50 years. The average follow-up was 33.1 months, which ranged from 11 months to 121 months. It should be noted that the female patient percentage and the average patient age could not be determined from the Schottle et al.[33] study, and the mean follow-up time could not be determined from the Schottle et al.[33] and Damasena et al.[37] studies. Thus, these studies did not contribute to the female patient percentage, average patient age, or average follow-up time respectively.

3.3. Indication for surgery

The indication for surgery varied moderately amongst the studies. Allen et al.[31] operated on patients with chronic lateral stability, who had failed non-operative treatment due to MPFL insufficiency, and whom had a TT-TG distance greater than 20 mm. Ahmad et al.[32] operated on patients with atraumatic recurrent patellar dislocations, subluxation sensations, and post-traumatic dislocations, who had failed non-operative treatment with an

Table 2
The demographic and outcome measures of all included studies by graft type.

Gracilis Autograft	
Allen et al.	
Patient Number (n)	9
Knee Number (n)	9
Mean Age, yr (range)	20.4 (15–35)
% Female	44
Tegner	5.5 ± 2.8
Kujala	93.8 ± 9.6
IDKC	89.1 ± 13.8
Return To Sport	yes = 5, N/A = 4
Range of Motion	**0°-100° = 1, 0°-130°/135° =4, 0°/5°-140° = 4**
Redislocation Event(s)	0
Reoperation	2
Complications	2
Follow-Up, mo. (avg., range)	35.8 (23–61)
Semitendinosus Autograft	
Allen et al.	
Patient Number (n)	7
Knee Number (n)	7
Mean Age, yr (range)	23.3 (16–38)
% Female	29
Tegner	5.4 ± 2.4
Kujala	90.9 ± 17.6
IDKC	85.8 ± 18.5
Return To Sport	yes = 4, N/A = 3
Range of Motion	**0°-120° = 1, 0°-130° = 1, 0°-140° = 5**
Redislocation Event(s)	2
Reoperation	3
Complications	1
Follow-Up, mo. (avg., range)	59.7 (29–121)
Chen et al.	
Patient Number (n)	25
Knee Number (n)	29
Mean Age, yr (range)	21.5 (17–28)
% Female	72
Kujala	89.2 ± 4.7
Lysholm	88.5 ± 4.8
Recurrent Instability	0
Complications	1
Follow-Up, mo. (avg., range)	36.8 (25–68)
Moitrel et al.	
Patient Number (n)	26
Knee Number (n)	28
Mean Age, yr (range)	26.6 (15–50)
% Female	62
IDKC	74 ± 17
Lille	82 ± 15
Recurrent Instability	5
Redislocation Events(s)	0
Complications	5
Follow-Up, mo. (avg., range)	24 (12–52)
Medial Retinaculum Autograft	
Cossey and Paterson	
Patient Number (n)	19
Knee Number (n)	21
Mean Age, yr (range)	21 (18–29)
% Female	58
Tegner	6.0 ± 1.1
Lysholm	95.7 ± 3.5
Turba Score	excellent = 11, good = 10
Redislocation/Instability	0
Complications	2
Follow-Up, mo. (avg., range)	23 (11–61)
Ahmad et al.	
Patient Number (n)	15
Knee Number (n)	16
Mean Age, yr (range)	25.7 (16–41)
% Female	67
Tegner	4.9 ± 1.6
Kujala	78.1
KOOS	77.1
Postoperative Instability	0
Subjective Assessment	satisfied = 14, unsatisfied = 1
Complications	3
Follow-Up, mo. (avg., range)	30 (26–55)
Schottle et al.	
Patient Number (n)	6
Knee Number (n)	7
Mean Age, yr (range)	30.1 (19–36)
Kujala	91.6 ± 3.6
Recurrent Instability	0
PostOp Apprehension Sign	1
Subjective Assessment	excellent = 5, good = 2
Follow-Up, mo. (range)	24–70
Franciozi et al.	
Patient Number (n)	48
Knee Number (n)	48
Mean Age, yr	25.2
% Female	75
Tegner	5.2
Kujala	84.4
IDKC	85.5
Return To Sport (of athletes)	yes = 13, no = 3
Recurrent Instability	0
Redislocation Events(s)	0
Complications	7
Follow-Up, mo. (avg., range)	41.5 (24–60)
Damasena et al.	
Patient Number (n)	17
Knee Number (n)	18
Mean Age, yr (range)	21 (12–47)
% Female	82
Tegner	6.25
Kujala	91
Visual Analog Scale	22.5
Return To Sport	yes = 17
Redislocation/Instability	2
Subjective Assessment	excellent = 15, good = 2
Follow-Up, mo.	≥60

abnormal TT-TG distance defined as greater than 18 mm. Schottle et al.[33] performed a MPFL reconstruction with TTT on patients with patellar instability and a TT-TG distance greater than 15 mm. Chen et al.[34] went to surgery for patellar instability and discussed a TT-TG distance greater than 20 mm as abnormal. Franciozi et al.[35] operated on patients with two or more episodes of patellar dislocation and with a positive apprehension test. A TT-TG distance greater than 17 mm was defined as abnormal. Moitrel et al.[36] performed

MPFL reconstruction with TTT if the patient continued to experience patellar instability after 6 months of non-operative treatment and if the TT-TG distance was greater than 20 mm. Damasena et al.[37] went to surgery after three or more lateral dislocation events and the presence of abnormal patellar tracking indicated by a J sign and patellar subluxation in the knee's range of motion. The TT-TG distance defined as abnormal was not mentioned. Finally, Cossey and Paterson[38] operated on patients with symptomatic patellar instability defined by the patella subluxing 3 or more quadrants during the patellar glide test and a positive apprehension sign. Moreover, all patients had failed non-operative treatment.

3.4. Surgical technique

The surgical technique for MPFL graft fixation also varied between the studies. Allen et al.[31] fixated their MPFL gracilis autografts and semitendinosus autografts with a locking whipstitch suture and two suture anchors in a "pants-over-vest fashion" with the knee in 30°, while checking for graft tensioning and patellar tracking. The femoral placement of the graft was reported to be in the depression between the medial epicondyle and adductor tubercle. Ahmad et al.[32] passed the whipstitched MPFL gracilis autograft through a "v-shaped intraosseous tunnel" in the patella to its fixation in the femur under fluoroscopic control. After assessing the MPFL graft isometry and patellar tracking, an interference screw fixated the MPFL graft at its femoral origin. Schottle et al.[33] fixated the MPFL semitendinosus autograft at the patella with two suture anchors and at the adductor tubercle with an interference screw after ensuring the patella was aligned in the trochlear groove throughout the total range of motion at that graft tensioning. Chen et al.[34] reported utilizing the autologous semitendinosus anatomic double bundle method to fixate the MPFL graft. Franciozi et al.[35] fixated the MPFL semitendinosus autograft at the patella with a titanium anchor, and after testing for satisfactory MPFL graft isometry defined by less than 3 mm of patella migration during flexion-extension, the graft was fixated at the femur with a bioabsorbable interference screw at a location 1 cm distal to the adductor tubercle and 1 cm posterior to the medial epicondyle. Moitrel et al.[36] utilized an overlapping suture through two transpatellar tunnels to fixate the MPFL semitendinosus autograft to the patella. With the knee at 30°, the femoral fixation was placed at the location described by Schottle et al.[20] with an interference screw under intraoperative radiological control. Damasena et al.[37] drilled a continuous tunnel from medial-to-anterolateral in the patella, in which they stabilized the MPFL semitendinosus autograft around the patella through this tunnel without any graft fixation. After assessing graft tensioning and patellar tracking, the MPFL graft was fixated in the femur with an interference screw with the knee in full extension. Cossey and Paterson[38] excised a longitudinal strip of the medial retinaculum from the lateral border of the vastus medialis to the level of the anteromedial portal. The medial retinaculum graft was fixated under a pocket of periosteum on the medial epicondyle, and was then fixated on the patella at the MPFL's anatomical insertion site.

3.5. Outcome measures to assess effect of graft choice

The complication rate represented a common outcome metric across all of the studies. The gracilis autograft demonstrated the greatest complication rate, followed by the semitendinosus autograft, and then by the medial retinaculum graft (Fig. 2). No statistical difference was found amongst the complication rates (Chi-Squared Test).[49,50] Knee stiffness represented the most common complication. The gracilis autograft demonstrated the greatest knee stiffness rate, followed by the semitendinosus autograft, and then by the medial retinaculum autograft (Fig. 3). No statistical difference was found in regard to the effect of graft choice on the incidence of knee stiffness.[49,50]

Concerning the gracilis autograft complications, Allen et al.[31] reported one patient experiencing the complication of peroneal neuropraxia which resolved, and another patient experiencing notable pain from the tibial tuberosity hardware. Ahmad et al.[32] described two patients with postoperative knee stiffness that resolved after manipulation under anesthesia, and another patient who developed a nonunion of the tibial tuberosity with a broken screw that required a revision surgery to achieve successful union. Concerning the semitendinosus autograft complications, Allen et al.[31] described one patient with a nondisplaced traverse midpatellar fracture and Chen et al.[34] described a mild skin infection that resolved. Franciozi et al.[35] described one patient with a nondisplaced patellar fracture after a postoperative trauma to the knee, two patients with knee stiffness requiring manipulation under anesthesia, and four patients with tibial tubercle hardware removal due to anterior discomfort. Moitrel et al.[36] reported on four patients with knee stiffness requiring manipulation under anesthesia, and one patient with knee stiffness, which became complicated by a *Staphylococcus epidermidis* infection requiring surgical revision by lavage and antibiotic therapy. Schottle et al.[33] and Damasena et al.[37] did not mention any complications in their work, which was taken for an incidence of no complications. Finally, concerning the medial retinaculum complications, Cossey and Paterson[38] reported one patient with a minor wound infection resolved by oral antibiotics, and another patient with symptoms from the tibial tuberosity bone screw.

The incidence of postoperative instability represented another outcome metric across all of the studies. This measure involved postoperative dislocation events, subluxation events, and positive apprehension signs. The semitendinosus autograft demonstrated the greatest postoperative instability rate, while the gracilis autograft and medial retinaculum autograft demonstrated no cases of postoperative instability (Fig. 2). No statistical difference was found amongst the postoperative instability rates.[49,50]

Knee functional outcome scores represented the final outcome metric shared amongst the included studies. The Kujala score, Lysholm score, International Knee Documentation Committee (IKDC) functional evaluation form, and the Tegner activity scale represented the most overlapping knee functional outcome scores utilized of the included studies, and thus were used to compare the effect of graft choice. These knee functional outcome scores are compared in Fig. 4.

4. Discussion

Our study discovered that patients undergoing MPFL reconstruction with TTT resulted in good overall patient outcomes. The postoperative instability rates and complication rates were low to moderate, which coincides with previous investigations focusing on MPFL reconstruction with TTT.[16,19] The knee assessment outcome scores reached levels of activity and ability in almost all patient cases. Overall, the results of this systematic review indicate that MPFL reconstruction with TTT represents an efficacious procedure for individuals with concomitant MPFL lesions and increased TT-TG distances.

There was great variation in the outcome measures and the follow-up time amongst the studies. However, the two measures that were ascertained from all of the studies were the complication rate and postoperative instability rate, which both represent important ways to evaluate a procedure.[29] While the results of this systematic review are not statistically significant for any of the

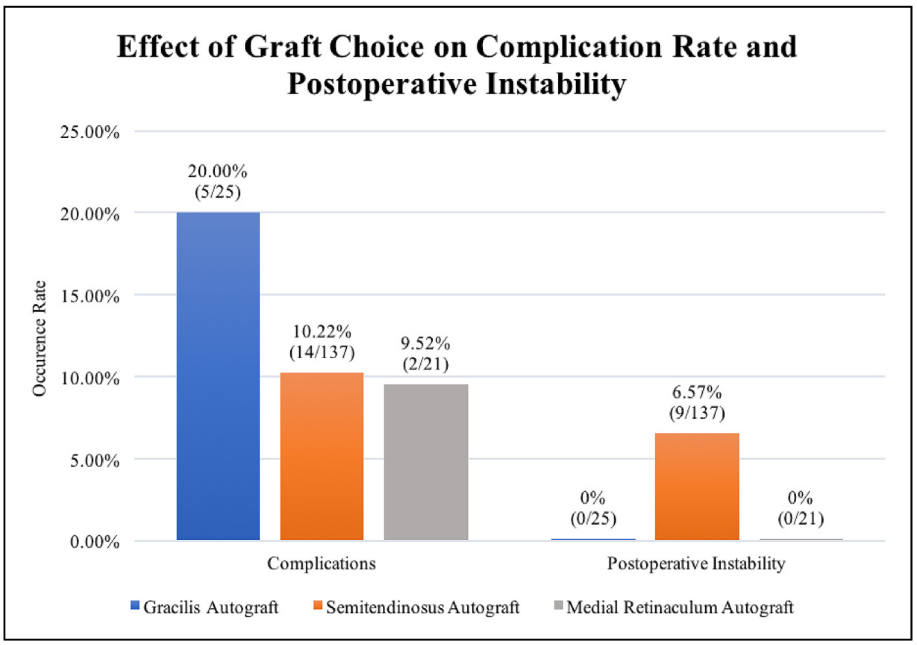

Fig. 2. The effect of graft choice on complication rate and postoperative instability.

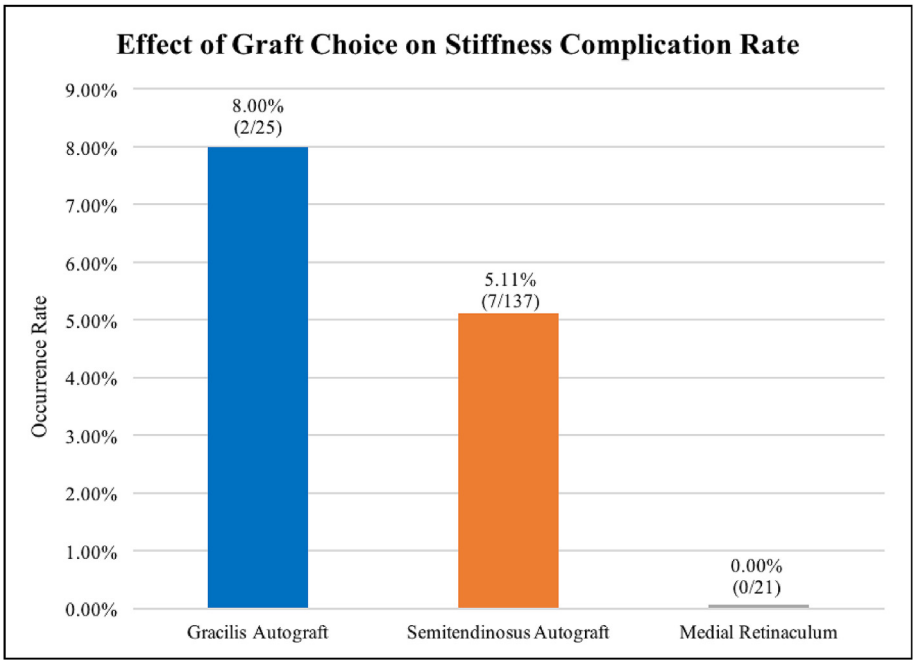

Fig. 3. The effect of graft choice on the complication of stiffness rate.

outcome measures, it serves benefit to speculate why the semitendinosus autograft demonstrated the highest postoperative patellofemoral instability rate, along with seven cases of knee stiffness.

The correct placement of the MPFL graft, especially with respect to the femoral attachment, represents a critical factor in the outcome of procedures involving MPFL reconstruction.[4,20–22] If the femoral attachment is placed too proximally and/or anteriorly, then the ensuing graft tension when the knee enters flexion can lead to medial patellofemoral pressure syndrome, which can present as postoperative pain, cartilage degeneration, and subsequent arthrosis.[21,24] Likewise, a femoral attachment too distal and/or posterior leads to MPFL insufficiency. Another important factor in MPFL reconstruction is to fixate the MPFL graft in proper tension with the knee at lower flexion angles (30°-45°), as lower flexion angles represent the angles at which the MPFL contributes to patellofemoral stability and minimizes the error in femoral tunnel positioning.[25] The reasoning behind correct MPFL graft placement and placement with the knee at 30° reflects the necessity of proper graft tension throughout the full knee range of motion. Patients with good outcome measures despite poorly positioned femoral attachments likely derives from properly tensioned grafts. Therefore, the underlying critical factor in MPFL reconstruction is correct

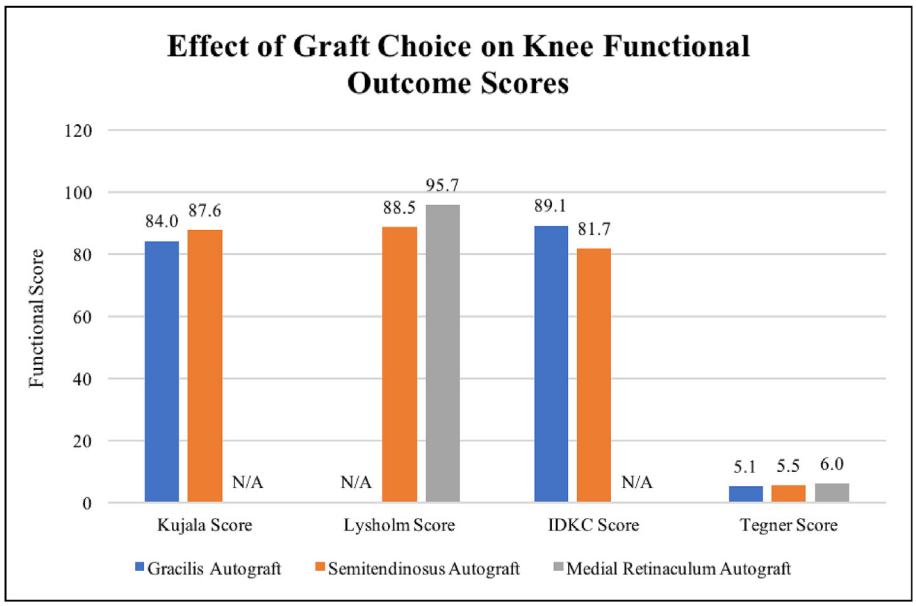

Fig. 4. The effect of graft choice on knee functional outcome scores.

graft tension for the total knee flexion-extension arc.[26]

The major concern of a TTT procedure is the possibility of overmedialization leading to postoperative patellofemoral complications.[23] Like a highly tensioned graft, an overmedialized tibial tubercle increases the contact pressure on the medial patellofemoral joint, which can result in medial patellofemoral pressure syndrome.[3] On the other hand, the less likely scenario of the tibial tubercle not being medialized enough can contribute to postoperative patellofemoral instability. Therefore, a MPFL reconstruction with TTT contains two individual procedures, which if conducted improperly, can both result in medial patellofemoral syndrome or patellofemoral instability.

Of the 9 semitendinosus autograft cases with postoperative patellar instability, 5 came from the Moitrel et al. study,[36] 2 came from the Damasena et al. study,[37] and 2 came from the Allen et al.[31] study. Moitrel et al.[36] describe following the radiographic criteria for proper MPFL femoral attachment during surgery, and setting the MPFL graft tension at 30°. However, Moitrel et al.[36] do not mention any intraoperative checks to ensure proper graft tensioning throughout flexion-extension like other studies have noted. Moitrel et al.[36] designated a TT-TG distance >20 mm as indication for medialization, but they do not report an intraoperative metric for the TTT. On the other hand, Damasena et al.[37] describe checking graft tension and patellar tracking throughout knee flexion-extension before proceeding to fixate the MPFL graft at the femur with the knee in full extension. However, Damasena et al.[37] do not mention any intraoperative technique to ensure proper femoral attachment. Damasena et al.[37] do not mention a designation for an abnormal TT-TG distance, but they do report medializing the tibial tubercle by 8–10 mm. Allen et al. reference a study[51] for their MPFL reconstruction procedure, which states the graft be fixed at 30° knee flexion and that the tension of the graft be intraoperatively checked with a patellar glide test.

In speculation of these studies, there lies a possibility of failing to restore proper patellofemoral biomechanics in the patients who experienced postoperative patellar instability. In the Moitrel et al.[36] study, the absence of checking graft tensioning throughout the flexion-extension increases the likelihood of improper graft tensioning even though the graft was fixated at 30°. Additionally, Moitrel et al.[36] report four complications of knee stiffness requiring manipulation under general anesthesia, which may reflect an increased pressure on the medial patellofemoral joint from an improperly tensioned graft. In both studies, the absence of an intraoperative metric for proper TTT increases the chance of overmedialization.

The ideal reconstruction graft would possess a similar stiffness to that of the native MPFL to best reproduce normal patellofemoral biomechanics in an anatomical MPFL reconstruction with TTT. The MPFL possesses an ultimate load of 208 ± 90 N with a stiffness of 8 N/mm, which is best replicated by the retinaculum, followed by the gracilis autograft, and then by the semitendinosus autograft.[9,48] The semitendinosus tendon possesses a considerably greater stiffness than these other structures.[9] Thus, in the case of an overly tensioned graft, the semitendinosus graft followed by the gracilis graft would theoretically be the first grafts to demonstrate medial patellofemoral syndrome in a MPFL reconstruction with TTT procedure. On the other hand, the medial retinaculum demonstrates the closest stiffness to that of the native MPFL, and the Cossey and Paterson[38] study demonstrates no postoperative patellar instability or complications related to graft placement. In a systematic review on the efficacy of isolated MPFL reconstruction, the quadriceps tendon graft demonstrated the greatest amount of stiffness complications, followed by the semitendinosus and gracilis.[30] Perhaps the potential pitfalls of the MPFL reconstruction and TTT procedures give reason to be more cognizant of graft choice for these procedures. Future research may consider addressing the effect of graft choice on improperly tensioned grafts and overmedialized tibial tubercles.

5. Conclusion

Our systematic review illustrates that MPFL reconstruction with TTT represents an overall efficacious procedure with a low postoperative patellofemoral instability rate, low to moderate complication rate, and improved knee assessment and subjective scores. While no significant differences were found amongst the various grafts, this review highlights how some of the pitfalls in the MPFL reconstruction with TTT procedure that lead to substandard

outcomes may be potentially influenced by graft choice. Graft choice along with intraoperative checks may reduce the amount of substandard outcomes due to these pitfalls.

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Research paper

Conventional versus minimally invasive total hip replacement through the posterior approach

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ABSTRACT

The rationale for minimally invasive surgery (MIS) is to minimize tissue damage in order to reduce blood loss, decrease postoperative pain, shorten hospital stay, and allow for faster rehabilitation. Objectives This study compares the short-term clinical and radiographic outcome between conventional and minimally invasive posterior approaches in total hip arthroplasty. Study Design & Methods We conducted a prospective, comparative pilot study containing 30 patients who underwent primary total hip arthroplasty between January 2017 and May 2017, 15 of them were operated through a conventional posterior approach and the other 15 were operated upon using a minimally invasive posterior approach. The exclusion criteria were severe protrusio or acetabular dysplasia as well as severe obesity (more than 120 kg body weight or a body mass index (BMI) > 40). For all patients, age, gender, indication, body mass index (BMI), preoperative hemoglobin and preoperative assessment using radiology, WOMAC and Harris hip scores were recorded. The patients were informed about the type of their operation. Results:There was a significant difference in the mean operative time ($p < 0.001$),rehabilitation and early return to workand usual activities ($p < 0.001$) in favour of the minimally invasive approach. Furthermore, there was no need for blood transfusion in the MIS group compared to 20% in the conventional group, better cosmetic results in the MIS group (mean scar length was 9.07 compared to 21.67 in the conventional approach) and more incidence of complications with the conventional approach (13.33% as compared to 0% in the MIS group). These differences were statistically highly significant ($p < 0.0001$). No significant differences were seen as regards the clinical outcome at 6 months post-operative (using the WOMAC and Harris hip scores) and the radiological results between in both groups. Conclusions:The minimally invasive posterior approach allows reduced blood loss, reduced operative time, decreased incidence of blood transfusion, faster rehabilitation and earlier return to workin total hip arthroplasty.

1. Introduction

THR has been developed for more than 40 years and most of the clinical practices are standardized for the patient cares. In the past, THA had been done by making a wound about 25 cm in length. Many surgeons believed that big wounds should be the standard approach for THA because the surgery is a big surgery and could only be reliably done with big wounds. In recent 10 years, this concept of “big surgery-big wound” has been challenged in many fields of surgery. Many surgical procedures can now be safely and adequately performed by the minimally invasive (MIS) approaches. The surgical approaches for THA have been adopting the concept of MIS and modified by many surgeons. However, the definition of a MISTHA is not as straight forward as the words meanings.

Based on the incision length, it is generally agreed upon that an incision less than 10 cm can be defined as MISTHA. However the MIS can also be interpreted as less soft tissue trauma or less bone tissue trauma when doing the THA. The incision wound length then is not necessarily equal to the extent of tissue injury during the procedure. To date, the MISTHA can be divided into two categories. One decreases the wound and muscle cutting and emphasizes the tissue repair through either a lateral or a posterior route.[1] The other spares muscle sectioning during the procedure through one,[2] two,[1] or multiple[3] incisions. The bridged incision methods minimize the incision length and can be extensile if difficulties are encountered during THA. The muscle sparing methods use tissue intervals for

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surgery but could be difficult if complications happened intra-operatively. In the literature, the complication rates are significantly higher in inexperienced, low-volume surgeons in the "learning curve" period for the muscle sparing techniques.[4] THA, however, is a reliable procedure and its clinical results should not be compromised by the surgical approaches. For those surgeons who start to learn the procedure, standard surgical approach with bigger wounds is strongly recommended. In the learning curve period of the MIS-THA, the incision should start from a standard length and then gradually reduces its size as the experiences accumulated. To master the MIS-THA surgical techniques, surgeons also need to familiar with the anatomy and different surgical approaches for THA.[5]

2. Methods

We conducted a prospective, comparative study containing 30 patients who underwent primary total hip arthroplasty between January 2017 and May 2017, 15 of them received primary total hip arthroplasty via conventional posterior approach (Fig. 1) and the other 15 patients received primary total hip arthroplasty using mini-invasive posterior approach (Fig. 2). Exclusion criteria were patients with severe protrusio or acetabular dysplasia and patients weighing more than 120 kg or body mass index (BMI) > 40. Patients in both groups received Clinical examination and assessment using Harris hip and WOMAC scores, Full laboratory investigations, Pelvis antero-posterior view, both hips with femur antero-posterior and lateral views. The follow-up period for both groups ranged from 6 to 8 months, Radiological assessment was done immediate post-operative, 3 and 6 months post-operative x-rays, pelvis AP view and hip with femur AP and cross table lateral views, Clinical assessment using Harris hip and WOMAC scores.

3. Results

In the conventional posterior approach group the mean age of the total number of patients was 44 of which 11 were males with mean age of 47.55 years and 4 cases were females with mean age of 34.25 years. In the mini-invasive posterior approach group, the mean age of total number of cases was 74 ± 7.26 showing a highly statistical increase ($P < 0.001$) corresponding mean age of the conventional approach group. 4 cases of this group were males with mean age 71.50 years and 11 cases were females with mean age of 74.33 years.

The mean value of blood Hb level of the conventional approach group pre-operatively was 13.27 ± 1.17 and post-operatively was 11.01 ± 2.13 while in the mini-invasive approach group the mean value of blood Hb level of the conventional approach group pre-operatively was 13.95 ± 0.98 and post-operatively was 11.71 ± 0.82 with no significant difference between the two groups ($P > 0.10–0.20$). The mean blood loss intra-operative in the conventional approach was 470 ± 172.05 ml compared to 373.33 ± 151.51 ml. Although there was an increase in the mean value of blood loss in the conventional group compared to the mini-invasive approach group, however this increase was statistically non-significant ($P > 0.1$). The mean operative time in the conventional approach group was 89.00 ± 15.08 min compared to 64.07 ± 10.79 in the mini-invasive approach group with a high statistical difference ($P < 0.001$). Three cases in the conventional approach group received autologous blood transfusion (each received 1 blood unit post-operative) representing 20% compared to none of the mini-invasive approach. The mean scar length in the conventional approach was 21.67 ± 0.596 cm compared to 9.07 ± 0.998 cm in the mini-invasive group with a high significant difference ($P < 0.0001$). 10 cases developed LLD post-operative representing 66.67% of total number of cases in the conventional approach group compared to 5 cases representing 33.33% of the total number of cases in the mini-invasive group with high statistically significant difference ($P < 0.001$). The mean value post-operative Womac scores were 7.28 ± 3.38 and 7.33 ± 5.49 in the conventional and mini-invasive approaches respectively, with no significant difference in the Womac scores ($P > 0.50$) was found between both groups. The post-operative Harris hip scores were 95.40 ± 2.44 and 96.47 ± 2.85 in the conventional and mini-

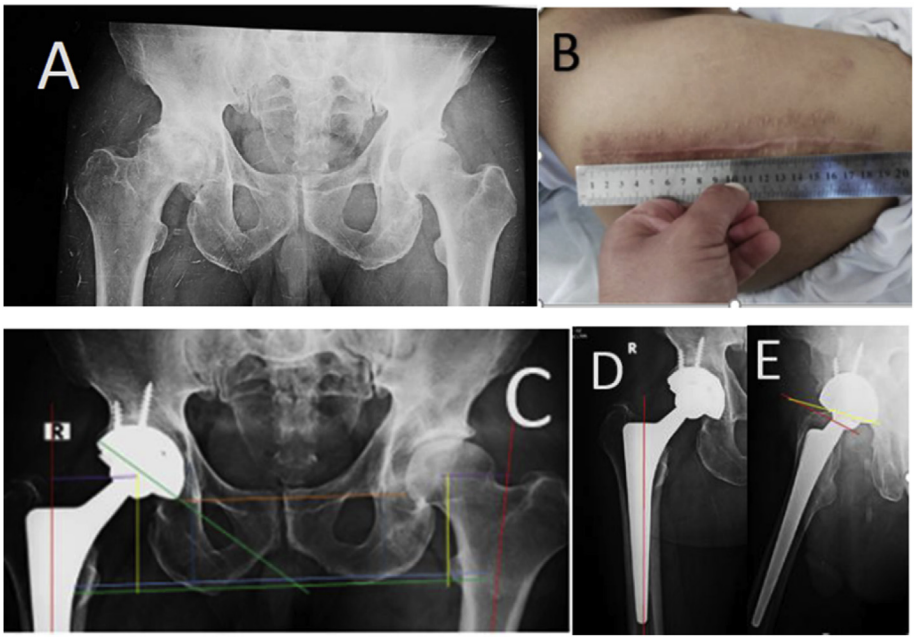

Fig. 1. A 57 years old male THR was done on the RT side using the conventional posterior approach **B**. Scar is about 19 cm **C**. LLD which is less than +0.5 cm on the Rt side, Acetabular cup inclination (abduction angle) about 45° **D**. femur AP view showing nearly neutral alignment of the femoral stem **E**. femur cross table lateral view showing the version of the acetabular cup which is nearly 15° anteversion.

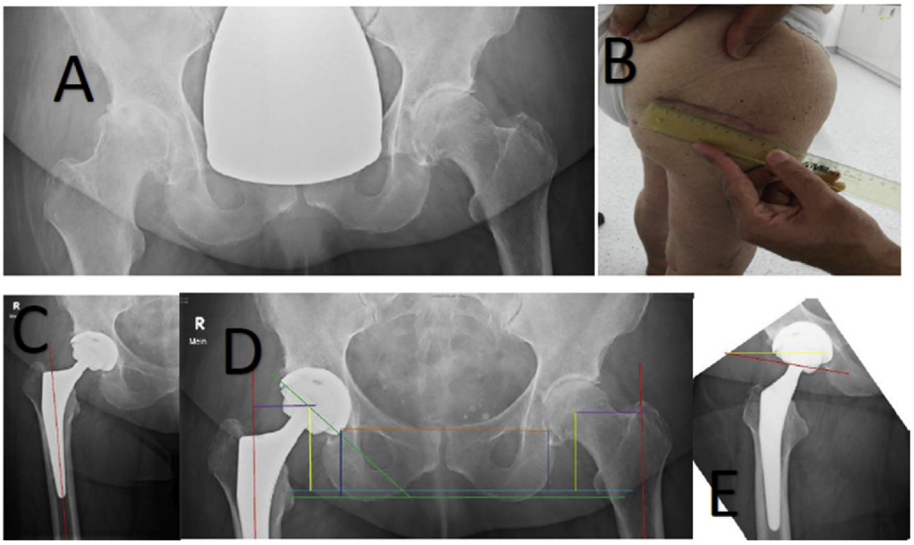

Fig. 2. A Female patient 70 years THR was done on the RT side using the mini-invasive posterior approach **B**. Scar is about 9 cm **C**. LLD is nearly absent, Acetabular cup inclination (abduction angle) about 40° D. femur AP view showing neutral alignment of the femoral stem **E**. femur cross table lateral view showing the version of the acetabular cup which is nearly 15° anteversion.

invasive approaches respectively, with no significant difference in the mean values of the Harris hip score ($P > 0.05–0.50$) was found between both groups. The mean value of time to rehab &return to work in the conventional approach group was 13.80 ± 4.50 weeks compared to 6.53 ± 0.72 weeks in the mini-invasive approach group showing a statistically significant increase **($P < 0.001$)** in the conventional group.2 cases of the total number of the conventional approach group showed complications representing 13.33%, all were operative. No cases in the mini-invasive approach group showed any complications. The mean cup version value in the conventional approach group was 13.33°±5.68° anteversion compared to 14.33°±3.59° anteversion showing no significant difference ($P > 0.5$). The mean value of the cup inclination in the conventional approach group was 44.33°±2.49° compared to 44°±2.71° in the mini-invasive approach group with no statistical difference ($P > 0.5$). Femoral stem neutral alignment was achieved in 13 cases 86.67% in the conventional approach group compared to 14 cases 93.33% of the mini-invasive approach with no statistically significant difference ($P > 0.5$) between both groups. While 2 patients 13.33% had varus mal-alignment of the femoral stem in the conventional approach compared to 1 case 6.67% in the mini-invasive approach with no statistical difference ($P > 0.5$) (Table 1).

4. Discussion

Total hip replacement has become one of the most successful procedures performed today, with predictably excellent and reproducible results.[6] Hozack et al.[7] used the Medical Outcomes Study Short Form–36 to show that primary total hip arthroplasty dramatically enhanced the patient's quality of life. Minimally invasive techniques for total hip arthroplasty (THA) have been introduced in the last several years and are becoming popular. The rationale of a minimally invasive or mini-incision technique is that it is a less intrusive or destructive surgery.[8] We conducted a prospective, comparative study. The study group contained 30 patients who underwent primary total hip arthroplasty between January 2017 and May 2017, 15 of them received primary total hip arthroplasty via conventional posterior approach, the other 15 patients received primary total hip arthroplasty using mini-invasive posterior approach, and the results were compared.

Some authors view a BMI >30 as a contraindication for an MIS approach to hip replacement.[9] Others do not see BMI as an impediment.[10,11] In this study we do not see BMI as an obstacle to mini-invasive THA where the mean value of BMI in the mini-invasive group was 29.49 ± 4.17.

In our study, there was an increase in the mean value of blood loss in the conventional group compared to the mini-invasive approach group, however this increase was statistically non-significant **($P > 0.1$)** (Table 1) in agreement with Woolsen et al.,[12] Sculco et al.,[13] Goldstein et al.,[14] Fink et al.,[15] Wright et al.,[16] and Pavone et al.,.[17] Meanwhile there was significant less blood loss in the mini-invasive posterior approach group in Chung et al.,[6] Chimento et al.,[9] Wenz et al.,[18] Nakamura et al.,[19] Ogonda et al.,[20] and Laffosse et al.,.[21]

The mean operative time in the conventional approach group was 89.00 ± 15.08 min compared to 64.07 ± 10.79 in the mini-invasive approach group with a high statistical difference ($P < 0.001$) between the mean two values in agreement with Sculco et al.,[13] Wenz et al.,[18] and Nakamura et al.,[19] in contrast to Woolsen et al.,[12] Chung et al.,[6]Goldstein et al.,[14] Chimento et al.,[9] Fink et al.,[15] Wright et al.,[16] and Laffosse et al.,[21] who all reported no significant difference between the conventional and mini-invasive approaches.

The mean scar length in the conventional approach was 21.67 ± 0.596 cm compared to 9.07 ± 0.998 cm in the mini-invasive group ($P < 0.0001$). Nakamura et al.,[19] reported the mean scar length in the conventional group was 18 cm (range 15–20) and 10.3 cm (range 9–13) in the mini invasive approach, Chung et al.,[6] reported the mean scar length in the conventional group was 20 cm (15–28) compared to 9.2 cm (6–11) in the mini invasive approach and Laffosse et al.,[21] reported the mean scar length in the conventional group was 15 cm (11–25) compared to 8.5 cm (6–10) in the mini invasive approach. So mini-invasive approach showed better cosmetic results.

The mean value of the LLD in the conventional approach group was found to be 1 ± 0.387 compared to 0.8 ± 0.245 in the mini-invasive approach group, however, the difference between the two means was statistically non-significant ($P > 0.10$). Fink et al.,[15] reported LLD 0.6 ± 2.7 in the conventional approach group compared to 0.4 ± 1.2 in the mini-invasive approach group with

Table 1
Comparison between the conventional and minimal invasive groups.

	Conventional	Minimal invasive	P value	
Side distribution	RT:LT 11:4	9:6		
Sex distribution:	Male: female 11:4	4:11		
Age distribution:	44 ± 14.43	74 ± 7.26	**(*P* < 0.001)**	
Body mass index	26.53 ± 2.72	29.49 ± 4.17	**(*P* > 0.05)**	
The blood hemoglobin (Hb) levels	13.27 ± 1.17 and post-operatively was 11.01 ± 2.13	13.95 ± 0.98 and post-operatively was 11.71 ± 0.82	***P* > 0.10** **−0.20**	
operative time	89.00 ± 15.08	64.07 ± 10.79	**(*P* < 0.001)**	significant difference
Blood loss	470 ± 172.05	373.33 ± 151.51	**(*P* > 0.1)**	
Scar length	21.67 ± 0.596	9.07 ± 0.998	**(*P* < 0.0001)**	significant difference
Limb length discrepancy	1 ± 0.387	0.8 ± 0.245	**(*P* > 0.10)**	
Womac score	preoperative 74.87 ± 5.52 Postoperative 7.28 ± 3.38	74.92 ± 14.58 7.33 ± 5.49	**(*P* > 0.5)** **(*P* > 0.5)**	
Harris hip score	preoperative 27.13 ± 6.49 postoperative 95.40 ± 2.44	32.47 ± 9.29 96.47 ± 2.85	**(*P* > 0.05)** **(*P* > 0.5)**	
Time to rehab &return to work	13.80 ± 4.50 weeks	6.53 ± 0.72 weeks	**(*P* < 0.001)**	significant difference
Complications	2	0		
Acet. cup version	13.33 ± 5.68	14.33°±3.59°	**(*P* > 0.5)**	
Acet. cup inclination	44.33°	44°	**(*P* > 0.5)**	
stem alignment	neutral in 13 varus in 2	neutral in 14 varus in 1	**(*P* > 0.5)** **P < 0.02**	

also statistically non-significant difference between both groups ($P = 0.581$).

The mean value in the conventional approach group was 13.80 ± 4.50 compared to 6.53 ± 0.72 in the mini-invasive approach group showing significant difference ($P < 0.001$) between both groups denoting faster rehabilitation and early return to work after mini-invasive hip replacement in agreement with Sculco et al.,[13] Chung et al.,[6], Chimento et al.,[9] Fink et al.,[15] Laffosse et al.,[21], DiGioia et al.[22]

But these results are in contrast to Woolson et al.,[6] Ogonda et al.,[19] Nakamura et al.,[18] and Bennett et al.,[23] who found no significant advantage to the minimally invasive posterior approach in terms of early functional results.

No significant differences in the WOMAC scores **(*P* > 0.50)** and Harris hip scores **(*P* > 0.05–0.50)** were found between both groups whether pre- or postoperatively showing no significant advantage to the minimally invasive posterior approach in terms of late functional and clinical results in agreement with Chung et al.,[6] Chimento et al.,[9] Fink et al.,[15] Laffosse et al.,[21] DiGioia et al.[22] who all reported faster rehabilitation, better earlier functional outcome and lower prevalence of limp but these become similar at 6 months postoperative like our study.

Also, these results are in agreement with Woolson et al.,[12] Ogonda et al.,[20] Nakamura et al.,[19] and Bennett et al.,[23] who also found no significant advantage to the minimally invasive posterior approach in terms of late clinical results but they showed also no significant difference in terms of early clinical results in contrast to our study.

In this study, two cases (13.33%) in the conventional approach group showed intraoperative complications while no patient in the mini-invasive group developed intra-operative complications showing a higher incidence of intra-operative complications in the conventional group.

No cases in both groups developed early or late postoperative complications. Meanwhile Sculco et al.,[13] Chung et al.,[6] Goldstein et al.,[14] Fink et al.,[15] Wright et al.,[16] Wenz et al.,[18] Nakamura et al.,[19] Ogonda et al.,[20] and Laffosse et al.,[21] reported no significant difference in the complications rates between both groups.

A meta-analysis[24] containing 9 studies comparing between the conventional and the mini-invasive posterior approach reported no significant differences between the two groups with respect to complications.

Meanwhile some authors like BAL Et Al.,[25] have recently reported increased complications rates during minimally invasive procedures but these for the most part involve the dual-incision technique.

5. Conclusion

The mini-invasive posterior approach is a reliable approach where satisfactory and reproducible implant positioning is provided. Its advantages are reduced bleeding, reduced operative time, decreased incidence of blood transfusion, faster rehabilitation and earlier return to work.

Declaration of competing interest

None of the authors has any potential financial conflict of interest related to this manuscript.

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Case report

Osteochondritis of distal femoral condyle due to tension band wiring of patella: A case report☆,☆☆,☆☆☆

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1. Introduction

Patellar fractures constitute about 1% of all skeletal injuries and are most prevalent within the age group of 20–50 years.[1] Operative treatment is recommended for displaced patellar fractures to restore the continuity of the extensor mechanism of the knee and to anatomically reduce the patellar articular surface.[2] Tension-band wiring using AO principles has been the gold standard, although several other techniques involving combinations of K-wires, screws, and cerclage wiring have been reported.[3,4] The tension-band construct, which is designed to convert anterior tension forces to compressive forces at the articular surface. Complications associated with tension band wiring have been up to 15% of cases and include; infection, non-union, arthrofibrosis, post-traumatic arthritis, symptomatic hardware and extensor mechanism insufficiency.[5]

There is paucity of literature on natural course of patellar fractures post tension band fixation. There have been a few studies on diagnostic arthroscopy before implant removal in patella fractures, but did not have enough cases or sufficient follow-up to highlight the natural history.

We report an unusual complication of osteochondritis of distal femoral condyle due to direct effect of tension band fixation of patella fracture.

1.1. Case report

A 42 year old man presented to our clinic with complaints of pain and swelling in his right knee since 3 months, with history of fracture patella on the same side. He had a road side accident resulting in direct fall to his right knee for which open reduction and tension band wiring was done 1 yr back in some private hospital. He was immobilised on cylindrical cast in extension for 6 weeks followed by full weight bearing ambulation at 12 weeks. He had mild anterior knee pain since he started weight bearing which aggravated in the past 3 months.

On examination, right knee had mild swelling with healthy midline surgical scar. Local temperature was slightly raised and there was generalised tenderness in the right knee with doughy

☆ The work has primarily been carried out at the Department of Orthopaedics, Maulana Azad Medical College and Lok Nayak Hospital, New Delhi, India.

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☆☆☆ A written informed consent was obtained from the patient authorizing radiological examination, photographic documentation and surgery. He was also informed that the data concerning the case would be submitted for publication and he consented.

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feel along the medial joint line. Extensor lag of 10° was present with painful terminal movements. Patellar grind test was positive with no valgus/varus instability.

Radiological examination was suggestive of united fracture patella with patello-femoral arthritis with tension band wiring in situ (intra-articular 'circlage' wire).

The patient was planned for diagnostic arthroscopy, debridement and implant removal.

Arthroscopic evaluation revealed synovial hypertrophy with grade 4 osteochondral defect (1 × 3) mm^2 in medial femoral condyle and grade 2 cartilaginous degenerative changes in patellofemoral joint. (see Fig. 1-3)

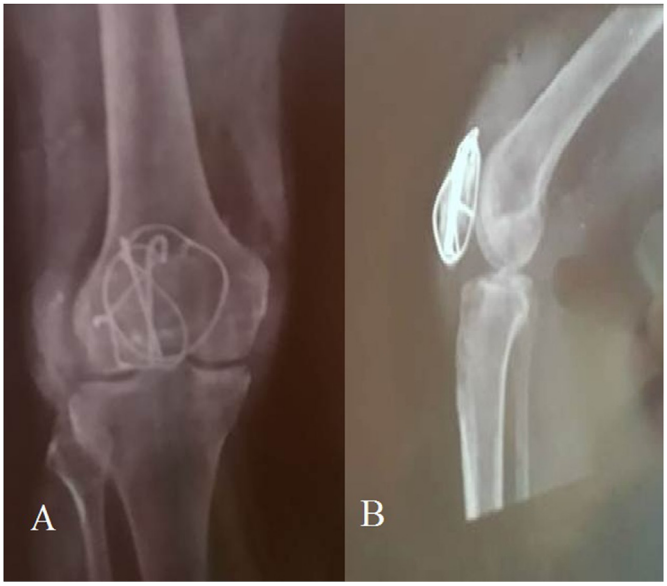

Fig. 1. Antero-posterior and lateral plain radiographs showing united fracture patella with tension band and encirclage wire (intra-articular) in situ.

Arthroscopic debridement with partial synoviectomy followed by tension band wire removal was done. Arthroscopic chondroplasty using radiofrequency probe was performed at the margins of osteochondral defect and eburnation of the cartilaginous irregularities at the patellofemoral joints. Microfracture awl was used to augment chondral healing at the defect site. Synovial biopsy and synovial fluid was sent for histopathological and microbiological examination.

Synovial biopsy was suggestive of acute on chronic synovitis, while synovial fluid cultures revealed no growth after 48 hrs of incubation at 37 °C.

The patient was followed up to 24 weeks and majority of his chronic symptoms had resolved by 8th week.

2. Discussion

The goal in treating patellar fractures is to restore the continuity of the extensor mechanism and to anatomically reduce the joint surface.[4] Although patella accounts 1% of all fractures but their functional outcomes remain largely ignored in literature. This case report presents an unreported complication and highlights that symptoms can remain following primary fixation of patella fracture which are accepted either by the patient or the treating centre and are not investigated further.

The development of patellofemoral osteoarthritis after fracture of the patella is reported in approximately 8.5% of cases.[5] The initial injury-related damage to the articular cartilage is advocated to be the determining factor leading to degenerative changes. Articular incongruity is another leading cause of post-traumatic arthritis of the patellofemoral joint.[5,6] Boström et al. noted that the development of osteoarthritis depends on the initial cartilage damage in first place and second to the quality of reduction. He was able to show that a step in the articular cartilage of more than 1 mm leads to higher rates of posttraumatic osteoarthritis.[2] Halkar et al. concluded that considerable information can be achieved by

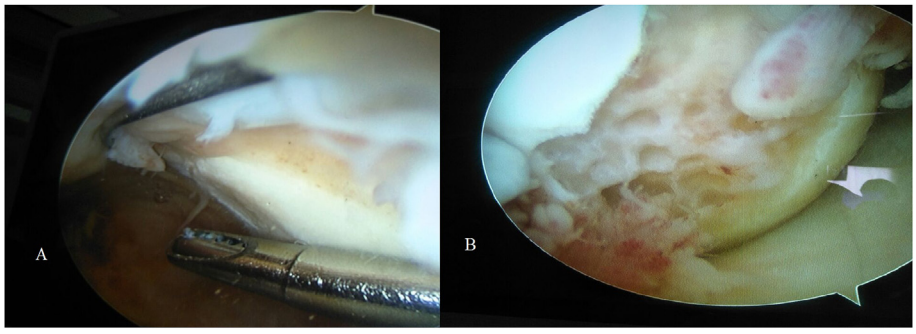

Fig. 2. Arthroscopic evaluation revealed intra-articular encirclage wire with synovial hypertrophy and grade 4 osteochondral defect (1 × 3mm^2) at the medial femoral condyle.

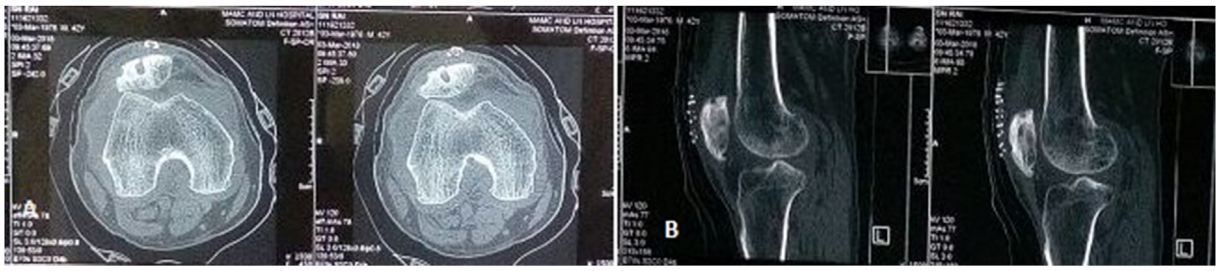

Fig. 3. NCCT right knee (axial and sagittal cuts) showing patello-femoral arthritic changes with united fracture patella and osteochondral defect in medial femoral condyle.

arthroscopy performed at the time of implant removal surgery in patella fractures. Their observation showed that healing of the fracture line and cartilage did not correlate with clinical and radiological evaluation.[5]

In our case the cause of patellofemoral arthritis may be attributed to the inta-articular circlage wire which might have caused grinding at the patellofemoral surface. The grade 4 osteochondral defect at the medial femoral condyle may be attributed to direct injury to knee caused by the fracture fragment of patella which might have driven into the medial femoral condyle at the time of primary trauma which was missed initially.

Conclusion: Seemigly simple tension band wiring of patellar fractures can lead to the aforementioned complication if the surgical technique is not performed aptly. This report also highlights the fundamental importance of standardised post operative imaging follow-up protocol and the importance of diagnostic arthroscopy in all patellar fractures fixed using contemporary fixation modalities to delineate their natural history.

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Case report

Isolated subscapularis pyogenic myositis in a young healthy adult

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ABSTRACT

Pyogenic myositis is a rare primary bacterial infection involving the deep skeletal muscles.[1] It most commonly occurs secondary to combination of muscle damage (e.g., due to intense exercise or local trauma) and a transient bacteremia.[2] The causative organism is usually *Staphylococcus aureus*.[2] Though any skeletal muscle can be involved, muscles around hip and large muscles of the lower extremities are commonly affected.[3] We report an unusual case of an isolated subscapularis pyomyositis in a young immunocompetent adult.

1. Case presentation

A 25-year old otherwise healthy male patient reported to our outpatient with complaints of sudden onset pain in his right shoulder region and an inability to raise the affected shoulder. He did not report any history of trauma or any constitutional symptoms. There was no family history of diabetes, malignancy or immunodeficiency. Active and passive shoulder movements in the plane of overhead abduction, external rotation and internal rotation were painful and restricted (Fig. 1). There was no local tenderness around the shoulder joint, no local rise of temperature, elbow and wrist movements were preserved and there was no distal neurovascular deficit. The cuff assessment tests were painful and the patient could not maintain the starting positions against resistance for the same. Considering no history of trauma and constitutional symptoms-axillary nerve palsy, brachial plexus neuritis or stingers were kept as differentials.

Keeping the above differentials in the mind, the patient was initially prescribed analgesics, pregabalin, B-complex vitamins and asked to follow-up after 7 days but the patient reported back after 2 days with no relief in symptoms.

Hemogram was ordered which revealed a raised total WBC count with increased neutrophil differential along with raised ESR and CRP. The blood glucose and a liver function test were within normal limits (Fig. 2). Shoulder radiographs were unremarkable.

A MRI of the right shoulder was performed which revealed edema with a local collection in the subscapularis muscle belly suggestive of an infective etiology (Fig. 3). A percutaneous ultrasound guided aspiration was performed and sent for bacteriological analysis, which came back as a growth of *S. aureus* (Fig. 2).

The patient was started on oral clindamycin 300 mg thrice daily for six weeks, based on sensitivity testing. He was reviewed after 2 weeks, when he reported good pain relief and demonstrated functional use of his shoulder. He could perform overhead abduction, forward flexion with mild terminal restriction of external rotation.

At 6 weeks follow-up, a repeat MRI of his shoulder showed subtle muscle edema along with complete resolution of the local collection in the subscapularis muscle belly (Fig. 3). The ESR, CRP and total counts were back to normal range.

The patient was afebrile and completely pain-free. He could perform comparable shoulder movements actively on both sides and had returned to his work without any difficulty (Fig. 4).

The patient was reviewed at 3 months and 6 months period; he had no shoulder pain, demonstrated comparable shoulder strength/range of motion, remained afebrile and could perform all his activities of daily living without any discomfort.

2. Discussion

Pyogenic myositis is a rare primary bacterial infection involving the deep skeletal muscles.[1] It most commonly occurs secondary to combination of muscle damage (e.g., due to intense exercise or local trauma) and a transient bacteremia.[2] The causative organism is usually Staphylococcus aureus.[2] Though any skeletal muscle can be

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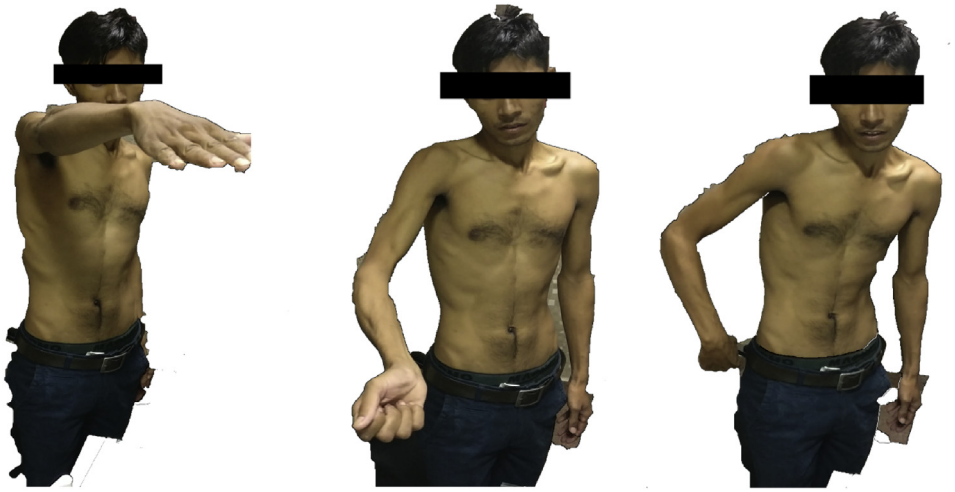

Fig. 1. Decreased forward flexion and rotations on presentation.

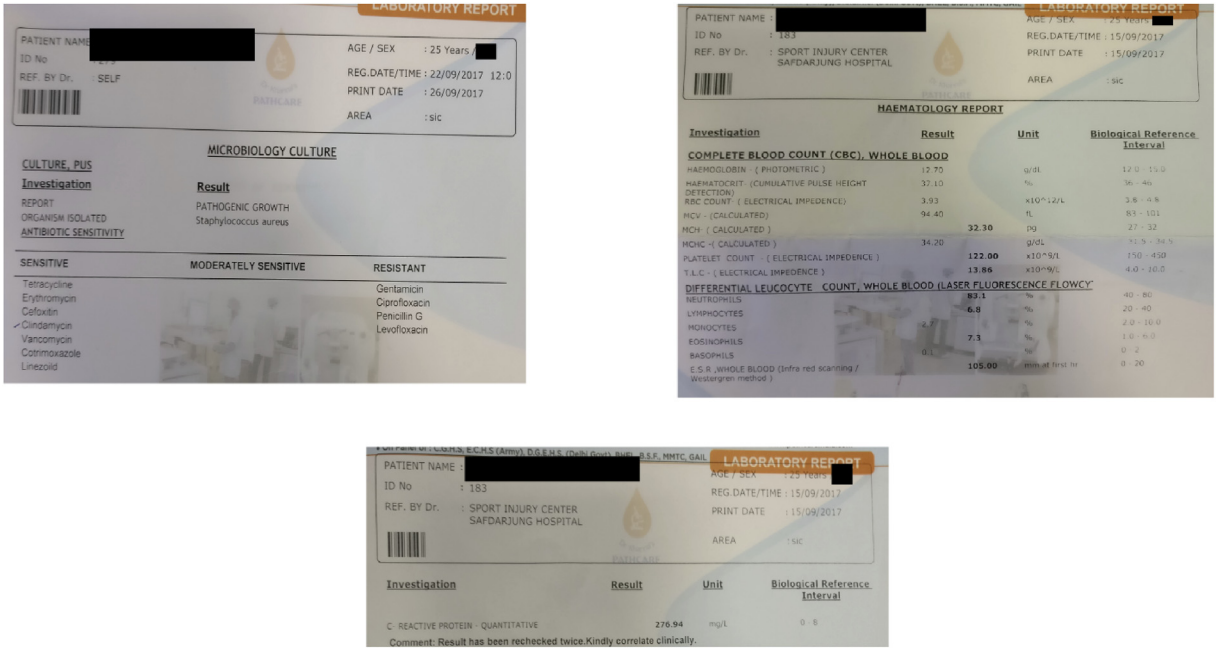

Fig. 2. Hemogram and Culture report of the patient.

involved, muscles around hip and large muscles of the lower extremities are commonly affected.[3]

Pyomyositis was first described in 1885 by Scriba, as an endemic disease in the tropics. Predisposing conditions includes recent history of trauma, skin infection, intramuscular injection, diabetes mellitus, strenuous exercise, HIV infection, and immunodeficiency.[4] MRI is considered the imaging modality of choice for the diagnosis of pyomyositis.[5] There is limited literature describing this condition in the subscapularis muscle. A Pubmed, Embase, Medline search with "subscapularis pyomyositis" revealed only 2 reports of isolated shoulder girdle involvement with either simultaneous involvement of infraspinatus[6] and teres minor muscle.[7]

Shashikiran et al. described a case of infraspinatus and subscapularis *Staphylococcus* pyomyositis in an 11-year old female, suspected secondary to a transient bacteremia, which was managed favourably with intravenous antibiotics.[6] McElnay et al. reported a recurring *Fusobacterium* pyomyositis of the subscapularis and teres minor in a 56-year old male, probably secondary to a complication of Lemierre's syndrome (an infective thrombophlebitits of internal jugular vein), managed with intravenous antibiotics and multiple surgical debridements.[7] Wolf et al. reported a case of *Fusobacterium* pyomyositis of the infraspinatus muscle alongwith septic arthritis of the shoulder in a young male; which was preceded by tonsillitis.[8] Our case did not report any preceding constitutional symptoms or sore throat complaints.

Most cases of classic Lemierre's syndrome occur in young, otherwise healthy, adults, ages 16–23 years, with a propensity for development among males.[9] Fusobacterium spp. infections have also been increasingly reported as a cause of opportunistic infections among immunocompromised hosts and patients undergoing surgery.[10]

In our case; the initial differential of axillary nerve palsy was excluded as the patient had comparable axillary dermatomes on both sides, could demonstrate isometric deltoid contractions

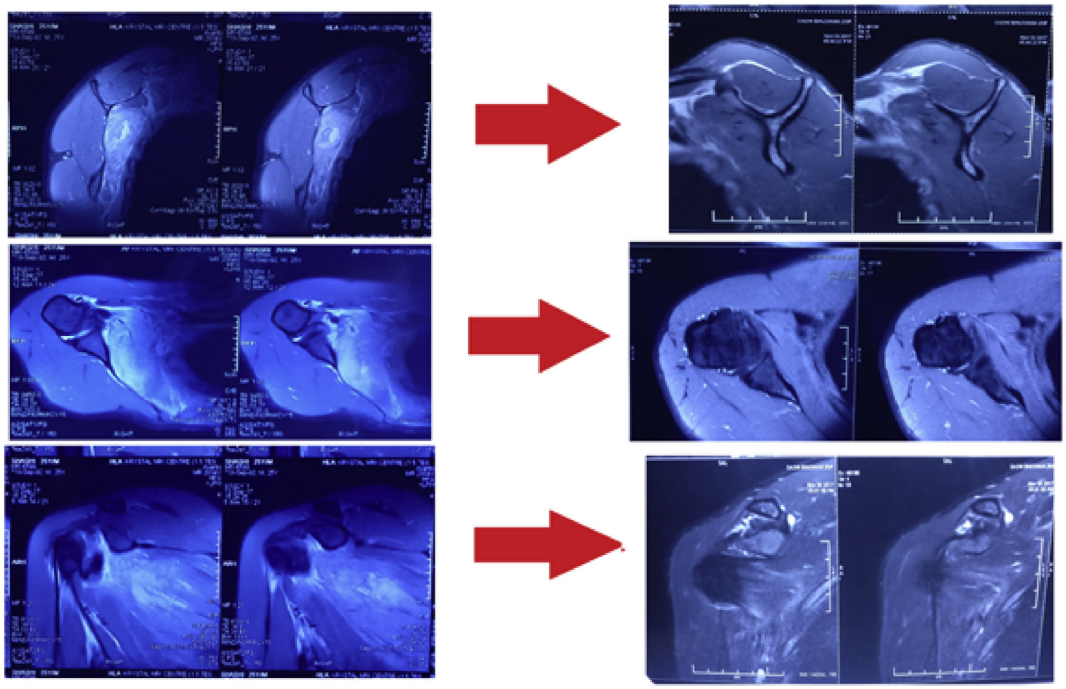

Fig. 3. Pre-treatment and Post-treatment MRI showing decreasing muscle edema with resolution of local collection in subscapularis muscle belly.

Fig. 4. Clinical Improvement in Flexion and Rotations after 6 weeks antibiotic course.

voluntarily and could maintain position of shoulder abduction when bought passively in that position. Brachial plexus neuritis was also ruled out as patient had preserved elbow, wrist and hand function. No history of trauma also ruled out stingers as a possible cause.

Jagernauth et al.[11] have reported a rare case of subscapularis pyomyositis which was managed with surgical drainage. We believe this to be the second reported case in the English literature of an isolated pyogenic myositis of the subscapularis muscle. The case is also unique as it occurred in a young healthy adult and was favourably managed with oral antibiotics with a good clinical outcome.

3. Conclusion

Whilst uncommon, a differential of pyogenic myositis should be

kept in patients presenting with sudden onset non traumatic severe pain with inability of shoulder movements as early diagnosis and management can achieve satisfactory clinical outcomes.

Declaration of competing interest

Nil.

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Case report

Synovial chondromatosis of ankle and it's arthroscopic management: A case report and review of literature

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ABSTRACT

Synovial chondromatosis is a rare joint disorder characterized by cartilaginous metaplasia originating from synovial membrane of joints, bursae or sheaths of the tendons. It is a benign disorder with potential for malignant transformation. Synovial chondromatosis is mostly seen in knee and hip joints and is rarely seen in the ankle joint. Traditionally, treatment has been open surgery with excision of loose bodies and synovectomy. We present case of a 27 year old male with synovial chondromatosis of ankle who had successful outcome after arthroscopic excision and synovectomy without any recurrence and malignant transformation. This case demonstrates the efficacy and reliability of arthroscopic loose body excision to treat synovial chondromatosis of ankle along with potential benefit over open excision.

1. Introduction

Synovial chondromatosis is a synovial proliferative disease involving cartilaginous or osteocartilaginous metaplasia that occurs within the synovial membrane of joints, bursae or tendon sheaths.[1] Although the etiology is unknown; trauma, infection, repeated stress and embryonic remnants have been proposed to play a role.[2] Synovial chondromatosis is most common in males in third to fourth decade of the life. Most commonly involved joints are knee and hip with smaller joints being involved rarely.[1,3,4] Synovial chondromatosis of ankle is exceedingly rare. Patients present with pain and swelling around ankle with limitation of movements. Clinical examination reveals effusion, crepitus and diffuse tenderness.

The disease is classified into three phases according to Milgram[5]: the early phase characterized with synovial chondrometaplasia but no loose bodies, the transitional phase with active synovial disease and loose bodies and the late phase with loose bodies and no synovial disease.

Traditionally, synovial chondromatosis of ankle has been managed with open excision of loose bodies and synovectomy.[6,7] With better understanding of the anatomy and better instrumentation, arthroscopic treatment of ankle pathologies is gaining wider acceptance. It has many potential benefits like better visualization of the joint, lesser morbidity, early rehabilitation and quick recovery.[8]

In this case report, we presented a case of anteriorly localized synovial chondromatosis of left ankle managed arthroscopically and discussed the potential merits of arthroscopic management. Prior informed consent was obtained from the patient to utilize the data of the case for research purposes.

2. Case presentation

A 28 years old male working as a resident in the surgery department presented to us with pain and swelling in his left ankle since 1 year. His job involved standing for long durations. He had progressive pain and mild limitation of movements at the ankle over the period of one year. He had no history of trauma, infection, any systemic inflammatory disease or any family history of bone and joint disorder. On physical examination, his left ankle revealed mild tenderness on anterior aspect on palpation along with palpable loose bodies. The pain increased on dorsiflexion of the ankle. The ankle showed no signs of instability. On radiological analysis, multiple nodules with calcification were located on anterior aspect of the left ankle. Magnetic resonance imaging (MRI) revealed calcified well circumscribed nodules in the anterior aspect of the left ankle (Figs. 1–2). The laboratory tests were found to be within normal limits. The patient was diagnosed as a case of synovial chondromatosis of the ankle causing secondary

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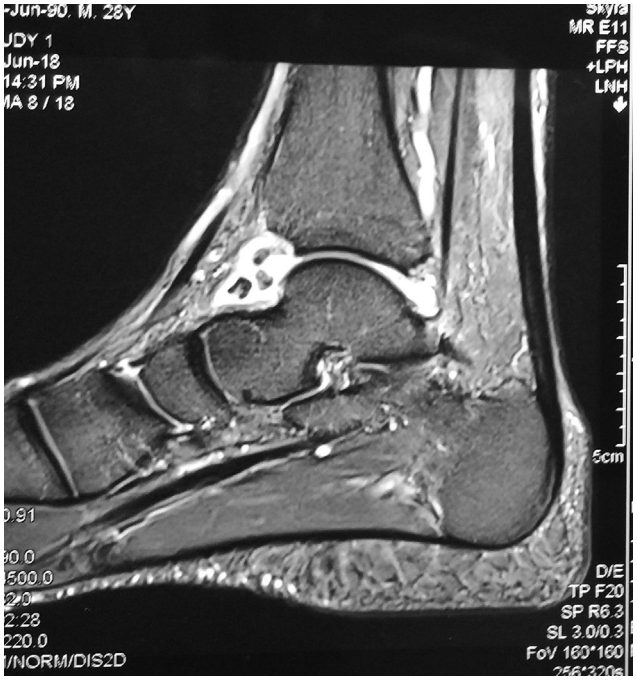

Fig. 1. MRI of the left ankle – sagittal view depicting calcified cartilaginous nodules in the anterior aspect of the joint.

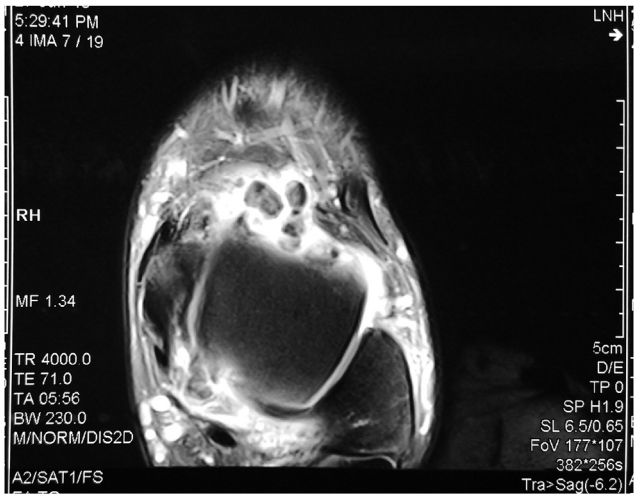

Fig. 2. MRI of the left ankle – axial view.

impingement and was planned for arthroscopic evaluation and loose body removal along with synovectomy.

The patient was given spinal anaesthesia and a tourniquet was applied. Standard anteromedial and anterolateral arthroscopic portals were made to access the ankle joint. On arthroscopic evaluation, multiple loose bodies (Fig. 3) and hypertrophic synovium

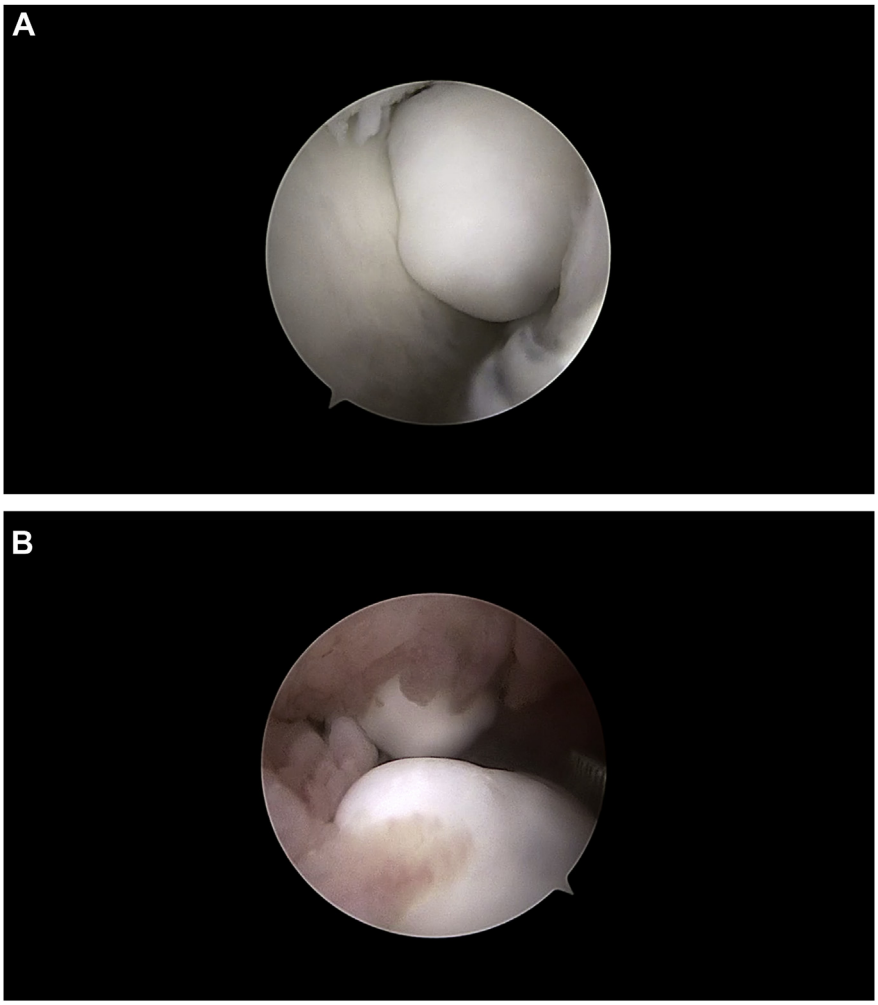

Fig. 3. (a,b) Arthroscopic view of the ankle joint with loose bodies.

(Fig. 4) were found. The cartilage over the talus and tibial side of the joint was found to be normal. Arthroscopic loose body excision and partial synovectomy was performed (Figs. 5–6). The portals were closed primarily without drain. A compression bandage was applied. Active and passive movements were allowed from the first post operative day. Patient was allowed partial weight bearing and by two weeks he was allowed full weight bearing ambulation. Histopathological examination confirmed the diagnosis of synovial chondromatosis with cartilaginous nodule proliferation (Fig. 7).

The patient's plantar flexion and dorsiflexion improved in the post operative period. Patient reported no complications in the follow up period up to 1 year and had no recurrence clinically and radiologically.

3. Literature review and discussion

Synovial chondromatosis is a condition associated with metaplastic changes in synovial lining of joint, tendon or bursa which results in multiple cartilaginous nodules in the joint.[1] The disease most commonly occurs in males within age group of 20–40 years. Most common symptoms are pain and swelling along with limitations of the range of motion across the joint. Knee is the most commonly involved joint followed by hip and other joints.[3,4] The calcified nodules can be detected on anteroposterior and lateral xray images. MRI helps in early identification of the disease. Differential diagnosis include osteocartilaginous loose bodies (post traumatic), periosteal chondroma and tenosynovial giant cell tumour.[13]

Synovial chondromatosis of ankle is an exceedingly rare entity with very few published reports in literature. Isolated cases of ankle synovial chondromatosis have been reported by Pathak,[9] Ozyurek[10] and Ozmeric.[11] These cases were treated with either open or arthroscopic excision. Galat reported the largest case series of patients with foot and ankle synovial chondromatosis in 2008.[7] In this study 8 patients underwent synovectomy and excision of the loose bodies. Over a follow up of 9 years, 4 patients remained asymptomatic without any recurrence. One patient had midfoot arthrodesis following degenerative changes. 3 patients underwent below knee amputation, one for multiple recurrences and two for malignant transformation to low grade chondrosarcoma. This report suggests that ankle synovial chondromatosis has a potential of leading to degenerative changes in the joint and also malignant

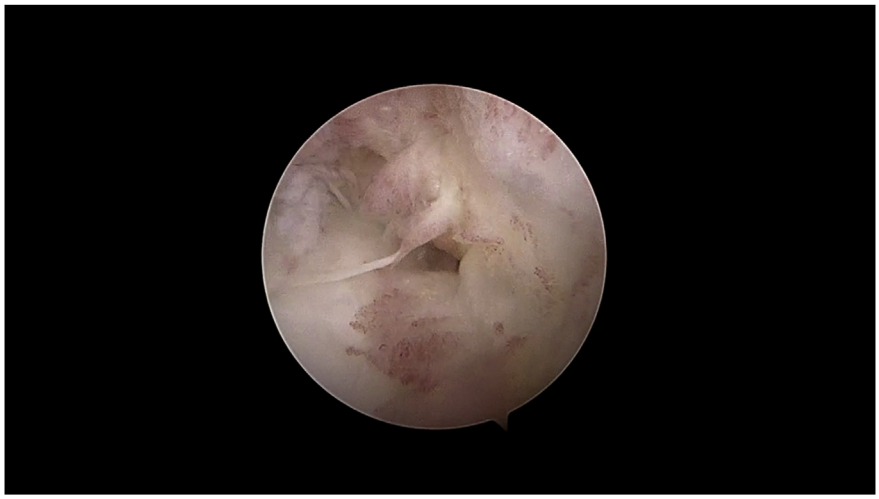

Fig. 4. Synovitis inside the ankle joint.

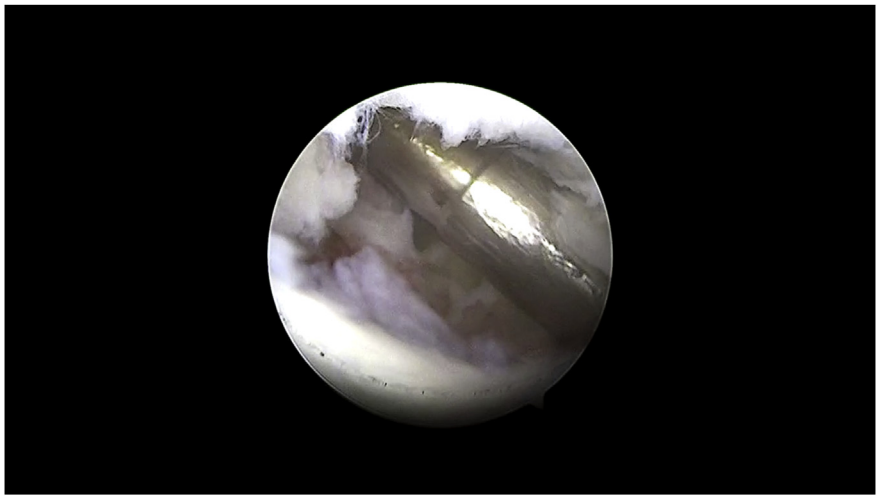

Fig. 5. Arthroscopic synovectomy being done.

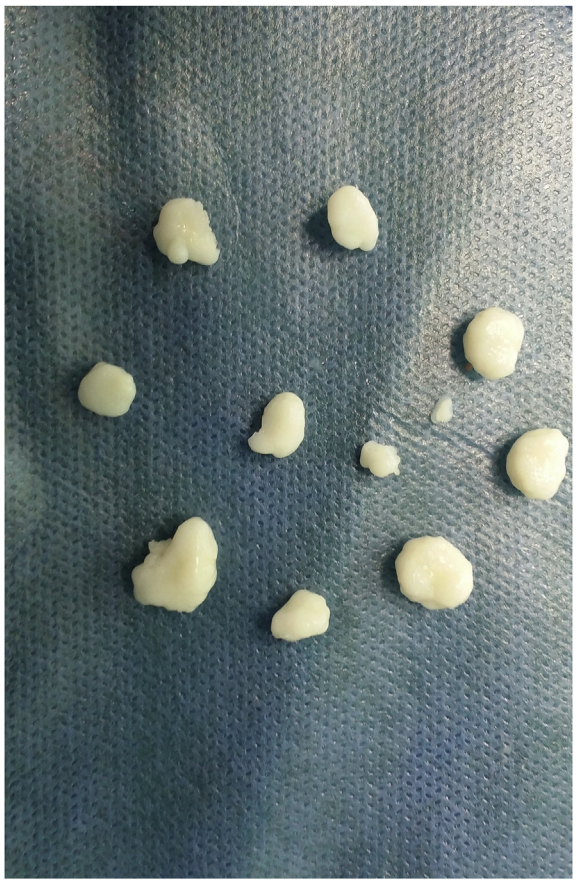

Fig. 6. Macroscopic image of loose bodies retrieved from the joint.

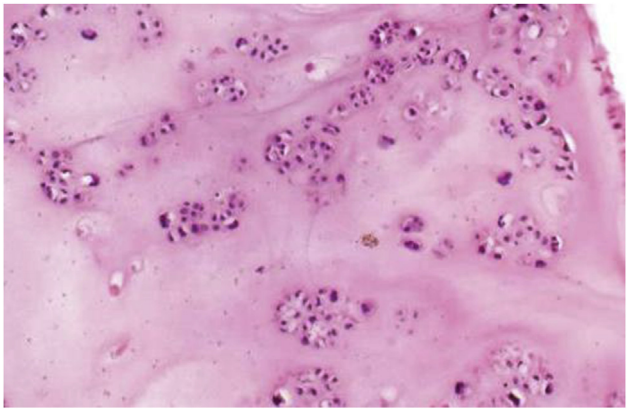

Fig. 7. Histopathological examination reveals cartilaginous nodules.

transformation. Hence, the condition should be promptly diagnosed and treated with synovectomy and loose bodies removal.

Traditionally, synovial chondromatosis of ankle has been treated with open surgery.[6,7] Arthroscopic excision and synovectomy is now getting acceptance.[12,14] Arthroscopic treatment has potential advantages like better access to the joint, lesser morbidity, early rehabilitation and recovery.[8] However, there is possibility of limited synovectomy or residual loose bodies with arthroscopic surgery. Loose bodies removal and synovectomy is becoming the standard arthroscopic treatment for management of ankle synovial chondromatosis.[12]

4. Conclusion

To conclude, ankle synovial chondromatosis is a rare phenomena and its arthroscopic treatment is a successful and reliable procedure. It has potential benefits over open surgery. We present this case report owing to its rarity and clinical importance.

Conflict of interest declaration

The authors report no conflict of interest. Authors have no financial aid to declare.

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Case report

Tibialis anterior artery pseudoaneurysm formation complicating an arthroscopically-assisted ankle arthrodesis with an intermittent non-invasive distraction technique; A case report

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ABSTRACT

The formation of pseudoaneurysms secondary to ankle arthroscopy is relatively uncommon (only twenty-three cases having been reported in the literature at a 2019 systematic review), the tibialis anterior and dorsalis pedis vessels being most commonly affected. Here is presented such a case, which has unusually occurred following an otherwise uncomplicated arthroscopically-assisted arthrodesis, a potential mechanism speculated upon, and suggestions for how to avoid such undesirable outcomes given.

1. Introduction

Pseudoaneurysms occur when blood escapes an artery but is contained by the adventitia and connective tissues surrounding the vessel. Catheterisation or traumatic instrumentation of a vessel, or shearing or bending forces applied to it are the most frequently cited aetiologies.[1] Since the advent of arthroscopic surgical techniques in the 1970s, arthroscopy has been used to manage a variety of conditions affecting the ankle with considerable success, with the conventional wisdom being that antero-lateral and antero-medial port placement carries a low risk of vascular injury. Arthroscopic approaches to the knee have resulted on occasion in pseudoaneurysm formation,[2] but as of a 2019 systematic review,[3] only twenty-three cases of pseudoaneurysm formation secondary to ankle arthroscopy have been reported in the literature.

One possible cause for the occurrence of the vascular lesions is the use of continuous distraction techniques. The ankle provides limited room to manoeuvre when it comes to arthroscopy. Without applying in-line traction, the surgeon is limited to an anterior working space, whereas distracting a dorsiflexed ankle opens up the posterior recesses of the joint allowing posterior ankle pathologies to be addressed. Invasive skeletal traction has become relatively infrequently employed, largely due to the occurrence of pin site complications, stress fractures of the fibula or tibia, and the increase in operating time required,[4] and so various non-invasive distraction methods have been developed.[5] They can be broadly divided into continuous and intermittent techniques. Continuous distraction involves application of a fixed weight (usual via adhesive tapes applied directly to the skin) distal to the joint throughout the procedure, and this has been speculated as a possible cause of pseudoaneurysm formation by placing shearing forces along the vessels.[6] The tibialis anterior (TA) artery would appear to be particularly vulnerable to these shearing stresses given its exposed position at the level of the ankle. Some surgeons prefer to use traction intermittently in an effort to avoid such complications.

Direct injury to the vessels during port site placement, variations in vascular anatomy, and the patient's pre-disposition to pseudoaneurysm formation (hypo-coagulable states for example), must also be taken into account. The below example of such a vascular lesion occurring secondary to ankle arthroscopy may encourage surgeons to consider their choice of distraction technique, and any other steps that might be taken to reduce the risk of their occurrence.

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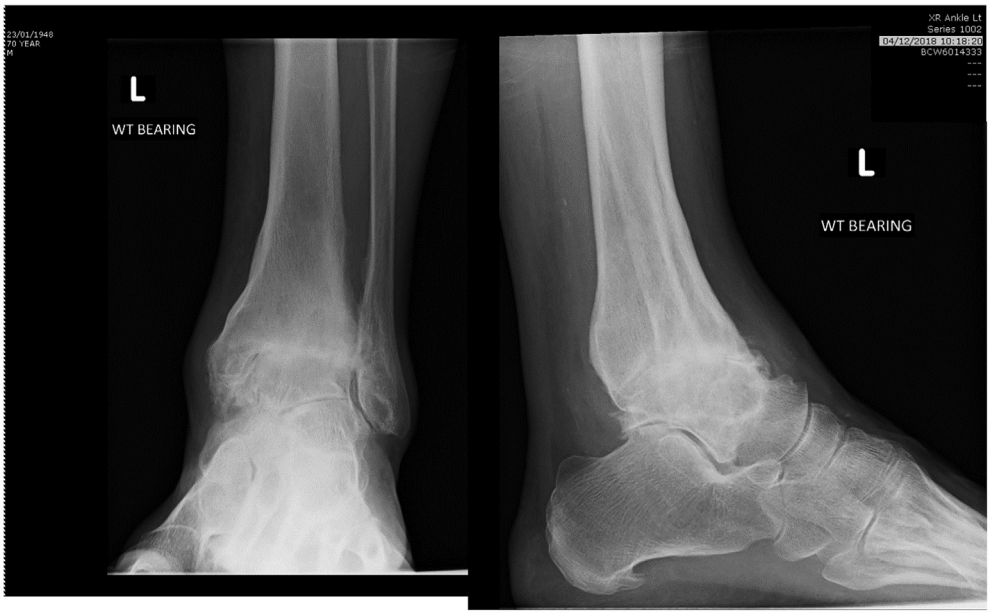

Fig. 1. Plain films of the patient's left ankle prior to intervention.

2. Case report

A 70-year-old man presented to a district general hospital in North Wales with a long history of osteoarthritis affecting his left ankle. He had an intra-articular distal tibial epiphyseal fracture in his youth. He suffered from eczema but was otherwise in good health. His plain films showed complete loss of the joint space and a degree of distal tibial recurvatum (Fig. 1). After a number of years of conservative management, he elected to undergo fusion in December of 2018.

His procedure was carried out arthroscopically, supine under general anaesthetic without tourniquet, and using intermittent non-invasive manual distraction of the ankle joint by passing a crepe-bandage above the ankle and around the operating surgeon's back, so that the surgeon could vary the degree of traction by leaning back on the spot whilst freeing-up both hands. Antero-medial and antero-lateral ports were placed, as well as an accessory medial port, and the joint was surveyed. Outerbridge Grade IV osteochondral lesions were noted across the majority of the weight-bearing surfaces. The motorised abrader was used to debride osteophytes and the devitalised chondral surfaces down to cancellous bone (confirmed with visualised bleeding). The extensive debridement required here may have presented another opportunity for inadvertent damage to vascular structures, however no evidence of excessive bleeding, or swelling consistent with an encapsulated haematoma was noted at the time. (A small amount of post-operative oozing was noted but not felt to be out of the ordinary).

The fusion was then performed by placing two partially threaded cannulated cancellous (6.5mm) screws into the talus in a transmalleolar configuration (Fig. 2). Guide pin attitude and final screw position was confirmed with the image intensifier in the usual manner. Nylon sutures were used to close the port sites and these were covered with simple dressings and wool and crepe bandaging.

The patient was comfortable postoperatively and sent home the

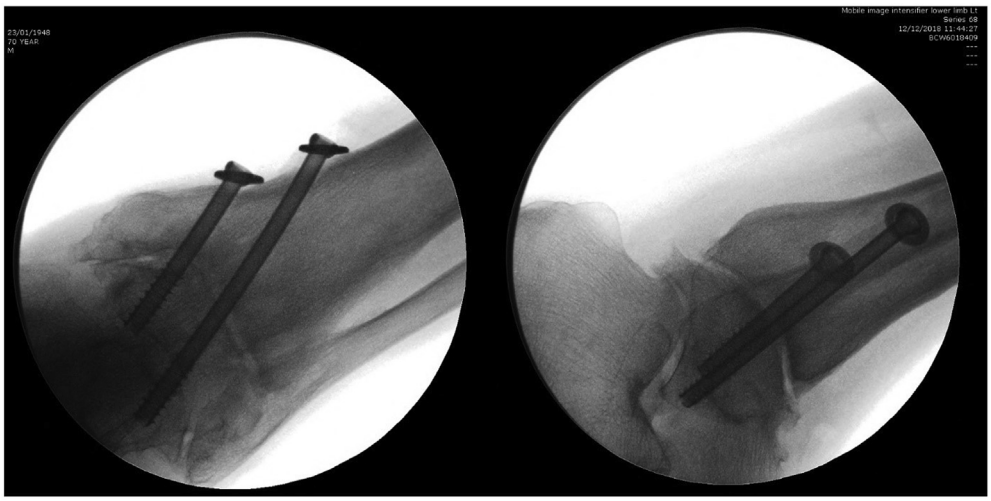

Fig. 2. Intra-operative imaging of the completed fusion.

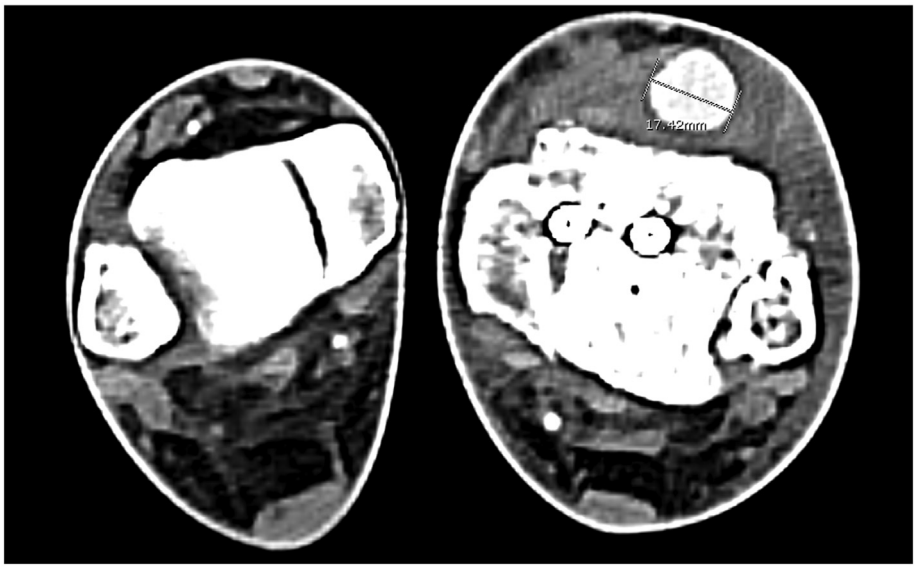

Fig. 3. CT angiography axial segments demonstrating the vascular lesion.

same day, but he re-presented eight days later complaining of a painful lump overlying the operated ankle joint. On examination, this was believed to be a TA pseudoaneurysm. The diagnosis was confirmed by CT angiography the following day (Fig. 3), which showed a 17mm pseudoaneurysm arising from the distal aspect of the left anterior tibial artery at the level of the ankle joint. He went on the receive radiologically-guided coil embolisation given his adequate collateral supply. A left-sided antegrade approach was made via the common femoral artery, with the anterior tibial artery being distally catheterised. It was not possible to identify to TA distal to the pseudoaneurysm, and as such, the vessel proximal to the lesion was embolised using a series of 3mm coils (Fig. 4). Post embolisation angiography (Fig. 5) demonstrated no antegrade filling or retrograde filling from the collaterals.

At 6-week follow-up his symptoms had resolved entirely, his wounds having healed nicely and he was partially weight-bearing without discomfort. At 5 months he was happy with his outcome and mobilising without any sign of the pain which had troubled him for a number of years.

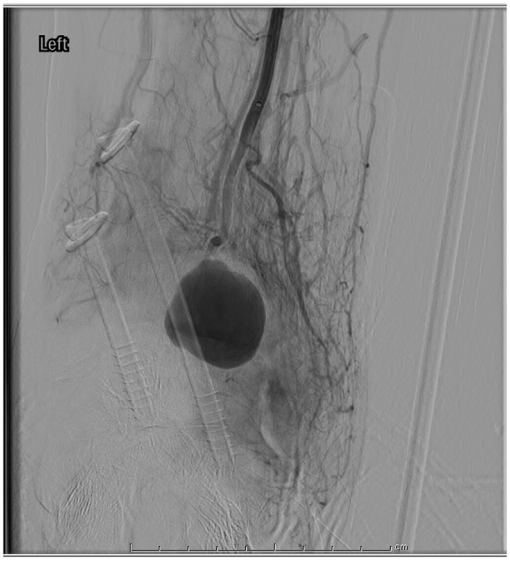

Fig. 4. Pre-embolisation angiography images of the pseudoaneurysm.

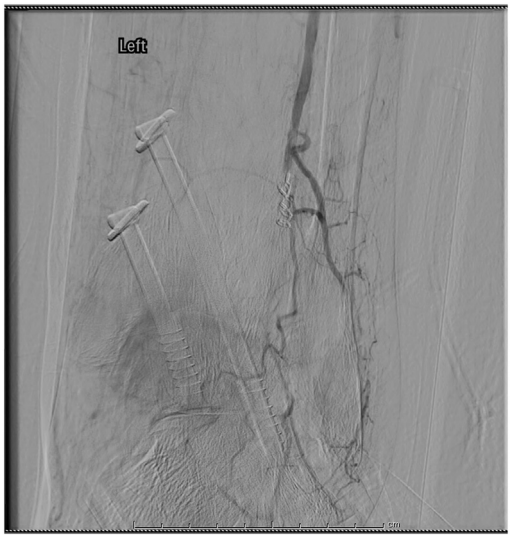

Fig. 5. Angiography post-embolisation of the pseudoaneurysm.

3. Discussion

Distraction techniques which create shear forces along the course of vessels has previously been speculated to contribute to pseudoaneurysm formation when employed continuously throughout the procedure, but other contributing factors may be implicated, such as the TA's relative vulnerability to mechanical disruption given the ankle's thick anterior fat pad, and the vessel's vulnerability during antero-medial port site placement.

Sparing use of distraction, and careful instrumentation about vascular sites would seem to be our best bets in avoiding this particular complication of ankle arthroscopy.

This case further demonstrates that ankle arthroscopy patients risk pseudoaneurysm development, and that varying the

techniques that we employ to distract the joint may go some way to assuaging this risk.

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