Arthroscopic Arthrolysis after Total Knee Arthroplasty

By

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As the candidate's supervisor I have approved this thesis for submission.

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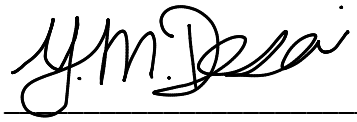
Signed:  Date: 11 August 2020

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To God for all that is possible.

Overview

Arthrofibrosis is an uncommon reason for poor outcomes after Total Knee Arthroplasty (TKA). There is paucity of evidence for the management of this complication. The aim of this study was to assess the longitudinal changes in the range of motion pre- and post-TKA, pre- and post-arthroscopy and at final follow up in patients who had arthroscopic arthrolysis for arthrofibrosis after TKA.

Patients were identified from a prospectively collected database who had an arthroscopic arthrolysis for decreased range of movement following TKA which was not present immediately post-TKA and not attributable to any other cause. Patients underwent a systematic arthrolysis, manipulation under anaesthesia (MUA) and intensive physical therapy thereafter. The main outcome measures were range of motion (ROM) recorded at different intervals and overall patient satisfaction.

A total of 16 patients were included for analysis. Patients were followed-up for a mean of 20 months (range 1 - 48 months) after the arthroscopic arthrolysis and MUA. The median pre-arthroscopic ROM was 28° (IQR 18°- 40°) and following arthroscopy was found to be 90° (IQR 88°- 100°). These gains however decreased with time to a median of 65° (IQR 38°- 88°) at final follow up. The mean improvement in the range of motion from the pre-arthroscopy value to that

found at final follow-up was 32° (95% CI = 19.0 - 45.3°, $p < 0.001$). Three quarters of patients were satisfied with the outcome of the procedure. One patient developed a complication in the form of an iatrogenic patella fracture.

Where other causes for knee loss of movement and pain have been ruled out, and arthrofibrosis is likely to be the sole cause of knee stiffness, arthroscopic debridement may be of benefit to improve ROM even if performed more than one year after the arthroplasty.

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Chapter 1: The review of literature

Introduction

Arthroplasty for advanced osteoarthritis of the knee is considered to be an effective method of pain management. Knee stiffness post arthroplasty is a known complication. The definition of this stiffness varies in literature. Kim et al. described a flexion contracture of > 15 degrees and/or < 75 degrees of flexion as significant.[1] Christensen et al. defined it as a range of movement < 70 degrees.[2] The prevalence ranges from 1.3% to 12%.[1,3] This stiffness is often associated with impairment in activities of daily living.[4]

The causes for stiffness are multi-factorial. Mounasamy et al. described risk factors for stiffness into preoperative, intraoperative and postoperative groups.[5] They further state that identifying the cause is useful in choosing the appropriate management. Pre-operative range of movement has been identified as the most important predictor of post-operative Range of Movement.[6] Patients with osteoarthritis usually sustained a loss of deep flexion whilst rheumatoid patients increased their arc of movement.[7]

Patients who present with stiffness and/or pain after total knee arthroplasty require sepsis to be ruled out or treated appropriately. Once this is done, a careful analysis of technical errors intra-operatively must be done. Surgical related factors such as errors in soft tissue balancing, component positioning errors and incorrect sizing may all lead to a decrease in range of movement. It is useful to document the range of movement achieved with gravity after capsular

closure at the time of the surgery so that one can anticipate the kind of range expected from the knee at 4 weeks post-surgery.[8] If there is a clear surgical error that leads to a stiff knee, revision surgery must be carefully planned and performed.[9] Despite the array of risk factors for the development of stiffness, the pathogenesis of arthrofibrosis is still unclear. Panni et al. describe it as the progressive production of scar tissue in the potential intra-articular spaces.[9] This includes the suprapatellar pouch, medial and lateral gutters and the intercondylar notch. According to the International Consensus of the Definition and Classification of Fibrosis of the Knee Joint, post-operative fibrosis is defined essentially as the exclusion of mechanical and septic complications of the stiff knee and attribute the painless stiff knee to fibrosis which was not present pre-operatively.

Current Literature

The options to treat arthrofibrosis include manipulation under anaesthesia, open arthrolysis, arthroscopic arthrolysis and finally revision total knee arthroplasty. A stepwise approach is usually adopted to this manage this complication.[5] Fitzsimmons et al. concluded in their systematic review that manipulation under anaesthesia and Arthroscopic release had similar outcomes and both fared better than open arthrolysis.[10] In another systematic review by H. Ghani et al., open arthrolysis had the best outcome and manipulation under anaesthesia and arthroscopic release had similar outcomes.[11] Both of these systematic reviews showed that manipulation under anaesthesia was done within 3 months of surgery and arthroscopy after 3

months. There was consensus on this management across all the included literature from these reviews.

We focus this study on arthroscopic arthrolysis and its outcomes. Besides the release, arthroscopy can be used for diagnostic purposes as well in the case of a tight PCL in a cruciate retaining implant or foreign body removal as is the case with loose or impinging cement. There appears to be uniformity in the technique of arthroscopic release. The suprapatellar pouch, medial and lateral gutters and intercondylar notch are all debrided using a shaver for the fibrous bands.[10] The anterior, medial and lateral access are easy and can be supplemented by various portals, however, the posterior access is poor. There is no literature available to substantiate an arthroscopic release together with an MUA. There are articles which report arthroscopic arthrolysis and do not mention an MUA, but the majority includes an MUA after the arthrolysis is performed.

Court et al. cite the ideal patient for an arthroscopic arthrolysis as the one who has failed non-operative management for stiffness at least 6 months after surgery and having a painless stiff knee.[12] Bocel et al. have reported that painful knees tend to have an incorrect diagnosis, as true arthrofibrosis is painless and thus do not improve as much from arthroscopic release.[13] They further reported an increase in ROM in 43% of patients but did not quantify it. Other studies show an average increase in ROM of 31 degrees in up to 94% of patients.[14,15] In yet another study, Jerosch et al. show a mean flexion of 119 degrees and an extension lag of 4 degrees post release.[16] They also stated that they were able to remove some of the remaining meniscal tissue or an anterior cyclops. Fitzsimmons et al. reviewed twelve articles evaluating arthroscopic

arthrolysis and found an initial increase range from 18.5-60 degrees and final increase from 5-58.4 degrees on average. They further noted that the timing of the arthroscopy had no overall effect on the outcome. The only published complication from arthroscopic release is a superficial wound infection.[17] The other advantage of arthroscopy is that haemostasis may be achieved and haematomas are not a described complication, as is the case with MUA alone.

In one article, including 32 arthroscopic releases specifically for arthrofibrosis, intra-articular fibrous bands, hypertrophic synovitis and peri-patellar adhesions were found in all the knees.[16] This article also noted 8 anterior cyclops lesions and 6 pseudomensicii.

Two parameters appear in literature, range of movement and Knee Society Scores (KSS), in assessing arthrolysis outcomes. Whilst the majority of literature focused on ROM improvements, there is paucity on the improvement in functional outcomes.[3,18] The knee society ratings have a functional and pain component to their scoring and can be compared individually.[19,20] A normal knee is allocated 100 points with 50 points for pain, 25 for ROM and 25 for stability. Functional outcomes also receive 100 points for a normal knee with 50 for walking and 50 for stair climbing. Jerosch et al. showed a statistically significant improvement in KSS ratings with improvements in pain and function from prior to arthroscopic release to final follow up. In another study with 27 patients undergoing arthroscopy for arthrofibrosis, the findings of KSS were similar however this study used patients who had hemi-replacements as well as aseptic loosening.[21]

This a rare complication and our data may be inadequate to make inferences on some aspects However we hope that the data may contribute to potential future meta-analysis and systematic reviews on the topic.

Research Question

We wanted to critically review the outcomes in terms of ROM at different intervals from the subset of patients who had undergone arthroscopic arthrolysis after arthroplasty in our arthroplasty unit for a diagnosis of arthrofibrosis.

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Chapter 2: Manuscript

Introduction

Arthroplasty of the knee is considered to be an effective method of pain management in patients with advanced osteoarthritis. Knee stiffness following arthroplasty is a recognized complication. The definition of this stiffness varies in literature. Kim et al. described a flexion contracture of > 15 degrees and/or < 75 degrees of flexion as significant.[1] Christensen et al. defined it as a range of movement (ROM) < 70 degrees.[2] According to the International Consensus of the Definition and Classification of Fibrosis of the Knee Joint, post-operative fibrosis is defined essentially as the exclusion of mechanical and septic complications of the stiff knee and attribute the painless stiff knee to fibrosis which was not present pre-operatively.[3] Histologically it is characterized by an excessive and disordered deposition of matrix proteins and proliferation of fibroblasts.[3] This is a rare complication with a prevalence of 1.3%.[1, 4] This stiffness is often associated with impairment in activities of daily living.[5]

The options to treat arthrofibrosis include MUA, open arthrolysis, arthroscopic arthrolysis and finally revision TKA. A stepwise approach is usually adopted to this manage this complication.[6] There is however conflicting evidence regarding to the optimal management. Fitzsimmons et al. concluded in their systematic review that MUA and arthroscopic release had similar outcomes and both fared better than open arthrolysis.[7] In another systematic review by Ghani et al., open arthrolysis had the best outcome with MUA and arthroscopic release having similar outcomes.[8]

The studies included in both of these systematic reviews favoured MUA within three months of surgery while surgery was used after three months in moderately stiff and painful knees. The ideal treatment strategy however remains to be identified.

The aim of this study was to assess the longitudinal changes in extension, flexion, and range of motion pre- and post-TKA, pre- and post-scope, and at final follow up (i.e., over 5 time points) in patients who had arthroscopic arthrolysis for arthrofibrosis after TKA.

Methods and Patients

This consecutive case series included all the patients who had arthroscopic arthrolysis performed for knee stiffness from arthrofibrosis after TKA at a single tertiary centre in the five year period from 2014 to 2019. Eligible patients were identified from a prospectively kept database. All the patients who had arthrofibrosis as a final diagnosis were included. Patients who had periprosthetic joint infection or overt metal ware malpositioning were excluded.

The study commenced after obtaining the prerequisite ethical and institutional approvals. Pre-TKA (index), the maximum post-TKA, pre-arthroscopy, post-arthroscopy and final ROM's were recorded. The time between arthroplasty and arthroscopy was also noted. ROM was used as the

main outcome measure. Other variables included age, gender, side, Body Mass Index (BMI) and type of implant (posterior stabilised or cruciate retaining). The diagnosis and indication for arthroplasty were captured together with any other complications that occurred. There was subjectively available satisfaction/overall happiness with outcomes available for all the patients from the notes.

Standard anterolateral and anteromedial arthroscopic portals with systematic exploration and releases were performed. First the supra-patellar pouch was addressed with the anterolateral arthroscopic sleeve and trocar. An up-down sweep with the introducer across the suprapatellar pouch was performed prior to arthroscopic visualisation. The suprapatellar pouch followed by lateral and medial gutters were then visualised and debrided using a motorised shaver. Any impinging synovitis between the tibia and femur was debrided. Once a static release and visualisation was performed, a dynamic view of the knee was performed and any further identified soft tissue fibrosis released. Biopsies for infection and lavage was performed routinely. Care by vigilance with the instruments and implants throughout the arthroscopy was taken in order not to damage the prosthetic components. Documentation of tourniquets and details of analgesia post operatively was inconsistently recorded.

MUA was performed intra-operatively after the arthroscopy on all the patients using gentle maintained short lever armed flexion and extension passive ROM. All patients received post arthrolysis physical therapy and some received continuous passive motion therapy with guidance

from the therapists. There was no standardised rehabilitation protocol in terms of intervention, duration or frequency. The notes were also insufficient in terms of allied health intervention. Once the patients were discharged, the outpatient rehabilitation was also not traceable.

The ROM was recorded from the notes. It was taken by different individuals at the various time intervals noted and often details such as whether clinical estimate or goniometer use was not documented. The post-TKA and post-scope ROM measurements were assessed passively, under anaesthesia. It was not always specifically recorded if the outpatient follow up ROM was assessed actively or passively.

Statistical analysis was performed using SPSS version 26 (IBM SPSS). Continuous variables were reported as mean (± SD) or median (with interquartile range) and categorical variables as number and percentages, unless otherwise stated. Since most outcome variables were not normally distributed, they were summarised using median and IQR, and changes in continuous outcomes over time were assessed using non parametric related-samples Friedman's two-way analysis of variance by ranks. Post hoc adjustment for multiple comparisons was done using Bonferroni correction to compare pairwise time points. All tests were two-sided and the level of significance was set at $p < 0.05$.

Results

A total of sixteen patients were included in the study. As shown in Table 1, twelve (75%) female and four (25%) males. The right knee was involved in ten (63%) cases. Osteoarthritis was the primary diagnosis and indication for arthroplasty in ten patients (63%). Post traumatic arthritis was the primary pathology for four (25%) patients and two (12%) had rheumatoid arthritis. The mean BMI was 32 $\pm$ 6 (range 21-41) and six patients (38%) had a BMI $\geq$ 35. The average age at the time of arthroscopy was 61 $\pm$ 6 years (range 48 - 72 years). All the patients in the series had arthrofibrosis as a final diagnosis. There were no patients who had undergone revision surgery in the study population.

Age (n=16)	Mean	61
	Standard Deviation	6
	Minimum	48
	Maximum	72
BMI (n=16)	Mean	32
	Standard Deviation	6
	Minimum	21
	Maximum	41
Side	Left	6 (38%)
	Right	10 (62%)
Implant	Missing	1 (6%)
	Cruciate retaining	3 (19%)
	Posterior stabilized	12 (75%)
Indication for TKA	OA	10 (63%)
	Post-trauma OA	4 (25%)
	RA	2 (13%)

Table I. Demographics and clinical characteristics of study participants. BMI- body mass index

The median time period between TKA and arthroscopy was 17 months (Interquartile range [IQR] 8 - 31 months, range 3 - 132 months). Patients were followed-up for a median of 18 months (Interquartile range [IQR] 7 - 33 months, range 1 - 48 months) after the arthroscopic arthrolysis and MUA. Table 2 shows the median values per group at each time point split by follow up time and by BMI. There were no differences over time for extension either overall or within-group.

		Follow up		BMI		Total (n=16)
		<=6 months (n=4)	> 6 months (n=12)	<35 (n=10)	>=35 (n=6)	
Pre-TKA Extension	Median	5	5	5	0	5
	Percentile 25	3	5	5	0	0
	Percentile 75	10	10	10	5	8
Post-TKA Extension	Median	0	0	0	3	0
	Percentile 25	0	0	0	0	0
	Percentile 75	0	5	5	10	8
Pre-scope Extension	Median	3	5	5	0	3
	Percentile 25	0	0	0	0	0
	Percentile 75	13	5	5	0	5
Post-scope Extension	Median	0	0	0	0	0
	Percentile 25	0	0	0	0	0
	Percentile 75	5	10	10	0	3
Final Extension	Median	5	0	0	0	0
	Percentile 25	0	0	0	0	0
	Percentile 75	15	10	10	0	5
Extension: Related-samples Friedman two-way ANOVA on ranks		p-value = 0.124	p-value = 0.095	p-value =0.214	p-value = 0.321	p-value =0.153
Pre-TKA Flexion	Median	80	80	80	85	80
	Percentile 25	60	40	40	75	58
	Percentile 75	85	85	85	90	90
Post-TKA Flexion	Median	75	65	65	25	45

	Percentile 25	58	45	45	20	35
	Percentile 75	85	80	80	40	75
Pre-scope Flexion	Median	45	38	38	20	30
	Percentile 25	38	30	30	20	20
	Percentile 75	48	45	45	30	45
Post-scope Flexion	Median	93	93	93	95	93
	Percentile 25	85	90	90	80	90
	Percentile 75	103	100	100	110	100
Final Flexion	Median	70	75	75	53	65
	Percentile 25	45	60	60	30	38
	Percentile 75	85	90	90	80	88
Flexion: Related-samples Friedman two-way ANOVA on ranks		p-value = 0.086	p-value =<0.001	p-value <0.001	p-value =0.007	p-value <0.001
Pre-TKA ROM	Median	73	75	75	83	75
	Percentile 25	50	35	35	70	50
	Percentile 75	83	80	80	90	83
Post-TKA ROM	Median	75	58	58	25	45
	Percentile 25	58	45	45	20	28
	Percentile 75	85	80	80	30	70
Pre-scope ROM	Median	35	30	30	20	28
	Percentile 25	30	20	20	10	18
	Percentile 75	43	40	40	30	40
Post-scope ROM	Median	93	90	90	95	90
	Percentile 25	80	90	90	80	88
	Percentile 75	103	95	95	110	100
Final ROM	Median	65	75	75	53	65
	Percentile 25	30	50	50	30	38
	Percentile 75	85	90	90	80	88
ROM: Related-samples Friedman two-way ANOVA on ranks		p-value = 0.095	p-value <0.001	p-value <0.001	p-value = 0.003	p-value <0.001

Table 2: Extension, Flexion and Range of Motion at each time period of measurement by follow up time and BMI

There were significant changes over time overall for flexion and range of motion ($p<0.001$). This difference persisted regardless of BMI, and in those who were followed up for > 6 months. On closer inspection, when the adjusted pairwise comparisons were examined, the time points which differed overall from each other with regards to flexion were pre-scope and final; pre-scope and post-scope and post-scope and final. For ROM the significant overall differences were between pre-scope and final as well as pre-scope and post-scope. Figure 1 shows the box and whisker plot over time.

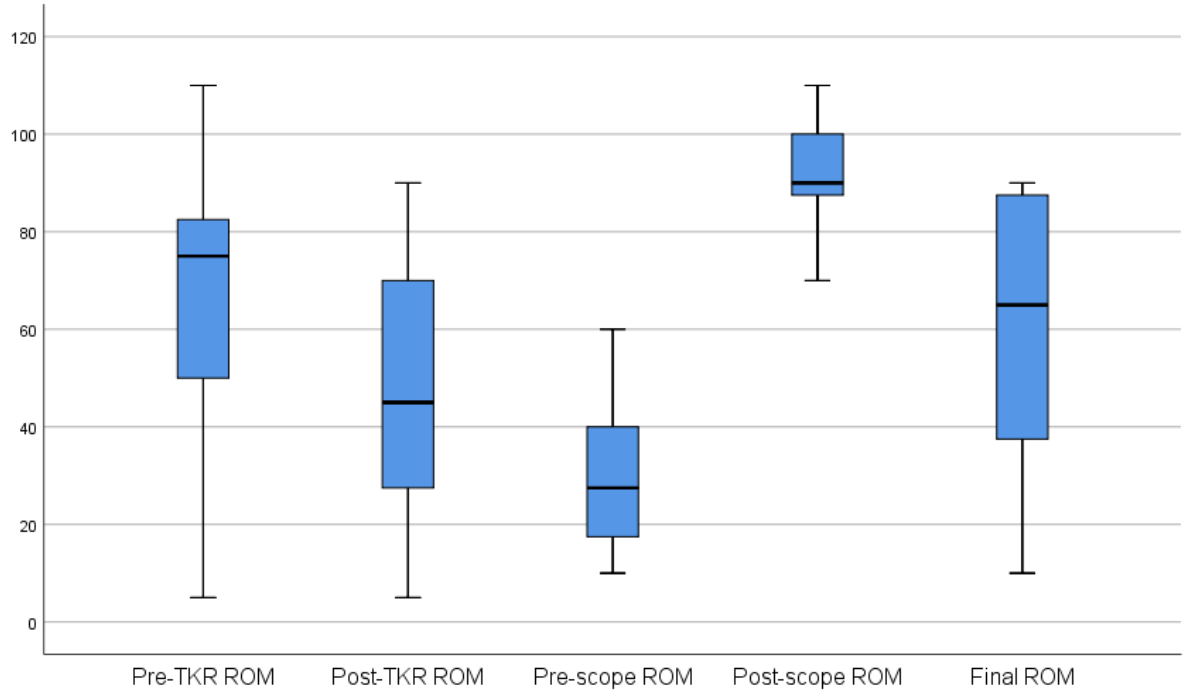

Figure 1: Box-and-whisker plot of ROM values over time (n=16)

Three quarters (75%) of patients who underwent the procedure were satisfied with the outcome. One of the dissatisfied patients sustained a patella fracture during the manipulation under anaesthesia.

Discussion

The causes for stiffness after TKA are multi-factorial. Mounasamy et al. described several risk factors for stiffness and divided them into preoperative, intraoperative and postoperative groups.[6] They further state that identifying the cause is useful in choosing the appropriate management. Arthrofibrosis as a pathological process is considered an independent pre-operative or patient risk factor for knee stiffness after arthroplasty.[9] The pathogenesis of arthrofibrosis is still unclear. Panni et al. describe it as the progressive production of scar tissue in the potential intra-articular spaces.[10] The patients included in our study were identified to have knee stiffness with or without pain after TKA with no identifiable cause besides arthrofibrosis.

There is conflicting data regarding the optimal management of arthrofibrosis following total knee arthroplasty. Court et al. cite the ideal patient for an arthroscopic arthrolysis as the one who has failed non-operative management for stiffness at least 6 months after surgery and having a painless stiff knee.[11] The addition of an arthroscopy to an MUA for post-TKA knee stiffness has several potential benefits. At the time of the arthroscopy, dynamic pathologies such as a tight PCL, soft tissue impingement or loose pieces of cement can be identified. There appears to be uniformity in the technique of arthroscopic release.[7] The anterior, medial and lateral access is relatively simple and can be supplemented by various portals, however, the posterior access remains problematic. In knees with cruciate retaining implants, the access to the posterior cruciate ligament is not adequate and can lead to implant damage. In this study we investigated

the outcome of arthroscopic release combined with MUA in the absence of any implant malpositioning, inaccurate sizing or septic complications.

We found that most patients who had arthroscopic releases followed by MUA in theatre had improvement in their ROM and were satisfied. Notably, this was also the case in patients where the arthroscopic arthrolysis was performed more than a year after the TKA. We noted a progressive decrease in ROM from immediately post MUA towards final follow up.

As our sample size was small due to this being a relatively rare complication, we could not conclusively identify any subset of patients who fared statistically worse from this procedure in terms of ROM or satisfaction except in those who were subsequently found to have other pathologies. Four patients were dissatisfied with the outcome of the procedure. The first required an open debridement for a patella clunk. The polyethylene insert was changed for a smaller one and the anterior edge was shaved back. While the patient was subsequently satisfied with the outcome, her ROM did not improve. The second patient underwent TKA for post-traumatic OA and had a 10-20° ROM prior to arthroscopy (16 months after TKA) that improved to 0-90° following the arthrolysis and MUA. Post-operatively he complained of severe anterior knee pain for which a plain film X-ray was done that revealed a missed iatrogenic patella fracture. This most likely occurred during the MUA and the patient was taken back to theatre two days after the arthroscopy for patella fracture fixation with tension band wiring. His rehabilitation and subsequent ROM were affected by this complication and even though the ROM arc improved by 20° at the 24 month follow up, he remained dissatisfied with the outcome. The third patient who

was dissatisfied with the final outcome was found to have spinal pathology after presenting with cauda equina on one of her follow up visits. In retrospect the patient's knee pain may have been the result of a radiculopathy and this may have been missed during the initial work-up. The final dissatisfied patient had a 65° improvement in ROM after arthroscopy at a 48 month follow up. The reason for the dissatisfaction was not clearly documented in the notes.

Bocel et al. have reported that painful knees tend to have an alternative pathology and not pure arthrofibrosis and thus do not improve as much from arthroscopic release.[12] They found an increase in ROM in 43% of patients but did not quantify the improvements in ROM. In the series by Jerosch et al., which included 32 arthroscopic releases specifically for arthrofibrosis, the authors found intra-articular fibrous bands, hypertrophic synovitis and peri-patellar adhesions in all the knees.[13] Other studies show an average increase in ROM of 31° in up to 94% of patients.[14,15] Jerosch et al. show a mean flexion of 119° and an extension lag of 4° post-release.[13] They also stated that they were able to remove some of the remaining meniscal tissue or an anterior cyclops in certain cases.

Fitzsimmons et al. reviewed 12 articles evaluating arthroscopic arthrolysis and found, on average, an initial increase range from 18-60° and final increase from 5-58°.[7] They further noted that the timing of the arthroscopy had no overall effect on the outcome with gains in ROM seen beyond one year after arthroplasty. The mean time from arthroplasty to arthroscopy was 30 months in our series. Our findings were similar in that we noted an improvement in the mean range of

motion of the knee following the procedure. However, the initial gains with a mean ROM to approximately 90° (gain range of 40°- 90°) in the immediate post-operative period was not maintained on the long term, with a mean ROM at final follow up of approximately 60° (gain range of 0°- 65°). In our cohort of patients we were unable to identify any specific factors associated with a lack of improvement in the ROM and the small number of cases prohibited a regression analysis. There is paucity in literature with regards to the rate at which these gains are lost.

Two parameters appear in literature on the assessment of arthrolysis outcomes, namely ROM and Knee Society Scores (KSS). The majority of literature focus on ROM improvements and there is scarcity of data on the improvement in functional outcomes or satisfaction.[4, 6] The knee society rating have a functional and pain component to their scoring and can be compared individually.[17, 18] Jerosch et al. showed a statistically significant improvement in KSS ratings with improvements in both pain and function at final follow up.[13] In another study with 27 patients undergoing arthroscopy for arthrofibrosis, the findings relating to KSS were similar, however, this study used patients who had unicompartmental replacements as well as aseptic loosening.[19] Due to the retrospective nature of our analysis, patient reported scoring could not be calculated from the limited information present. The notes did include overall satisfaction with the procedure and outcome as a simple reported confirmation. Whether this entailed a decrease in pain or an improvement in functional outcomes remained unclear. However, it is noteworthy that a quarter of patients were dissatisfied with the outcome.

There is limited data available to substantiate an arthroscopic release together with an MUA although most authors perform an MUA post-arthrolysis.[7] The arthroscopy together with the MUA could potentially address both the flexion and extension contractures as the arthroscopy alone does not address the posterior aspect of the knee and thus to an extent, the extension deficit. Whilst the focus of this study was not to differentiate the gains in flexion versus extension, we advocate a prospective controlled study to evaluate these differences and may contribute to more effective decision making.

A learning curve exists with this procedure due to complexity added by the presence of implants, however the complication rate is relatively small.[20] The only published complication from arthroscopic release is a superficial wound infection.[20] The other advantage of arthroscopy is that haemostasis may be achieved and haematomas are not a described complication, as is the case with MUA alone. The complications of MUA performed after arthroscopic arthrolysis remain the same as for an independent MUA. These findings are reflected by our data as well with a patella fracture occurring during the MUA.

Whilst post operative rehabilitation was performed by allied health professionals, there was no standardised protocol. It was tailored for each patient and suited to their compliance and social circumstances as well. The notes on intervention were also not always clear. This is a potential confounder in the outcomes as different patients received different types of therapy with varying frequencies and durations.

There are several noteworthy limitations to our study. The small sample size and retrospective nature of this study are both shortcomings found in the other studies in the field. This is a rare complication with TKA and thus sample size is a problem frequently encountered, even within dedicated arthroplasty units. The short follow-up is also a concern.

After stratifying the patients into two groups, those who are followed up less than 6 months and those beyond 6 months, Table 1 shows that their medians and IQR values are similar and thus the subset of patients with final review within 6 months of arthroscopy still had comparable results to those followed up at a longer time interval. With ROM being the primary variable considered, it would have been ideal to standardise and validate its' reporting. The variation in observers and methods of recording may lead to potential inaccuracies with the measurements. The ROM was recorded at many different time intervals and by different observers.

The absence of validated patient reported outcome scores is another obvious shortcoming, which needs to be addressed in future studies. Without a control group it is not possible to comment on the contribution the arthroscopy or MUA would have had or if the combination of procedures is any better than either procedure done in isolation. While arthroscopic arthrolysis combined with MUA appears to hold promise it is not advisable to make any recommendations based solely on the data presented here. We recommend that future research incorporate a multi-centre model to increase the sample size which will enable the identification of prognostic factors relating to the clinical outcome. The data generated from this pool of patients may also be used for future meta-analysis to provide higher level of evidence.

Conclusion

Where other causes for knee stiffness and pain after TKA have been ruled out and arthrofibrosis is likely to be the sole cause of knee stiffness, arthroscopic debridement may potentially be of benefit to improve ROM and patient satisfaction, even if performed more than one year after the arthroplasty.

Ethics Statement

Ethical approval was obtained from University of Kwa-Zulu Natal BREC Ethics committee (BE 697/18) and the Inkosi Albert Luthuli Central Hospital CEO prior to the data collection. All patient details were kept confidential and their identities were assigned numbers for the database.

Author contributions

YD was responsible for concept development, data collection and interpretation and manuscript preparation. LM contributed to data analysis, interpretation and manuscript preparation. PR contributed to concept development and data collection.

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Appendix 1: The final Study Protocol

MMed Research Protocol

Dr. Y. Desai

Student number: 203500363

University of KwaZulu-Natal

Department of Orthopaedics

1. Title

Arthroscopy post total knee arthroplasty for knee stiffness

2. Aim of the Study

The aim of this retrospective study is to determine the effectiveness of arthroscopic arthrolysis for arthrofibrosis post total knee arthroplasty.

3. Specific Objectives

The objective is to conduct a retrospective review, including all arthroscopy post total knee arthroplasty in a single unit over a five year period with an exception to septic indications. By including all arthroscopy, overlap in pathology can be defined as well as comparing range of movement and patient satisfaction scores (KSS) pre and post arthroscopy. Other variables including patient demographics, implant choices, complications of arthroplasty as well as arthroscopy and lastly diagnosis/findings can be described.

4. Background / Literature Review

Arthroplasty for advanced osteoarthritis of the knee is considered to be an effective method of pain management. Knee stiffness post arthroplasty is a known complication. The definition of this stiffness varies in literature. Kim et al described a flexion contracture of > 15 degrees and/or < 75 degrees of flexion as significant.[1] Christensen et al defined it as a range of movement < 70 degrees.[2] The prevalence ranges from 1.3% to 12%.[1,3] This stiffness is often associated with impairment in activities of daily living.[4]

The causes for stiffness are multi-factorial. Mounasamy et al. described risk factors for stiffness into preoperative, intraoperative and postoperative groups.[5] They further state that identifying the cause is useful in choosing the appropriate management. Pre-operative range of movement has been identified as the most important predictor of post-operative Range of Movement.[6] Patients with osteoarthritis usually sustained a loss of deep flexion whilst rheumatoid patients increased their arc of movement.[7]

Patients who present with stiffness and/or pain after total knee arthroplasty require sepsis to be ruled out or treated appropriately. Once this is done, a careful analysis of technical errors intra-operatively must be done. Surgical related factors such as errors in soft tissue balancing, component positioning errors and incorrect sizing may all lead to a decrease in range of movement. It is useful to document the range of movement achieved with gravity after capsular closure at the time of the surgery so that one can anticipate the kind of range expected from the knee at 4 weeks post-surgery.[8] If there is a clear surgical error that leads to a stiff knee, revision surgery must be carefully planned and performed.[9] Despite the array of risk factors for the development of stiffness, the pathogenesis of arthrofibrosis is still unclear. Panni et al describe it as the progressive production of scar tissue in the potential intra-articular spaces.[9] This includes the suprapatellar pouch, medial and lateral gutters and the intercondylar notch. According to the International Consensus of the Definition and Classification of Fibrosis of the Knee Joint, post-operative fibrosis is defined essentially as the exclusion of mechanical and septic complications of the stiff knee and attribute the painless stiff knee to fibrosis which was not present pre-operatively.

The options to treat arthrofibrosis include manipulation under anaesthesia, open arthrolysis, arthroscopic arthrolysis and finally revision total knee arthroplasty. A stepwise approach is usually adopted to this manage this complication.[5] Fitzsimmons et al. concluded in their systematic review that manipulation under anaesthesia and Arthroscopic release had similar outcomes and both fared better than open arthrolysis.[10] In another systematic review by H. Ghani et al., open arthrolysis had the best outcome and manipulation under anaesthesia and arthroscopic release had similar outcomes.[11] Both of these systematic reviews showed that manipulation under anaesthesia was done within 3 months of

surgery and arthroscopy after 3 months in the moderately stiff and painful knee across all their included literature.

We focus this study on arthroscopic arthrolysis and its outcomes. Besides the release, arthroscopy can be used for diagnostic purposes as well in the case of a tight PCL in a cruciate retaining implant or foreign body removal as is the case with cement. There appears to be uniformity in the technique of arthroscopic release. The suprapatellar pouch, medial and lateral gutters and intercondylar notch are all debrided using a shaver for the fibrous bands.[10] The anterior, medial and lateral access are easy and can be supplemented by various portals, however, the posterior access is poor. There is no literature available to substantiate an arthroscopic release together with an MUA. There are articles which report arthroscopic arthrolysis and do not mention an MUA, but the majority includes an MUA after the arthrolysis is performed.

Court et al cite the ideal patient for an arthroscopic arthrolysis as the one who has failed non-operative management for stiffness at least 6 months after surgery and having a painless stiff knee.[12] Bocel et al have reported that painful knees tend to have incorrect diagnosis and thus do not improve as much from arthroscopic release.[13] They further reported an increase in ROM in 43% of patients but did not quantify it. Other studies show an average increase in ROM of 31 degrees in up to 94% of patients.[14,15] In yet another study, Jerosch et al show a mean flexion of 119 degrees and an extension lag of 4 degrees post release.[16] They also stated that they were able to remove some of the remaining meniscal tissue or an anterior cyclops. Fitzsimmons et al reviewed 12 articles evaluating arthroscopic arthrolysis and found an initial increase range from 18.5-60 degrees and final increase from 5-58.4 degrees on average. They further noted that the timing of the arthroscopy had no overall effect on the outcome. The only published complication from arthroscopic release is a superficial wound infection.[17] The other advantage

of arthroscopy is that haemostasis may be achieved and haematomas are not a described complication, as is the case with MUA alone.

In one article, including 32 arthroscopic releases specifically for arthrofibrosis, intra-articular fibrous bands, hypertrophic synovitis and peri-patellar adhesions were found in all the knees.[16] This article also noted 8 anterior cyclops lesions and 6 pseudomensicii.

Two parameters appear in literature, range of movement (ROM) and Knee Society Scores (KSS), in assessing arthrolysis outcomes. Whilst the majority of literature focused on ROM improvements, there is paucity on the improvement in functional outcomes.[3,18] The knee society ratings have a functional and pain component to their scoring and can be compared individually.[19,20] A normal knee is allocated 100 points with 50 points for pain, 25 for ROM and 25 for stability. Functional outcomes also receive 100 points for a normal knee with 50 for walking and 50 for stair climbing. Jerosch et al showed a statistically significant improvement in KSS ratings with improvements in pain and function from prior to arthroscopic release to final follow up. In another study with 27 patients undergoing arthroscopy for arthrofibrosis, the findings of KSS were similar however this study used patients who had hemi-replacements as well as aseptic loosening.[21]

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5. Keywords

Total knee Arthroplasty

Arthrofibrosis

Arthroscopic arthrolysis

6. Study design

Retrospective chart review

6.1. Study Population

The study population will include all patients who underwent knee arthroscopy post total knee arthroplasty with an indication for stiffness, with or without pain. The exclusion criteria include septic knees. The Study population includes patients over a five year period from a single arthroplasty unit in Durban, KZN.

6.2. Sample Strategy

The above study population will be extracted from patient records at this institution. A database with their information will made including their follow up visits to assess range of movements and satisfaction scores. Patients who will be included will have to have undergone the arthroscopy and follow up at the unit.

6.3. Sample Size

The sample size will depend on the exact number of patients who meet the criteria. An estimated average according to the unit stats is about 30 patients over the sampling period.

6.4. Inclusion and Exclusion Criteria

Inclusion Criteria:

- All patients who had arthroscopy post total knee arthroplasty for stiffness

Exclusion Criteria:

- Septic knees
- If ROM pre and post arthroscopy was not recorded

6.5. Data collection methods and tools

Data collection will be achieved by capturing all patients onto a Microsoft Excel program data bank. Patient's demographic details, laboratory results, information from their operative notes, materials and

prosthesis that was used and complication will be captured on the data bank. Their arthroscopy findings as well as arthroscopic intervention will be captured. Knee society scores will be considered where available.

6.6. Data analysis techniques and statistical analysis

With the aid of a statistician, descriptive statistics will be used to analyse data. The following parameters will be analysed and compared in each sample group:

Patient demographics:

- Age
- Gender
- BMI <35 or >35
- Left or Right side
- Type and size of implants used
- Primary or revision surgery
- Diagnosis and indication for arthroplasty
- Diagnosis at arthroscopy

Outcome measures

- KSS pre and post arthroscopy where available
- ROM pre arthroscopy, passively during arthroscopy and post arthroscopy at follow up

7. Study location

The study is done from a single arthroplasty unit in Kwa Zulu Natal, South Africa.

8. Study period

The study period will be January 2013- December 2017.

9. Limitations of the Study

Being a retrospective study, the study is limited to the accuracy of the initial data capture methods. The Sample size is also small as this is not a common problem and arthroscopy is even more seldom done.

10. Ethical Consideration

- No direct patient contact will be made during this study; all data will be extracted from the hospital charts, and reported on.
- All patient information will be held strictly confidential.
- No financial benefit

11. Report and Implementation

Data from this study will be analyzed and presented via:

- Presentation at conferences
- Submitted for publication in a peer review journal.

Appendix 2: The Guidelines for Authorship for the Journal selected for submission of the manuscript

Yussuf Desai *

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Declarations:

a) Authorship

The authors confirm that all authors have made substantial contributions to all of the following:

- The conception and design of the study, or acquisition of data, or analysis and interpretation of data.
- The drafting the article or its critical revision for important intellectual content.
- Final approval of the version to be submitted.

b) Sound scientific research practice

The authors further confirm that:

- The manuscript, including related data, figures and tables has not been previously published and is not under consideration elsewhere.
- No data have been fabricated or manipulated (including images) to support conclusions.
- This submission does not represent part of a single study that has been split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time (e.g. 'salami-publishing')

c) Plagiarism

The authors confirm that the work submitted is original and does not transgress the plagiarism policy of the journal.

- No data, text or theories by others are presented as if they were the authors' own.
- Proper acknowledgements of others' work have been given (this includes material that is closely copied, summarized and/or paraphrased); quotation marks are used for verbatim copying of material.
- Permissions have been secured for material that is copyrighted.

d) Conflict of interest statement

YD, PR and LCM have no conflict of interest to declare.

e) Funding sources

No funding was received for the purposes of performing this study

f) Compliance with ethical guidelines

The author/s declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.

Prior to commencement of the study ethical approval was obtained from the following ethical review board: BREC - reference number BE697/18

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Informed written consent was not obtained from all patients for being included in the study.

Appendix 3: Ethical approvals

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **yussuf desai** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 06/27/2017.

Certification Number: 2423429.

health
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DIRECTORATE:
Health Research & Knowledge Management

NHRD Ref: KZ_201905_026

Dear Dr YM Desai
UKZN

Approval of research

1. The research proposal titled **'Arthroscopic arthrolysis post total knee arthroplasty'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby **approved** for research to be undertaken at Inkosi Albert Luthuli Central Hospital.

2. You are requested to take note of the following:
   a. Kindly liaise with the facility manager BEFORE your research begins in order to ensure that conditions in the facility are conducive to the conduct of your research. These include, but are not limited to, an assurance that the numbers of patients attending the facility are sufficient to support your sample size requirements, and that the space and physical infrastructure of the facility can accommodate the research team and any additional equipment required for the research.
   b. Please ensure that you provide your letter of ethics re-certification to this unit, when the current approval expires.
   c. Provide an interim progress report and final report (electronic and hard copies) when your research is complete to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba on 033-395 2805.

Yours Sincerely

C E Lütge

Dr E Lutge
Chairperson, Health Research Committee
Date: 21/06/19.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

25 June 2019

Dr YM Desai (203500363)
School of Clinical Medicine
College of Health Sciences
Yussuf.desai@gmail.com

Dear Dr Desai

Protocol: Arthroscopy post total knee arthroplasty for knee stiffness.
Degree: MMed **BREC REF: BE697/18**

EXPEDITED APPLICATION: APPROVAL LETTER

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received 26 November 2018.

The study was provisionally approved pending appropriate responses to queries raised. Your response received on 21 June 2019 to BREC letter dated 20 May 2019 has been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have been met and the study is given full **ethics approval** and may begin as from 25 June 2019. **Please ensure that site permissions are obtained and forwarded to BREC for approval before commencing research at a site.**

This approval is valid for one year from **25 June 2019.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **noted** by a full Committee at its next meeting taking place on **09 July 2019.**

Yours sincerely

Prof D Wassenaar
Acting Chair: Biomedical Research Ethics Committee

Supervisor:paulry@ialch.co.za Postgrad admin: Veronica Jantjies

Appendix 4: Raw Data sheet

Pre-TKR ROM	Post TKR ROM	Time from TKR to scope	Pre scope ROM	Post-scope ROM	Final ROM	Sex	Age	BMI	Side	Type implant	Primary/revision	Diagnosis for arthroplasty	Happy with scope
5-40	0-90	12 months	5-45	0-90	10-60 @1/12	f	61	21	r	ps	primary	post trauma OA	yes
5-90	0-70	9 months	0-30	0-110	0-90 @2/12	f	58	32	l	ps	primary	post trauma OA	yes
0-80	0-45	30 months	0-45	0-95	0-80 @6/12	f	62	25	r	ps	primary	OA	yes
0-80	0-90	48 months	5-015	0-90	10-30 @12/12	f	65	29	r	ps	primary	OA	yes
5-75	10-80	11 years	0-40	0-80	0-60 @ 48/24	f	72	41	r	cr	primary	OA	yes
15-80	0-80	2 years	20-50	10-80	20-30 @ 6/12	f	48	32	r	ps	primary	RA	no
5-80	5-40	4 months	5-030	0-90	0-90 @48/12	m	55	32	r	ps	primary	post trauma OA	no
5-80	10-40	8 months	0-20	0-100	0-45@36/12	m	59	35	l	cr	primary	OA	yes
10-90	0-70	3months	5-45	5-90	0-90@12/12	f	57	33	l	ps	primary	OA	yes
15-40	20-45	3months	5-020	10-100	0-60@24/12	m	69	23	r	ps	primary	OA with synvitis	yes
10-85	15-60	18 months	10-030	10-100	0-70@24/12	f	59	29	r	ps	primary	OA	yes
0-90	0-20	10 months	0-20	0-110	0-85@24/12	f	63	41	l	ps	primary	OA	yes
0-5	5-010	16 months	10-020	0-90	0-30 @24/12	m	58	41	l	ps	primary	post trauma OA	no
0-90	0-20	31 months	0-30	0-110	0-80 @ 12/12	f	70	36	r	ps	primary	OA	yes
0-110	0-30	22 months	0-10	0-80	10-20 @ 8/12	f	62	35	r	cr	primary	OA	no
5-025	0-45	10 years	0-60	0-100	0-90 @ 36/12	f	55	30	l	?	primary	RA	yes
ps- posterior stabilised ; cr- cruciate retaining													
OA- osteoarthritis ; RA- Rheumatoid arthritis													