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International Consensus Definition and Classification of Knee Joint Fibrosis

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Contributions of authors

All authors were involved in the consensus forming process through contribution to three Delphi rounds. Draft consensus statements were written by NK and then revised and re-written by all authors during the consensus process. The draft manuscript was prepared by NK. All authors edited and revised the manuscript. The consensus process was coordinated by NK and DJD.

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Abstract

To develop a definition of knee fibrosis occurring after surgery an international panel of experts took part in a formal consensus process composed of a discussion phase and three Delphi Rounds. Post-surgical knee joint fibrosis was defined as a restricted range of motion (ROM), in flexion and/or extension, that is not attributable to osseous or prosthetic block to motion from malaligned or mal-positioned or incorrectly sized components, metal hardware, ligament reconstruction, *infection (septic arthritis), pain*, chronic regional pain syndrome (CRPS) or other specific causes, but is due to soft tissue fibrosis that was not present pre-operatively. Movement restriction was graded as mild, moderate or severe according to the flexion range (90 to 100°, 70 to 89°, <70°) or extension deficit (5 to 10°, 11 to 20°, >20°). Recommended investigations to support its diagnosis and a strategy for patient management were also agreed upon. The development of standardised, accepted criteria for diagnosis, classification and severity grading of post-surgical knee fibrosis will facilitate identification of patients for inclusion in clinical trials, the development of clinical guidelines, and eventually to help inform clinical management.
Introduction

Joint fibrosis is a well-recognised pathological process that involves diffuse scarring within a joint and the surrounding soft tissues leading to restricted joint movement and joint pain. Fibrosis may be a devastating complication following knee surgery that often requires further surgical intervention to remove the fibrotic tissue, with resultant surgical morbidity, risk of adverse effects and significant risk of recurrence.

Tissue from fibrotic knee joints is composed of a dense, disorganised extracellular matrix of collagen fibrils interspersed with α-smooth muscle actin containing myofibroblast cells. Arthroscopy of fibrotic knees has demonstrated well-defined intra-articular fibrous bands.

A variety of different clinical criteria have been used to diagnose post-traumatic fibrosis, including range of motion (ROM) deficit and the presence of fibrotic scar tissue seen at operation. The lack of a consistent, widely accepted disease definition is reflected in the wide range of incidence reported in the literature for fibrosis post-total knee arthroplasty (TKA) as low as 1%, or as high as 15%.

Furthermore there is no standardised, accepted clinical guideline for the investigation and management of knee fibrosis. Consequently, recommendations on the use of computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound imaging and the role of knee aspiration in diagnosing knee fibrosis are inconsistent. The role and timing of treatment, such as manipulation under anaesthesia (MUA), is also debated and several different clinical management guidelines have been proposed.

The lack of a precise definition of post-surgical knee fibrosis presents a challenge for research that requires standardised patient selection with a robust diagnosis of knee fibrosis. Whilst our understanding of the cellular pathology is progressing, our ability to identify affected patients consistently and robustly is hindered by a lack of consensus on diagnostic criteria, grading, current role of imaging techniques and treatment options. The aim of this study was to develop a definition, diagnostic criteria and classification system for post-surgical knee fibrosis using a recognised formal consensus process.
Methods

A Delphi process (brainstorming, narrowing down, quantification) was applied based on previously published consensus statements \(^{15}\) and followed guidelines set out by the NHS Research and Development Health Technology Assessment programme \(^{16}\) and the British Medical Journal \(^{17}\). The consensus process applied here is outlined in Figure 1.

An expert panel that included knee surgeons, rheumatologists, basic scientists working on fibrosis, pathologists and musculoskeletal physiologists was selected based on publication record in knee arthroplasty, joint fibrosis, involvement in knee joint fibrosis investigation and treatment and willingness to engage in the consensus process. Key individuals involved in diagnosis of joint fibrosis \(^{18,19}\), analysis, management and revision of TKA failure \(^{20}\), investigation and treatment of post-surgical fibrosis \(^{1,5,13,14,21-23,13,24-32}\) and basic research on fibrosis \(^{33-35}\) formed the Joint Fibrosis Consensus Working Group. Founding members (SH) and Presidents and Past-Presidents of the European Knee Society (JB, JA), the Past-President of the International Society of Arthroplasty Registries (OF), members of the Knee Society (MM, JN, JB, FH), Head of the Norwegian Knee Arthroplasty Register (OF), Past-President of the Arthroplasty Society of Australia (PL), Deputy Director of the Australian Orthopaedic Association National Joint Replacement Registry (PL), and members of the British Association for Knee Surgery Research Board (AT) were part of the Group. Previous participants in an international consensus group on prosthetic joint infection (MM, FH, RMJ) were also included. Several members have also Chaired instructional courses for knee stiffness and contracture management (MM, AB, PL).

In the first step of the process members of the working group identified specific topics that required consensus formation (brainstorming). A literature review was undertaken (NK) focusing on key areas requiring consensus and circulated to the panel for comments. A search was done of Medline (via PubMed), Embase and Cochrane databases for papers on knee fibrosis. Only reports in English were included that were published between 1950 and June 2015. These studies formed the start of the Delphi process. The following search terms were used: ‘arthrofibrosis’, ‘fibrosis’, ‘knee’, ‘arthroplasty’, ‘knee replacement’, ‘ligament reconstruction’. Overall 320 papers were reviewed and information on key topics (definition, classification, diagnosis, investigation, management) from 47 reports was circulated to the group. Feedback from the panel was used to define key areas for consensus and to draft initial statements (NK, DJD).
Draft consensus statements were circulated for rating by use of a scale of 1 (disagree) to 10 (agree), and comments. An online survey tool (www.sosci.de) was used throughout the Delphi process. These inputs were integrated and the amended consensus statements were prepared with a detailed explanation for each revision. Anonymised results from the first round were then recirculated for scoring, comments, and proposed revisions for statements that scored 7 or less in the first round. Three rounds were required before final revisions were derived. A predetermined mean score of 7 or more (with three or fewer outliers: defined as scores less than 4) was used to define consensus.
Results – Consensus Findings

Consensus was reached on 24 statements that fulfilled the criteria for acceptance. These statements were grouped into eight key categories (Definition and Classification, Investigations, Diagnosis etc.).

**Definition and Classification of the Condition**

Post-surgical knee joint fibrosis was defined as restricted knee joint ROM, in flexion and/or extension, that is not attributable to bony or prosthetic block to motion from malaligned or mal-positioned components, metal hardware, ligament reconstruction, infection *(septic arthritis)*, pain, CRPS or other specific causes, and is due to soft tissue fibrosis that was not present pre-operatively. **Pain is a possible cause of stiffness; this can be demonstrated by examination under anaesthesia.** The term post-surgical knee fibrosis was selected by the panel, rather than arthrofibrosis, which is commonly used in the literature, as a precise name for the deposition of fibrotic scar tissue in the knee joint following surgery. Post-surgical knee fibrosis encompasses ligament reconstruction and arthroplasty surgery. Fibrosis following trauma was considered as a separate condition. **It was recognised that knee fibrosis may be primary (spontaneous), if it occurs without a preceding traumatic injury, joint infection, or surgical procedure, but the overwhelming majority of knee fibrosis occurs following either trauma, infection (septic arthritis) or surgery (secondary). The classification of knee fibrosis as primary or secondary reflects this consensus (Figure 2).**
**Consensus Statements – Definition and Classification**

- Post-surgical knee joint fibrosis is defined as restricted ROM, in flexion or extension, that is not attributable to osseous or prosthetic block to motion from mal-positioned or incorrectly sized components, metal hardware, ligament reconstruction, infection (septic arthritis), pain, CRPS or other specific causes, and is due to soft tissue fibrosis that was not present pre-operatively.

- Joint fibrosis may be spontaneous (primary) or following an insult such as surgery or trauma (secondary).

- Spontaneous knee joint fibrosis, in the absence of trauma or surgery, is extremely rare. Post-trauma or post-surgery knee fibrosis is much more clinically important.

- This classification can be further sub-categorised into post-arthroplasty joint fibrosis, post-ligament reconstruction fibrosis etc., according to the algorithm in Figure 2.

**Investigations**

The principal aim of investigation in a patient with a stiff, painful knee and suspected fibrosis following surgery is to exclude other causes of stiffness. These include, but are not exclusively limited to, osseous or prosthetic block to motion from mal-positioned or incorrectly sized components, metal hardware, ligament reconstruction or infection or CRPS. Plain films and CT scans are useful for identifying component mal-positioning or a bony block to motion, such as heterotopic ossification. Infection must be excluded and laboratory evaluation of blood inflammatory indicators (C-reactive protein), cell count and differential, as well as aspiration of the joint for microbiological culture and cell count is strongly recommended. *Criteria set out by the Musculoskeletal Infection Society (MSIS) should be used to rule out infection*.  

Aspiration of stiff knee joints may not find fluid available; in this situation injection of saline and re-aspiration is not recommended in the Philadelphia Consensus Meeting on periprosthetic joint infection.

A number of painful and stiff knees post TKA are related to wrong indication with no bone-on-bone disease. *Evaluation of preoperative x-ray images makes the diagnosis in these cases without the need for further sophisticated assays.*
In addition to intra-articular scarring, a fibrotic or non-elastic extensor mechanism can result in knee stiffness and pain. Evaluation of pre-operative x-ray images can be used to find evidence for extensor mechanism disease. Removal of intra-articular scarring will be ineffective in restoring knee motion in these cases.

Fibrosis may be present with other causes of knee pain and stiffness post-surgery, and may be triggered by them (e.g. by infection or mechanical conflict). When fibrosis occurs alongside another pathology causing stiffness, this was not considered true post-surgical knee fibrosis.

At present fibrosis cannot yet be robustly diagnosed by MR imaging but it may be useful in the future as metal artifact reducing scan sequences are being developed for this purpose. In the future the basis of MR objective measurements of fibrosis could be the quantification of fibrotic tissue in the knee joint, such as in the parapatellar gutters, or the measurement of perisynovial thickness.

**Consensus Statements – Investigations**

- There is no definitive diagnostic imaging test available for diagnosing postsurgical knee fibrosis
- Knees should be investigated by plain radiographs (which may show patella infera). CT scans can help identify component mal-positioning
- The purpose of x-ray and CT imaging is to rule out causes of stiffness post-surgery (e.g. implant malalignment, component sizing issues). There is currently not enough evidence for the routine use of MRI in diagnosing fibrosis
- We propose an algorithm for investigation of patients with stiff knee joints post-surgery (Figure 3)

**Diagnosis**

Post-surgical knee fibrosis is a clinical diagnosis that can only be made when investigations have been performed to exclude other causes. The clinical diagnosis may be supported by
direct visualisation of fibrosis at surgery, either arthroscopically or by open techniques. Laboratory evaluations and aspiration for microbiological culture should be performed routinely to rule out infection according to the Musculoskeletal Infection Society (MSIS) criteria. Bone scan alone is not recommended to rule out infection. Histological criteria have been proposed, but biopsy to make a diagnosis is not required. Tissue taken at the time of débridement may be sent for histopathological evidence of fibrosis to support the diagnosis.

<table>
<thead>
<tr>
<th>Consensus Statements – Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A clinical diagnosis of joint fibrosis may be made after excluding other causes of stiffness</td>
</tr>
<tr>
<td>• The clinical diagnosis may be confirmed surgically (either through open or arthroscopic visualisation of the joint), but surgery is only warranted as an intervention and is not justified for diagnosis alone</td>
</tr>
<tr>
<td>• Tissue biopsy is not required to make the diagnosis</td>
</tr>
<tr>
<td>• Further research into radiological measures of fibrosis (e.g. perisynovial tissue thickness, knee circumference) is required before their widespread use in diagnosis</td>
</tr>
<tr>
<td>• Further research is required to identify robust predictors of joint fibrosis. These may include serum biomarkers</td>
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**Range of knee motion**

Reduction in flexion and/or extension is required for a diagnosis of joint fibrosis. The severity of ROM loss can be graded according to the amount of restricted movement. This criterion is active rather than passive ROM, as examiners may apply varying degrees of pressure. For simplicity, an absolute ROM is used for grading of severity. Comparison with pre-operative ROM and with the contralateral knee may be useful clinically, but these comparisons can be affected by pre-operative stiffness and the presence or absence of contralateral disease. The goal of TKA includes establishment of ROM, therefore absolute ROM restriction forms part
of the criteria for the diagnosis of joint fibrosis. Three levels of severity were agreed according to the movement restriction (mild, moderate and severe). Extreme ROM loss, with global ROM <30° in total, that may happen in knee ankylosis following septic arthritis as described by Bae et al. (2005)\textsuperscript{40}, does not form part of the severity classification for post-surgical knee fibrosis. The severity of knee fibrosis is not solely due to the degree of ROM limitation and other factors are important, including pain.

<table>
<thead>
<tr>
<th><strong>Consensus Statements – Range of motion Restriction</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• A restricted range of motion in flexion or extension, or both flexion and extension must be present for a diagnosis of knee joint fibrosis</td>
</tr>
<tr>
<td>• The severity may be graded according to motion loss based on the deviation from full flexion or extension as mild, moderate and severe extension restriction (5-10°, 11-20°, &gt;20°) or flexion range (90-100°, 70-89°, &lt;70°).</td>
</tr>
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</table>

**Pathological Anatomy**

Information on the patho-anatomical location can be gained from clinical examination and correlation with areas of swelling or particular ROM deficit. However, direct visualisation is the gold standard for determination of the location of fibrosis. MRI may in the future become a useful tool for identifying areas of fibrosis. Focal fibroses such as infra-patella contraction syndrome (IPCS)\textsuperscript{41} do not generally cause severely restricted ROM. Thorpe et al. describe a syndrome of painful patellofemoral dysfunction, but not ROM restriction, following TKR in 11/635 patients\textsuperscript{42}. Intra-articular lesions were found transversely on the patella, or running between the patella and the fat pad or the intercondylar notch. Arthroscopic removal of the lesions resolved patient’s symptoms without a change in their active ROM. Without an ROM restriction these lesions do not form part of the disease definition of post-surgical knee fibrosis.
Consensus Statements – Pathoanatomy

- The anatomical location of fibrosis can be demonstrated during open or arthroscopic surgery. Current imaging modalities (e.g. USS, MRI) are not yet validated for visualising fibrosis
- The location of the scar tissue may be as follows:
  - Infrapatellar (Hoffa) fibrosis
  - Medial or lateral parapatellar fibrosis or scarring (gutter)
  - Suprapatellar pouch fibrosis, scarring or obliteration
  - Patella tendon shortening
  - Posterior fibrosis
  - Quadriceps muscle fibrosis/scarring (vastus intermedius)
  - Intrasubstance fibrosis of the knee joint capsule,
    - Diffuse fibrosis or scarring involving a combination of the above
- Local fibroses such as infrapatellar contraction syndrome or discrete bands of adhesions that do not cause restricted range of motion are not sufficient for a diagnosis of Knee Joint Fibrosis, and are considered Local Fibrosis

Histopathology

Criteria for a tissue diagnosis have been proposed. Histopathologically post-surgical knee joint fibrosis is characterized by a varying degree of fibrosis (cellularity of fibroblasts). In one report a count of beta-catenin positive cells above a set threshold level (>20 per high power field, 0.307mm²) allows, in conjunction with the clinical information, the histopathological diagnosis of arthrofibrosis. Histopathological analysis of tissue taken during surgery performed to débride fibrotic lesions responsible for reduced ROM is useful to support the diagnosis, but biopsy is not required for diagnosis, particularly as it requires an invasive procedure that may cause infection.
Prevention and Management

There is some evidence that aggressive physical rehabilitation regimens can reduce the incidence of fibrosis, but in some patients this may actually precipitate or worsen fibrosis. Some evidence exists that optimised post-operative pain control can reduce the requirement for subsequent MUA post-TKA. Pharmaceutical modulation of inflammation with corticosteroids and the interleukin-1 receptor antagonist Anakinra has been used to reduce the inflammatory response and decrease fibrotic tissue formation and pain post-operatively. Further research is required to optimise the post-surgical recovery period to reduce the incidence of fibrosis.

Management of fibrosis depends on the stage. Early fibrosis, which often has a ‘soft end-point’ to knee motion, may be treated successfully with physical therapy and manipulation. Analgesic therapy and relaxation techniques may also be helpful. In addition mechanical soft tissue stimulation using instruments such as Astym have shown early results in stiff TKA. Established fibrosis, typically present after three to six months post-surgery, often has a hard end-point to knee motion. There is some evidence that MUA performed within three months post-surgery is more effective than that performed after three months. Use of MUA should be considered alongside risk of iatrogenic fracture, particularly in patients with inflammatory conditions such as rheumatoid arthritis. Timing of MUA was debated within the group, with some members feeling that MUA is safe and effective up to six months post-surgery. This debate is reflected in the range of time post-surgery that MUA is considered an option (three to six months) although it is emphasised that effort should be made to exclude other causes of stiffness as early post-operatively as possible to allow MUA to be performed before fibrosis becomes established.

MUA should be performed at the time of maximum muscle relaxation by flexing the hip to 90 and grasping the tibia proximally to avoid leverage on the joint. The knee is flexed slowly and gently until palpable and audible separation of adhesions no longer occurs (as described in Consensus Statements – Histopathology).

Consensus Statements – Histopathology

• Further research is needed to determine a histological definition of fibrosis.
Consensus was reached that established fibrosis requires arthroscopic or open débridement. Revision of the implant may be required to re-establish ROM.

Consensus Statements – Prevention and Management

- Early fibrosis, <3 to 6 months post-operatively, may respond to treatment with physiotherapy and rehabilitation therapy and manipulation under anaesthesia (MUA), whereas established, ‘late’ fibrosis is relatively resistant to physical therapy and MUA
- Some evidence exists that successful post-operative pain control can reduce the incidence of post-surgical knee fibrosis 47, although further research into prevention of post-surgical knee joint fibrosis is required
- Further research is required to develop an evidence-based management algorithm to prevent post-surgical joint fibrosis
- We propose an algorithm for management of diagnosed post-surgical knee joint fibrosis (Figure 4)

Joint registries and fibrosis

Joint replacement registries do not currently allow sufficiently granular identification of patients with post-surgical knee fibrosis. ‘Arthrofibrosis’ or stiffness is often used as an umbrella term for stiff knees, lack of movement and true fibrosis, making it difficult to define true fibrosis cases. Furthermore, procedures for treating fibrotic stiffness, such as MUA and arthroscopic débridement, where open surgery is not performed and components are not changed, are not recorded in most registries.
Consensus Statements – Joint Registries

- Registries in their current form do not provide a robust resource for identifying patients who have post-surgical joint fibrosis due to a range of different limitations, including lack of a current, accepted disease definition and diagnostic criteria and most national registries do not include reoperations without component removal or change or closed procedures
Discussion

This international consensus provides agreement amongst a multidisciplinary panel for the definition, classification and diagnostic criteria of post-surgical knee fibrosis. Knee fibrosis is defined as a clinical diagnosis characterised by restricted knee ROM. The severity of fibrosis may be grouped according to the degree of ROM restriction and a grading scale is proposed. The diagnosis may be supported by direct visualisation of fibrosis at surgery and by histopathological analysis of knee tissue, although formal biopsy is not indicated or required.

Post-surgical knee fibrosis presents both a diagnostic and therapeutic clinical challenge. It is considered a clinical diagnosis of exclusion that requires thorough investigation to prove that stiffness and pain is not due to another cause. The list of possible causes of post-surgical knee stiffness is long, but infection and component malalignment or technical surgical error in particular must be excluded. Investigation algorithms have been presented for the analysis of the failed TKA. A significant proportion of failed TKAs are due to malrotation of implanted components, and this must absolutely be ruled out before making a diagnosis of fibrosis. The cornerstones of investigation remain a directed clinical examination, knee aspiration and laboratory evaluation to rule out infection, and plain films and CT scan to analyse implant position. MRI scan with artifact reducing sequences may in the future provide a non-invasive method to describe intra-articular fibrosis.

Fibrosis may co-exist with other conditions and may be triggered by them, such as following trauma or mechanical conflict caused by component malalignment. Fibrosis in this context was not considered post-surgical knee fibrosis, which currently has an unknown aetiology. Tissue from arthrofibrotic joints is composed of a dense, disorganised extracellular matrix of collagen fibrils interspersed with α-smooth muscle actin containing myofibroblast cells which form intra-articular fibrous bands. The molecular mechanism underlying the development of post-traumatic fibrosis is not known. It is likely that different triggers converge on a common ‘fibrotic pathway’, involving myofibroblasts and TGF-1β signaling. Furthermore, there is some evidence that fibrotic type conditions are heritable.

The patho-anatomic location of the fibrosis may be a range of different locations for a diagnosis of fibrosis, but must be sufficient to cause movement restriction. Limited pathology in local fibroses that do not cause ROM restriction such as infra-patella contraction syndrome is not considered knee fibrosis.
Alongside imaging investigation aspiration of the knee is recommended to rule out infection. Provided this is performed in sterile conditions the risk of introducing infection is outweighed by the need to establish whether stiffness is due to infection. Histopathology may be used to support the diagnosis of fibrosis, and recent publications have provided diagnostic criteria, such as the number of beta-catenin staining cells, but these criteria need validation before biopsy can be recommended to establish a diagnosis.\(^{18,19}\)

There was considerable debate over ROM restriction and whether this should be measured against pre-operative values or against the contralateral knee. Several grading systems have been proposed.\(^{9,10,55}\) Agreement was reached on grading severity by absolute ROM restriction irrespective of pre-operative stiffness or ROM of the contralateral knee. The limitation of the chosen grading is that knees with reduced ROM pre-operatively often do not regain ROM post TKA. The important message is that some degree of motion restriction in either flexion, extension, or both is absolutely required for a diagnosis of post-surgery joint fibrosis. It is also important to note that to judge success solely on ROM achieved would miss the main reason for TKA, namely pain reduction.

Rehabilitation protocols aimed at restoring ROM have reduced incidence of stiffness post-surgery, particularly following ACL reconstruction\(^ {13,47,56,57}\), but the optimum regimen remains unknown. Similarly, management of the stiff TKA remains challenging and evidence for particular treatment approaches is not available. There is limited evidence that optimised pain control can reduce the requirement for MUA in stiff knees post-TKA.\(^ {43}\) Good analgesia should form part of the management plan for patients undergoing TKA. One critical concept in the approach to fibrosis is of early versus late disease. The fibrotic condition is a disease spectrum, and early fibrosis often has a soft end-point to motion and will be amenable to physical therapy and manipulation. Conversely, established fibrosis, which likely occurs after 3 to 6 months, often has a hard end-point to knee motion. It is refractory to physical therapy and manipulation runs the risk of iatrogenic fracture and should be avoided.\(^ {48}\) There was considerable debate over the timing of MUA post-surgery. A consensus that MUA more than six months post-surgery was not indicated, but between three and six months some members felt MUA was appropriate. There is limited evidence that MUA is most effective less than three months from surgery.\(^ {23}\) The timescale for MUA was left deliberately open and consensus was reached on a statement that MUA may be considered up to three to six months post-surgery.

Patients resistant to non-operative treatment require arthroscopic or more invasive surgical procedures to excise and remove the soft tissue contractures.\(^ {3}\) In knee disease, arthroscopic
release may be used as an initial approach of choice. Kim et al. (2004) provide a treatment algorithm for arthroscopic débridement involving capsular distension with fluid, medial and lateral retinacular releases, graft débridement and posterior joint release. Open surgery for fibrosis is reserved for knees resistant to conservative or arthroscopic procedures (2% of cases) and often requires large incisions with extensive surgical exploration of the joint and surrounding extra-capsular soft tissues. The outcomes of surgically treated post-traumatic fibrosis of the knee are poor, with most patients unable to return to pre-injury level of function. Currently, available treatments work by stretching or surgically removing the fibrotic tissue; they do not address the biological basis of disease. This may contribute to recurrence of post-traumatic fibrosis, which is a frequent problem.

The role of joint replacement registries in fibrosis research was considered. Population level studies of patients with fibrosis would allow identification of risk factors, provide more precise incidence data, and inform management strategies. Currently, robust identification of patients with fibrosis in National Registries is challenging; arthrofibrosis as a reason for revision forms one group in the Australian registry, while the UK registry uses stiffness, despite the range of different pathologies that this encompasses. Furthermore, only patients having a formal revision procedure involving exchange, removal or insertion of components are captured by registries, significantly underestimating the number of patients with fibrosis who are treated with non-operative measures or débridement only. A way forward for registries might be to use this consensus statement as a definition and include joint fibrosis post TKA as a revision cause and also include open revision procedures not involving implant components and closed procedures such as MUA.

This consensus process has provided a definition, classification and diagnostic criteria for knee fibrosis post-surgery. The aim was not to provide a clinical guideline on the management of these patients, because further research into the prevention and management of knee fibrosis is required. These statements should now undergo a period of validation to allow this definition and classification system to be improved upon and modified.
References


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56. DeHaven KE, Cosgarea AJ, Sebastianelli WJ. Arthrofibrosis of the knee following


**Figures**

Figure 1. The Delphi Consensus Process followed in the formation of Consensus Statements on post-surgical knee fibrosis

Figure 2. Classification system for knee fibrosis

Figure 3. Investigation algorithm for patients with suspected knee fibrosis following total knee replacement

Figure 4. Management algorithm for post surgery knee fibrosis
Brainstorming
18 experts

Topics for Consensus Agreed On

Literature reviewed
Statements drafted

First Delphi Round
18 experts

Second Delphi Round
18 experts

Third Delphi Round
18 experts

Consensus
24 Statements Accepted
Post-surgical Joint Fibrosis Definition Formed

8 Topics
- Definition
- Investigations
- Diagnosis
- Range of Motion
- Pathoanatomy
- Histopathology
- Management
- Joint Registries

24 statements
- 1 Definition
- 2 Classification Statements + 1 Algorithm
- 3 Investigation Statements + 1 Algorithm
- 5 Diagnosis
- 2 Range of Motion Severity Scale
- 3 Pathoanatomy
- 1 Histopathology
- 3 Management Statements + 1 Algorithm
- 1 Joint Registry

Literature Review
- 327 Papers reviewed
- Information from 46 papers circulated

Information from 4 topics:
- Definition
- Investigations
- Diagnosis
- Range of Motion
Knee Joint Fibrosis

Primary*
No causative insult identified
*Extremely rare in the knee

Secondary
Initiating factor identified

Following Traumatic Injury or Infection

Post-arthroplasty
Local
Generalised

Post-surgery
Post-ligament Reconstruction or other procedure
Local
Generalised
Post-surgery Stiff knee Investigation Algorithm

History
- Pain control after surgery inadequate?
- Rehabilitation followed?

Clinical examination
- Measure ROM (active versus passive)
- Test patellar mobility
- Test quadriceps action
- Test joint stability

Examine

Investigations
1. Imaging
   - Plain XRs – heterotopic ossification, patella infera
   - CT scan – component malalignment
2. Serology
   - Inflammatory markers
3. Aspiration
   - To rule out infection

Additional Optional Tests
1. Histology
   - Biopsy to demonstrate scar tissue
2. MRI – scar tissue

**NOTE THAT NOT ALL INVESTIGATIONS ARE MANDATED, CLINICAL JUDGEMENT IS REQUIRED AND THE DIAGNOSIS MAY BE MADE CLINICALLY WITH SUPPORT OF PLAIN RADIOGRAPHS**

Exclude
- Chronic Regional Pain Syndrome
- Infection, wound issues, wrong surgical indication
- Problems with implant (mal-positioning, cement, ectopic bone formation (rare), loosening, mal-alignment)

Diagnosis of Post-surgery knee fibrosis may be made
<3-6 Months Post-op
Early Fibrosis

Cases may respond to non-operative measures*
Physiotherapy, stretching, movement exercise, relaxation techniques
Static progressive splints

ROM improved
ROM not improved

>6 Months Post-op
Late Fibrosis

Trial of non-operative measures*
Physiotherapy, stretching, movement exercise, relaxation techniques
Static progressive splints

ROM not improved

MUA

Surgical Procedure
First line – arthroscopic
Second line – open debridement to restore ROM, may require revision of TKR

*Important to work up patient to exclude causes of stiff TKR whilst non-operative treatments are employed