Causation Review - Meniscal Tears.

Classification Of Meniscal Tears Of The Knee And The Evidence That Certain Tears Are Degenerative In Origin; Including The Relationship Of Meniscal Tears To Knee Osteoarthritis.

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Important Note

This causation review summarises information on the classification of meniscal tears of the knee and the outlines the evidence that certain tears are often degenerative in origin.

It is not intended to replace clinical judgement, or be used as a clinical protocol. A reasonable attempt has been made to find and review papers relevant to the focus of this report but it is not exhaustive. The content does not necessarily represent the official view of ACC or represent ACC policy.
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Summary

Background
In this report the clinical and physiological associations, natural history and causation of knee meniscal tears is reviewed and evidence presented to assist ACC decide which types of meniscal tear in relation to the subject and situation are likely to be due predominately to a traumatic injury event and therefore compensable and which are predominately due to non-injury causes. (Evidence of best treatment options is only noted in this review).

The terminology that describes certain tears as ‘traumatic’ or ‘degenerative’ is widespread in the medical literature and widely accepted as a broad concept. This paper reviews the evidence for this terminology to assess its reasonableness. For reasons of simplicity the current classification of traumatic or degenerate is used in the paper while seeking the evidence for it.

Meniscal tears are a common orthopaedic diagnosis and partial meniscectomy is the most frequent surgical procedure performed by orthopaedic surgeons in the United States with more than 50% of the procedures performed in patients 45 years and older.

ACC data
Because ACC does not collect detailed surgical procedure codes it is not known how many procedures are done that include repair or resection of knee menisci. It is believed that a high proportion of knee arthroscopies however would include these procedures.

Between July 2008 and June 2009 ACC paid for 8999 simple and complex knee arthroscopic procedures at a total cost of $29,275,965. These figures exclude those coded for anterior cruciate ligament (ACL) reconstruction and knee arthroscopic procedures that proceeded to open surgery. The costs only refer to the elective surgery costs; costs for subsequent workers compensation etc., are not included.

The highest arthroscopic rate of intervention in the year 08/09 expressed as a rate per 1000 of population occurred in the 50 to 59 age year group when the rate just exceeded 4; the next highest rate occurred in the 40 to 49 years olds and then the 60 to 69 years olds where the intervention rate was respectively 3.76 and 3.38 per 1000. 69.4% of all knee arthroscopies were done in those 40 years of age and over at a cost of $20,312,477: much of ACC’s costs for knee arthroscopy are incurred by middle aged and older subjects.

Classification of meniscal tears
As commonly used in the literature ‘traumatic tears’ is a term used to describe tears that are believed to arise predominately as a result of a specific, traumatic injury event and are often considered to include vertical, bucket handle and radial tears. Traumatic tears normally occur in younger sports-active people with or without associated cruciate ligament injury; the meniscus typically splitting in a vertical direction.

Similarly ‘degenerative tears’ is a term used to describe tears that arise predominately due to degenerative processes and include horizontal, flap and complex tears as well as meniscal degeneration and destruction. They are amongst the most common of the meniscal lesions. There appearance at arthroscopy is highly variable and includes fraying of the free edge, central degeneration, centrally located horizontal tears, fringe tags, degenerative flap tears and extensive fibrillation of the entire meniscus.
Main results

Several lines of evidence for the classification of tears into traumatic and degenerative types are reviewed by considering their occurrence and association with

- Age (4.1),
- Anterior cruciate ligament injuries (ACL injuries) (4.2),
- Other specific traumatic events (4.3)
- Occurrence in symptomatic and asymptomatic knees (4.4)
- Body mass index (4.5),
- Osteoarthritis (OA) (4.6),
- Outcomes after meniscectomy (4.7),
- Specific occupations (4.8).

The summarised evidence is as follows:-

1. Age: There is high quality evidence from a cohort study which shows that tears and meniscal degeneration increase in frequency with age. This evidence is supported by a range of case series studies including histological studies and direct observation at surgery covering populations in many different countries. Degenerate tears are extremely common in the general population. The Framingham data suggest that about one third of knees in those over 50 years of age have degenerate tears. The prevalence of grade 2 MRI signal changes, indicative of early degeneration was already 24.1% at the posterior horn of the medial meniscus in a young population. Grade three changes indicative of frank tearing had a prevalence of 76% in one study on older asymptomatic subjects (mean age 67) and reached 91% in those with symptomatic osteoarthritis (91%).

2. ACL injuries: There is good evidence, consistent across a range of case series studies that 70 to 90% of tears associated with acute ACL injuries are traumatic type tears - peripheral, longitudinal tears. The percentage of degenerative tears found (flap and horizontal tears) is small.

3. Other traumatic events (not specifically ACL): There is some evidence from a cohort study and number of case series studies that longitudinal/bucket handle/vertical tears predominately occur due to specific injury events and horizontal tears due to degeneration but these classifications are by no means exclusive.

4. Occurrence in symptomatic and asymptomatic knees: There is some evidence that degenerate tears occur with high frequency bilaterally, in the symptomatic knee and the asymptomatic knee of the same person, whereas traumatic tears are more commonly found unilaterally in the symptomatic knee.

5. Body mass index: There is good evidence that prevalence of tears is strongly associated with BMI. These tears are likely to be mainly degenerate in nature.
6. Osteoarthritis (OA): There is excellent evidence from a variety of studies that degenerative tears particularly horizontal tears, complex tears and degenerate menisci are more strongly associated with the presence of OA than other tears. In one study the percentage of horizontal tears increased from 18.4% where no OA was present to 61.5% for grade 3 OA.

7. Outcomes after meniscectomy: There is some evidence from retrospective, cohort/case series studies that meniscectomy/repair, results in worse longer term outcomes for the patient if the surgery was conducted for a tear that was degenerate, or in a meniscus that was degenerate. However the evidence is not compelling.

8. Specific occupations: One paper has been reviewed that provides some evidence suggesting that floor layers have a higher prevalence of degenerative tears than graphic designers but this increased prevalence did not result in increased levels of pain or discomfort nor was there any difference in complaints between those with tears and those without, even though about 50% of the total population surveyed reported knee complaints.

This body of evidence taken as a whole makes a compelling case, based on associations with various factors, for a dichotomous classification of tears into those predominately of a degenerative origin and those of predominately traumatic. This classification though is not absolute. It is accepted that there are many gray areas; for example it seems possible that a traumatic event may exacerbate degeneracy already present creating frank degenerate tears.

Degenerative changes in the meniscus are well under way in many subjects under 30 years of age and that by 50 to 60 years of age, full, degenerative tears are common place in at least one third of subjects and in some populations’ prevalence is over 50%. Unless these changes are associated with the presence of OA, such degeneration is often but not always asymptomatic and disability is not obvious.

There is excellent evidence that degenerate tears are strongly associated with the presence of OA and in this case associated with significant pain and disability. The degenerate tear is in fact so common in the elderly with moderate OA it has been suggested that it is pointless to conduct an MRI to prove their presence.

It has been suggested that ACC is currently paying for a number of arthroscopies undertaken in knees with significant levels of OA, to resect the degenerate meniscus, remove loose bodies and osteophytes, and debride the chondral surface on the assumption that this is treating a personal injury rather than a disease. This assumption is probably ill-founded and it needs to be confirmed that ACC is not funding a number of surgical cases contrary to its legislative mandate.

**Conclusions**

It is suggested that arthroscopy undertaken for resection of degenerate tears associated with OA should not typically be regarded as compensable under ACC’s legislation, the pathological processes at play, being on the balance of probabilities substantially attributable to advancing age and disease and not to trauma. A number of suggestions are made that may assist with case decisions and follow up.
Classification Of Meniscal Tears Of The Knee And The Evidence That Certain Tears Are Degenerative in Origin; Including The Relationship Of Meniscal Tears To Osteoarthritis (OA).

1. Introduction and general approach

At the suggestion of the Clinical Advisory Panel, Elective Services, a report has been prepared that aims to delineate the situations, from the perspective of causation (not treatment), when ACC should approve surgical treatment of knee meniscal tears. It seeks to establish the evidence for the propositions that –

- Certain meniscal tears are predominately of degenerative origin and therefore not typically compensable under the Accident Compensation Act 2001.

- Meniscal tears associated with OA are usually a reflection of a degenerative process and that in such cases ACC should not pay for the surgical repair of either the tear or for the amelioration of the osteoarthritis. This is essentially a particular case of that above.

To answer these propositions the evidence for the association of knee meniscal tears with various clinical and physiological factors and their natural history/causation is reviewed (section 4).

A major reason for undertaking the review is the belief that some arthroscopies being done in middle aged and older subjects takes place in knees where advanced OA is present; these cases being treated as personal injury rather than disease. If this is so ACC is possibly paying for a number of interventions which would more properly be funded by the District Health Boards (DHBs).

The terminology that describes certain tears as ‘traumatic’ or ‘degenerative’ is widespread in the medical literature and widely accepted as a broad concept. This paper seeks to present the evidence behind this terminology and test if it is reasonable. For reasons of simplicity the current dichotomous classification of traumatic or degenerate is used in the paper while seeking the evidence.

It is accepted that the term ‘causation’ in the context of this paper is not always appropriate as the evidence for a traumatic/degenerative classification is typically based on association of tear types with various clinical and physiological factors. In the final analysis the attribution of cause is dependant on the individual case, in the light of all the evidence and clinical presentation.
Because the literature is extensive and mostly case series in design, not all papers have been reviewed. While this approach is less than ideal it is practical. Key papers and topics that may have been missed can be added if drawn to our attention. An emphasis has been placed on reviewing cohort and case/control studies when they were available. Ovid Medline, EMBASE, TRIP, Cochrane and other evidenced based healthcare databases were searched for papers relevant to the topic. Papers were graded according to the Sign methodology (Appendix 2).

The knee meniscus and meniscal tears

The lateral and medial meniscus of the knee joint are fibrocartilaginous C-shaped discs that occupy the joint space between the femur and the tibia. They are composed of collagen, embedded in which are fibrochondrocytes that are able to synthesize the matrix. In cross-section the menisci are wedge-shaped.

The medial meniscus is firmly attached to the joint capsule whereas the lateral is more mobile. Both menisci are attached to the tibia through the anterior and posterior horns. The meniscus is typically avascular with only the peripheral 10 - 30% of the meniscus vascularised. Only the outer third of the meniscus has pain fibres; this may not necessarily equate to an absence of pain if a tear occurs in the non-innervated region. The menisci are integral to knee function providing load transmission, shock absorption, joint lubrication and joint stability.

According to Englund (2008) a meniscal tear is a common orthopaedic diagnosis and partial meniscectomy is the most frequent surgical procedure performed by orthopaedic surgeons in the United States with more than 50% of the procedures performed in patients 45 years and older. The location of tears in many cases is typically on the posterior horn of the medial meniscus in line with peak pressures in deep knee flexion and restricted medial meniscal movement.

Many patients with meniscal tears present without any history of injury or symptoms attributable to a tear itself, the pain being due to osteoarthritis related pathology (OA) and the tear being identified later by MRI. Others have a history of a rotational knee injury or a sudden tearing sensation and sharp pain after squatting. Meniscal tears may also cause intermittent locking, snapping, or limitation of extension. Acute lesions are often associated with acute trauma symptoms, hemiarthrosis and possible torn collateral ligaments and ruptured ACL.

2. ACC Data

Because ACC does not collect detailed surgical procedure codes it is not known how many arthroscopies are done that include repair or resection of knee menisci nor how many are done in knees where advanced OA is also present. It is believed that a good proportion of knee arthroscopies however would include meniscal resection and be done in knees with advanced OA. Between July 2008 and June 2009 ACC paid for 8999 simple and complex knee arthroscopic, elective, procedures (coded KNE 50 and 60) at a total cost of $29,275,965. These figures exclude those coded for anterior ligament (ACL) reconstruction and knee arthroscopic procedures that proceeded to open surgery. The costs only refer to the elective surgery costs; costs for subsequent workers compensation etc are not included.

The breakdown of knee arthroscopies by age is shown in figure one and the crude rates of intervention in figure 2. Arthroscopic interventions reached a maximum in those 40 to 49 of age closely followed by those 50 to 59 (Fig 1). However when these interventions are expressed as a crude rate per 1000 of population the highest intervention rate occurred in the 50 to 59 age...
year group (fig 2) when the rate just exceeded 4 per 1000; the next highest rate occurred in the 40 to 49 years olds and then the 60 to 69 years olds where the intervention rate was respectively 3.76 and 3.38 per 1000.

Meniscal surgery is often done in association with ACL reconstruction in around 70 – 80% of cases. The intervention rate for ACL reconstructions is shown in Figure 3, where in sharp contrast to the interventions being coded under simple and complex knee arthroscopy the peak age for intervention is in the 20 to 29 year olds.

69.4% of knee arthroscopies (KNE 50 and 60) were done in those 40 years of age and over at a cost of $20,312,477 (Figure 4). These data show that much of ACC’s costs for knee arthroscopy are incurred in middle aged and older subjects.
Fig 2. Intervention rates per 1000 of population for knee arthroscopies, simple and complex (codes KNE 50 & 60); Jul 08 to Jun 09

Age group

No. of interventions per 1000 of population

<20 20 - 29 30-39 40-49 50-59 60-69 70-79 >=80

Fig 3. Intervention rate for ACL reconstructions per 1000 of population 08/09

Age group

Intervention rate per 1000

<20 20 - 29 30-39 40-49 50-59 60-69 70-79 >=80
3. Classification of tears and degeneration (excludes the discoid meniscus)

Meniscal injuries can be classified on their appearance, location, shape, extent and origin (Fig 5) \(^\text{11}\). It should be noted that some tears are known by a variety of names and it is not always clear if various writers use terminology consistently.

**Figure 5.** Four types of meniscal tear; across the diagram – Longitudinal, Horizontal, Radial and Flap. Copied from Englund\(^\text{13}\)
3.1. Vertical or Longitudinal (concentric) tears. Vertical or longitudinal tears occur in the line with the circumferential fibres of the meniscus and parallel to the outer margin of the meniscus. Most longitudinal tears of the medial meniscus occur in the middle and posterior thirds11. In the lateral meniscus it is common to find acute, complete or incomplete longitudinal tears of the posterior horn when the ACL is ruptured.

3.2. Peripheral tears. Peripheral tears are vertical or longitudinal tears, found in the peripheral one third of the meniscus. Stable vertical longitudinal tears which tend to be found in the peripheral, vascular portions of the menisci have good potential for self healing14.

3.3. Bucket handle tears are an exaggerated form of a longitudinal tear where a portion of the meniscus becomes detached from the tibia and the end result is a dislocated central part of the meniscus looking like a bucket handle. They are 3 times more common in the medial meniscus than the lateral and may be associated with acute ACL tears. Bucket handle tears are commonly seen in young adults with a history of locking, extension block or slipping of the joint15.

3.4. Radial tears are vertical tears which also occur often at the junction of the posterior and middle thirds and extend from the inner free margin toward the periphery. They are more common in the lateral meniscus and are often associated with ACL tears15. If they reach the periphery it transects the entire meniscus. Radial tears which occur in the avascular inner one-third of the meniscus have little potential for healing14. They are commonly traumatic and occur in younger, physically active patients.

3.5. Horizontal, cleavage or fish-mouth tears are common in older people and extend from the inner free margin to the intrameniscal substance where myxoid degeneration may be present. These tears divide the meniscus into superior and inferior flaps. They have little or no healing capacity.

3.6. Oblique tears are also known as flap or parrot beak tears; they are oblique vertical cleavage tears and usually occur at the junction of the posterior and middle thirds of the meniscus.

3.7. Complex degenerative tears are common in older subjects. The tears occur in multiple planes and are combinations of the above.

3.8. Displaced tears are fragments of a torn meniscus partially attached to the meniscus and migrating to any position within the joint. Displaced meniscal fragments are often clinically significant lesions requiring surgery because of pain and knee locking15. Any shape of a meniscal tear can result in a displaced fragment.

3.9. Root tears are tears in the posterior or anterior central meniscal attachment5.

3.10. 'Traumatic tears' is a term used to describe tears that are believed to arise predominately as a result of a specific, traumatic injury event and include vertical, bucket handle and radial tears. Traumatic tears normally occur in younger sports-active people with or without associated cruciate ligament injury; the meniscus typically splits in a longitudinal direction. The central part of the meniscus may dislocate centrally and cause locking of the knee. Traumatic injury is considered more frequent in the medial meniscus16.
3.11. ‘Degenerative tears’ is a term used to describe tears that arise predominately due to degenerative processes and include horizontal, flap and complex tears as well as meniscal degeneration and destruction. According to Strobel degenerative lesions are among the most common of the meniscal lesions. There appearance at arthroscopy is highly variable and includes fraying of the free edge, central degeneration, centrally located horizontal tears, fringe tags, degenerative flap tears and extensive fibrillation of the entire meniscus.

Reparable and non-reparable tears.

Possible options for the treatment of tears include, no surgery/conservative therapy only, meniscal repair, partial meniscectomy and complete meniscectomy. Surgeons attempt to preserve as much meniscal tissue as possible because of the increased development of degenerative changes in the knee after the removal of large amounts of meniscus.

A further useful classification of tears then is into reparable and non-reparable. Only about 20% of meniscal tears are suitable for repair. Factors affecting success include tear age, location, pattern, age of patient as well as associated injuries. Tears amenable to repair include unstable tears greater than 1 cm in length occurring in the outer 20% to 30% toward the periphery (vascular, red zone). Those tears occurring more toward the junction of the red-white zone may also heal. ACL tears are present in about 80% of knees with reparable meniscal tears.

According to Jee horizontal, radial and complex tears usually cannot be repaired and most often require partial meniscectomy.

4. Evidence for the traumatic/degenerative classification based on causation

Englund and may others believe that horizontal, flap, complex tears and tears in a meniscus with degenerative changes are all of degenerative origin and distinguishable from those that arise from trauma. Longitudinal and bucket handle are typically thought of as traumatic in origin and generally occur in younger populations. Opinion as to whether a radial tears is traumatic is less clear. Several lines of evidence for this classification are reviewed below for evidence of association of tear types with:-

- Age (4.1),
- ACL injuries (4.2),
- Other specific traumatic events (4.3)
- Occurrence in symptomatic and asymptomatic knees (4.4)
- Body mass index (4.5),
- Osteoarthritis (OA) (4.6),
- Outcomes after meniscectomy (4.7),
- Specific occupations (4.8).
4.1. Patterns of occurrence of meniscal tears and meniscal degeneration with age

Evidence Statements: Evidence from MRI findings that degenerative meniscal pathology including tears in the meniscus is associated with increasing age.

- Degenerative meniscal pathology and meniscal tears are detectable by MRI; areas of increased signal intensity can be seen where the tear or degeneration occurs in the meniscus\(^1\).

- There is high quality evidence from the Framingham cohort\(^5\), (50 – 90 years of age) which shows that tears and meniscal degeneration as determined by MRI increases with age. Overall prevalence of meniscal damage was 35% and meniscal tear 31%. The great majority of these tears were degenerative (horizontal, flap, complex and tears in a degenerated meniscus).

- There is some evidence from a smaller Australian study, (mean age 47, 57% female) that tears are common in middle aged Australians and prevalence was found to correlate strongly with age. Although their method did not discriminate whether the tears were of traumatic or degenerative origin their presence did correlate with other systemic degenerative factors and not with past knee injury suggesting that they were most likely of the degenerative type.

- There are a number of papers of which 8 have been reviewed here that studied the prevalence of meniscal tears and degeneration by MRI in small selected, non-random, populations of volunteers and patient groups. While the quality of this evidence is low it overall, presents a consistent picture. Meniscal degeneration as shown by increased areas of MRI signal intensity in the meniscus increases with age and is already common in younger groups of subjects: The prevalence of grade 2 signal changes indicative of early degeneration was already 24.1% at the posterior horn of the medial meniscus in a young population of health professionals of mean age 28\(^6\). Grade three changes indicative of tears had a prevalence of 76% in one study on older asymptomatic subjects (mean age 67) and reached 91% in those with symptomatic osteoarthritis (91%)\(^7\).
Evidence Statements: Evidence from histological findings that degenerative meniscal pathology including tears in the meniscus is associated with increasing age.

- Noble was amongst the first to draw attention to the association of horizontal cleavage lesions with degenerative pathology and the increased prevalence in older subjects in his review of the meniscal pathology in 170 cadavers.
- Noble also found that flap tears were associated with horizontal tears in 87% of cases.
- While Noble observed a marked age effect, horizontal tears were also found in younger subjects, as were the first signs of other degenerative pathology.
- The quality of the evidence of these studies is low.

Evidence Statements: Evidence from surgical findings that degenerative meniscal pathology including tears in the meniscus is associated with increasing age in symptomatic subjects.

- Repeatedly, surgeons have reported their observations of the occurrence of tears and meniscal degeneration with age in the symptomatic knee. Seven such studies are reported here.
- A repeated and generally consistent observation is that the mean age of those who present with horizontal, flap, complex or degenerate menisci are 10 to 20 years older than those presenting with longitudinal, bucket handle or radial tears which are generally found in the younger adults. For example, Lewandrowski found that essentially all medial meniscal derangements occurred in the older patients (early 50's) with the exception of bucket handle and longitudinal tears which were significantly more common in the younger (mid twenties).
- While essentially all these studies are case series and therefore of lower quality some studies were very large, reporting the results from a number of centres and it seems reasonable to conclude that their findings are typical of the populations involved.

Discussion

The objective of this section was to review the evidence that those tears classed as degenerative are much more common in the elderly, that the traumatic tear type is more commonly found in the young, that the frequency of degenerative tears increases with age and that MRI detected degeneration is already present in younger subjects.
MRI is a key technology as it is able to not only detect tears in the meniscus but also reveal areas of increased signal intensity where synovial fluid has entered into gaps in the matrix of the menisci and thereby show areas of degenerative change. Studies have shown that such MRI signal changes correlate closely with pathology as seen macroscopically and microscopically. Radiologists have devised grading systems to quantify the degree of degeneration and these systems are in common use. The grading represents a continuum of degeneration culminating in frank tears (Appendix 2).

The best evidence found comes from a survey of subjects living in Framingham of age range 50 to 90\textsuperscript{5}. The graphs (Fig 6) provide excellent evidence that tears increase in prevalence with age and that they are chiefly of the degenerative type. On average 31% of these subjects had tears, 35% had meniscal damage and 40% of the knees with meniscal tears had horizontal tears, 37% complex, 12% oblique, 15% radial, 7% longitudinal and 1% root tear.

Evidence from lesser quality studies is strongly supportive of these findings. Ding\textsuperscript{21} in his study of Australians of mean age 47, found a strong correlation of tears with age and that these tears had strong correlations with other degenerative pathology suggesting that the tears were degenerative in nature as well. Kornick\textsuperscript{22} also found that the prevalence of meniscal abnormalities to increase with age, grade 2 changes having the highest correlation coefficient (0.88). This suggests that it is not only the prevalence of tears that increase with age but also the prevalence of pre-tear degeneration.

The work of Noble\textsuperscript{3 4} on cadavers provides further evidence albeit of low evidential quality. He found that 60% of those of mean age 65 had at least one horizontal tear and 27% flap tears. The association of horizontal and flap tears was strong. Younger subjects had only one-third the prevalence of horizontal tears, though even they had evidence of related meniscal degeneration such as chondrocyte proliferation and degeneration, with mucoid degeneration and microcyst formation seen in several subjects less than 30 years of age.

Finally a number of studies based on direct observation at surgery provide evidence that in the symptomatic patients requiring surgery longitudinal type tears are predominately a tear found in the young and the degenerate tears have a peak prevalence about 10 to 20 years later. Smillie\textsuperscript{23} for example reported on the results of 3000 meniscectomies finding that 36% of tears were longitudinal, (average age 31) and 50% horizontal (average age 43). Similarly Poehling\textsuperscript{24} reviewing the findings of 10,117 knee arthroscopies suggested that meniscal tears fell into two patterns, degenerative and traumatic based largely on association with age and association with ACL injury. They concluded that injuries to the menisci occurring with an associated anterior cruciate injury, radial tears, and tears within 3 mm of the meniscosynovial junction were associated with a younger and more active patient who was more likely to sustain a traumatic or sports-related injury. Tears described as complex, horizontal cleavage, and flap tears were associated with an older age group and followed a more degenerative pattern. Such tears are common in the aging population and are typically asymptomatic.

Authors such as Poehling\textsuperscript{24} class radial tears as traumatic as well, based on their higher occurrence in younger male subjects and association with ACL injuries. This classification though is not as clear cut as that for longitudinal tears.

The evidence reviewed here is not exhaustive as only a sample of papers has been reviewed. The evidence comes from investigative studies using MRI, direct observation at surgery and histological studies at autopsy.
The quality of this evidence is with the two notable exceptions of Englund and Ding generally low since much of it is based on selected, case series, populations. However, these selected populations have come from Australia, Japan, Europe, Britain, and USA and some of the clinical studies are based on very large patient populations.

Conclusions

Overall the weight of evidence though not totally conclusive is strongly suggestive that horizontal, flap, complex tears and tears in a meniscus with degenerative changes are all of degenerative origin and occur much more frequently in older populations.

Degenerative pathology other than frank tears is already detectable by MRI in a significant proportion of young adults in their late twenties.

Longitudinal, bucket handle and radial tears occur in populations that are of mean age that is significantly younger than those with degenerative tears. It seems highly likely that they are predominately of traumatic origin.

Papers reviewed

MRI studies

Degenerative pathology is able to be diagnosed by MRI which show areas of increased signal intensity where it occurs. A classification of MRI detectable degenerative changes may be seen in the paper Rytter. The increased signal intensity observed in meniscal tears has been attributed to synovial fluid imbibed within the gaps (Review 1).

Hajek has shown that central areas of abnormal high signal intensity on MRI seen in 32 of 34 cadaveric and patient menisci correlated positively with degenerative alterations as seen macroscopically and microscopically. Similarly Stoller by comparing MRI with histological studies found that there was a one to one correspondence between the histology and MRI findings of meniscal tears and degeneration.

1. Englund et al (Fig 6) investigated the prevalence of meniscal tears in a population randomly selected from those 50 to 90 years of age living in Framingham Massachusetts. In total 991 subjects were surveyed of whom 57% were female. They found that the prevalence of a meniscal tear or meniscal destruction in the right knee as detected on MRI ranged from 19% among women 50 to 59 years of age to 56% among men 70 to 90 years of age. Overall prevalence of meniscal damage was 35% and meniscal tear 31%. Of those with tears 66% had a medial tear, 24% lateral and 10% both lateral and medial. In knees with one or more tears the tear involved the posterior horn of the medial or lateral meniscus in 66% of the cases, the body segment in 62% and the anterior horn in 11%. Most of the tears were classed as degenerative; 40% of the knees with meniscal tears had horizontal tears, 37% complex, 12% oblique, 15% radial, 7% longitudinal and 1% root tear. Prevalence of tears increased with age in both sexes (p<001 for trend). The most frequent location of horizontal tears was the posterior horn of the medial meniscus.

They concluded that incidental meniscal findings on MRI of the knee are common in the general population and increase with increasing age.
This paper provides high quality evidence of the increasing prevalence with age of meniscal tears/damage most of which were of a degenerative classification, in a large cohort of older Americans. High quality cohort study Sign level = 2++

Figure 6. Prevalence of meniscal damage in the right knee among 426 men and 565 woman from the general population of Framingham. Used with permission. NEJM (Englund’s study) 5.

2. Ding et al21 has determined the prevalence of tears by MRI in a random selection of controls chosen from the electoral role in Hobart, Tasmania. They found that in 159 subjects of mean age 47 and of whom 57% were female that in the medial compartment 14.4% had anterior tears, 47% body tears and 39.6% posterior tears. The corresponding percentages for the lateral compartment were 16.3%, 42.1 % and 18.8%. Tears in the control group had a strong correlation with age (p<.001). The authors regarded these tears to be most likely of the degenerative type as they were associated with other degenerative factors in the knee (eg lateral tibiofemoral cartilage defect P<0.025; medial tibiofemoral cartilage defect P<001) but not with past knee injury. No figure was given for overall prevalence but in the total cohort of 294 subjects which included the adult children of subjects who had a knee replacement, meniscal tears were found in a total of 72% of subjects. This percentage appears to be considerably higher than in the population studied by Englund5. This study provides some evidence of a high prevalence of degenerative-like tears in an Australian population of middle age. Sign level = 2-

3. Kornick22 studied 280 meniscal horns in 64 asymptomatic volunteers aged between 10 and 74. They found that the prevalence of meniscal abnormalities increased sharply with age. The prevalence of all signal abnormalities correlated with age, grade 2 changes having the highest correlation coefficient (0.88). The correlation coefficient for grades 1 and 3 changes were 0.60 and 0.71, respectively. The posterior horn of the medial meniscus had a significantly higher prevalence of abnormalities than did other meniscal locations. This was a study based on volunteers and so cannot be said to be representative of the population at large. A prospective cross-sectional report in a selected population – Sign level = 3
4. Bhattacharyya\textsuperscript{7} reported a case – control study on the clinical importance of meniscal tears as detected by MRI in the presence or absence of symptoms of OA (mean age 67 for asymptomatic controls recruited from patients with no knee pain or documented diagnosis of arthritis and mean age 65 for cases; 154 patients, 49 controls). They found that medial or lateral meniscal tears were a very common finding in older asymptomatic subjects (prevalence, 76%) but were more common in the patients with symptomatic osteoarthritis (91%). Men had a higher prevalence of meniscal tears than did women. A prospective cross-sectional report in a selected population – Sign level = 2-.

5. In contrast to the high prevalence of tears found by Bhattacharyya, La Prade has reported on the prevalence of meniscal tears found in asymptomatic knees of 54 health professional volunteers\textsuperscript{6} of average age of 28.5 years (54% female); The prevalence of tears was only 5.6% (medial meniscus, 1.9%; lateral meniscus, 3.7%). The prevalence though of Grade II signal changes indicative of early degeneration was already 24.1% at the posterior horn of the medial meniscus in this young population. A prospective cross-sectional report in a selected population – Sign level = 3

6. Jerosch studied 82 asymptomatic volunteers\textsuperscript{26}, (152 knees) with no history of knee trauma, age range 18 – 62 and found the following prevalence of MRI signals in the meniscus –

<table>
<thead>
<tr>
<th>Age</th>
<th>% with grade 0 (normal changes)</th>
<th>% with grade 3 or 4 changes (signal reaches articular surface or fissuration or fragmentation of surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 – 22</td>
<td>56.6</td>
<td>0</td>
</tr>
<tr>
<td>23-29</td>
<td>51.1</td>
<td>0</td>
</tr>
<tr>
<td>30-49</td>
<td>39.1</td>
<td>7.8</td>
</tr>
<tr>
<td>&gt;50</td>
<td>14.3</td>
<td>28.6</td>
</tr>
</tbody>
</table>

The table shows again that in asymptomatic subjects there is an increasing prevalence of MRI meniscal signal alterations which increases with age. A prospective cross-sectional study in a selected population; Sign level = 3

7. Boden\textsuperscript{27} has also studied by MRI the meniscal abnormalities in 74 asymptomatic volunteers without histories or symptoms of knee injury (mean age 34, 55% female). Sixteen percent of the asymptomatic volunteers had meniscal abnormalities consistent with a tear. The prevalence of MRI findings of a meniscal tear increased from 13% in individuals younger than 45 years of age to 36% in those older than 45. 30% of the volunteers showed meniscal abnormalities consisting of a linear area of increased MR signal not communicating with a meniscal edge indicative of meniscal degeneration. 14% of those 16-25 (14 subjects) had tears in the posterior area of the medial compartment compared to 18% in those 46 – 65 (11 subjects). A prospective cross-sectional study in a selected population; Sign level = 3
8. Meniscal abnormalities on MRI have also been studied by Fukuta in 115 Japanese asymptomatic volunteers (mean age 47.5, 52% female). Such abnormalities became more prevalent with age in both men and women. 42.2% of all menisci were graded normal; 8% grade 3 indicating a meniscal tear. 41.7% of those over 60 had a grade 3 tear. Prevalence was not different between men and women. A prospective cross-sectional study in a selected population; Sign level = 3

9. Kaplan investigated by MRI 20 asymptomatic professional basketball players without a history of knee injury, mean age 26.1. The overall prevalence of various grades of meniscal lesions was 20% on MRI. Medial intra-meniscal signals accounted for 87.5%; lateral 12.5%. They concluded that meniscal lesions are common in asymptomatic young, professional basketball players. A case series; Sign level = 3

10. Rytter has evaluated the association between occupational kneeling and degenerative meniscal tears in a cross-sectional study of case and control volunteers. The study included 92 male floor layers and 49 male graphic designers, with a mean age of 55.6 years (range 42-70 yrs). Using MRI (grade 3 signal intensity, MRI) they found bilateral degenerative tears in the knees of 75.8% of floor layers and 57.7% of graphic designers. A case control design but essentially cross-sectional in nature in a selected population. Sign level = 2

Histological studies

11. Noble studied the prevalence of horizontal tears in 100 cadavers of mean age 65. Sixty per cent of subjects had at least one horizontal tear, the incidence being 29 per cent out of the 400 menisci. 27% of the subjects had parrot beak (flap) tears; parrot beak tears were associated with horizontal tears in 87% of cases. 12% of cases had a longitudinal tear. The high co-occurrence of horizontal and flap tears compared to longitudinal would support the argument for a concordance of origin for horizontal and flap tears. Case series - Sign level = 3

12. In a follow-up study in 70 subjects (280 menisci) less than 55 years (mostly in the range 20 to 55) Noble found that 18.6% exhibited at least one horizontal cleavage lesion (6.4% of menisci) one third of the incidence found in older subjects. Only one of those with a horizontal tear was under 40. The increase in prevalence of horizontal tears between the younger and older groups provides some evidence that horizontal tears are related to age and that they are of degenerative origin. Even though horizontal tears were more common in the elderly, the younger subjects also had a significant percentage of tears. Noble also found evidence of other early degenerative changes in the younger group; Evidence of degeneration was found in 76% of the grossly normal medial menisci examined and 54% of the lateral menisci. The earliest and most common features of degeneration were chondrocyte proliferation and degeneration, with mucoid degeneration and microcyst formation seen in several subjects less than 30 years of age. The evidential quality of these papers is relatively low given that the populations investigated are unlikely to be representative of the general population. Case series - Sign level = 3

13. Ferrer-Roca also conducted an histological study of menisci from 68 patients (ages varying from 4 to 69). They found horizontal cleavages in 34% of 70 menisci the most
common tear seen, 5 were parrot beak tears. 16 cleavages were grade 3 (tear reached base of the triangle). They however found no significant age correlation. Case series - Sign level =3

Arthroscopic and other surgical studies

14. Smillie²³ reported in 1967 the results of 3000 meniscectomies. He classified tears as predominantly longitudinal or predominantly horizontal and found that 36% of tears were longitudinal, (average age 31) and 50% horizontal (average age 43). He concluded that the horizontal tear is a lesion of middle age occurring in abnormal fibrocartilage. 83% of horizontal tears were found on the posterior horn of the medial meniscus. Case series - Sign level =3

15. Lewandrowski² reported the arthroscopic findings on 1750 knees in patients who had chronic knee pain after a traumatic event and intact collateral and cruciate ligaments (Mean age 37.5 years, age range 6 to 77; mean age of younger group was, female 25.6, male 27.5; older group female 53, male 52.5). They found that in the medial compartment, 38% had intact menisci, 37.8 flap, horizontal, complex or degenerative lesions and 24% longitudinal, bucket handle or radial lesions. Differentiating the meniscal lesion by age they found that essentially all medial meniscal derangements occurred in the older patients (p<.001) with the exception of bucket handle and longitudinal tears which were significantly more common in the younger (P<.001). In the lateral compartment where the frequency of meniscal lesions was low, radial and bucket handle tears and complex meniscal lesions were more often observed in the younger age group (p<.001). Horizontal tears and meniscal degeneration occurred more often in the older patient group (P<.001). Since these cases were all referred after trauma it shows that significant numbers of degenerative tears will be found in such a population. Case series - Sign level =3

16. Metcalfe³¹ has reported the distribution of tears by age in stable knees in a larger series of meniscectomies; The percentage of tear types by age was -

<table>
<thead>
<tr>
<th>Tear type</th>
<th>&lt;40 years</th>
<th>&gt;=40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td>Complex</td>
<td>13</td>
<td>35</td>
</tr>
<tr>
<td>Flap</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Radial</td>
<td>10</td>
<td>3.2</td>
</tr>
<tr>
<td>Bucket Handle</td>
<td>21</td>
<td>3.5</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>17</td>
<td>7</td>
</tr>
</tbody>
</table>

The greater percentage of horizontal and complex tears with age is further suggestive of the role of degeneration with these types of tear. Case series - Sign level =3

17. Poehling²⁴ has reviewed the findings of 10,117 knee arthroscopies in the United States which revealed 6039 tears; 71% were in males. The study suggested that meniscal tears fell into two patterns, degenerative and traumatic based largely on association with age and association with ACL injury. Injuries to the menisci occurring with an associated anterior cruciate injury, radial tears, and tears within 3 mm of the meniscosynovial junction were associated with a younger and more active patient who was more likely to sustain a traumatic or sports-related injury. Tears described as complex, horizontal
cleavage, and flap tears were associated with an older age group and followed a more degenerative pattern. Their findings are summarised in the table below.

<table>
<thead>
<tr>
<th>Tear type</th>
<th>% of all lesions</th>
<th>% female</th>
<th>Age of peak incidence - male</th>
<th>Age of peak incidence - female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex tears</td>
<td>30</td>
<td>31</td>
<td>41-50</td>
<td>61-70</td>
</tr>
<tr>
<td>Peripheral tears (within 3mm of meniscosynovial junction)</td>
<td>26% of patients</td>
<td>24</td>
<td>21-30</td>
<td>11-20</td>
</tr>
<tr>
<td>Flap</td>
<td>21</td>
<td>26</td>
<td>31-40</td>
<td>61-70</td>
</tr>
<tr>
<td>Horizontal</td>
<td>12</td>
<td>11</td>
<td>31-40</td>
<td>51-60</td>
</tr>
<tr>
<td>Radial</td>
<td>9.3% of patients</td>
<td>27.7</td>
<td>11-20 and sustained to age 40</td>
<td>51-70 but widely spread across the age spectrum</td>
</tr>
<tr>
<td>Tears associated with ACL injuries</td>
<td>36.6%</td>
<td>31%</td>
<td>21-30</td>
<td>11 – 20</td>
</tr>
<tr>
<td>Tears not associated with ACL injuries</td>
<td>63.3%</td>
<td>19.2%</td>
<td>31 - 40</td>
<td>61 - 70</td>
</tr>
</tbody>
</table>

The authors drew the following conclusions -

- **Complex meniscal injuries** were the most common. Their late onset, the peak at age 41 – 50 and the shape of their distribution curve with age closely approximated those tears not associated with an ACL injury. Horizontal tears and flap tears had an onset about 10 years earlier than complex tears.

- **For those patients** with an intact ACL, the injury appears to start as a horizontal cleavage injury in men at about 31-40 years and in women at 51-60 years. The cleavage tear most likely then progressed relatively quickly to a flap tear by age 31 – 40 in men and 61 – 70 in women. Thus in the middle aged patient with a meniscal injury without an associated ACL tear it is likely that the tear will be anywhere along the spectrum of horizontal to complex.

- **Peripheral tears** had a prevalence analogous to that of those tears in the presence of an ACL injury and the authors concluded that they are most likely of traumatic origin; Radial tears were most likely the result of trauma also being seen in the younger more active patient. Those injuries to the meniscus occurring with an associated ACL injury, radial tears and those lesions within 3mm of the meniscosynovial joint were associated with younger and more active patients who were considered to more likely to sustain a traumatic or sports related injury.
Those tears described as horizontal, flap and complex were associated with an older age group and followed a more degenerative pattern.

This was a large case series reporting data from 17 medical centres across 15 states - evidential quality is moderate for the type of population surveyed. Sign level = 3

18. Drosos\textsuperscript{32} has reviewed a case series of 392 patients with normal x-rays (mean age 39). It was found that traumatic tears (longitudinal, bucket handle) and degenerative tears (horizontal, flap and complex) had a similar prevalence up to age 40, thereafter degenerative tears became predominant with a 76% occurrence. A case series - Sign level = 3

19. Christoforakis\textsuperscript{33} has reviewed 497 arthroscopies for meniscal tears (mean age 40.8, age range, 16-76, 29% female). All patients were symptomatic and in 34.4% there was a history of injury. 61% of subjects had complex or horizontal tears. The mean age of those with complex or horizontal tears was 44.8 and that for other tears was 33.6. Case series - Sign level = 3

20. Tsai\textsuperscript{34} also reported his case series on 356 subjects all who had clinical symptoms of internal derangement of the knee, such as meniscal, cruciate ligament injury or osteoarthritis. Of the meniscal injuries 84% were medial and 16% lateral. The age distribution of the medial meniscus tears was as follows: bucket handles 33 +/- 9 years; flap tears 42 +/- 10 years and degenerative tears 53 +/- 10 years. For the lateral meniscus the age distribution was: bucket handles 34 +/- 9 years, cleavage and radiating tears 37.5 +/- 12 years, flap tears 29 +/- 7 years, peripheral tears 32 +/- 9 years and degenerative tears 48 +/- 11 years. Osteoarthritis was observed in 52% of all medial degenerative tears, whereas a low frequency was found in association the remaining tears. Case series - Sign level = 3

4.2. Association of tear type with traumatic injury to the ACL

ACL injuries are common knee injuries and meniscal tears are frequently found in association with them. They typically occur in younger sports players. When the ACL is torn there is some objective evidence of a traumatic injury event having occurred and it would therefore seem likely that the type of tear that occurs in this situation could well be described as of traumatic origin. The evidence of a range of papers is reviewed here that ‘traumatic type’ tears are associated more strongly with ACL tears than tears believed to be of degenerative origin. The emphasis was placed on reviewing papers that described types of tears.
Evidence Statements

- There is good evidence, consistent across a range of case series studies that 70 to 90% of tears associated with acute ACL injuries are peripheral, longitudinal tears. The percentage of flap and horizontal tears is small.
- Tears associated with acute ACL injury may occur slightly more often in the lateral compartment but in either case are most commonly found on the posterior horns of the menisci.
- There is consistent evidence from case series data that as time from injury increases and the ACL tear becomes chronic, the percentage of tears in the medial compartment increase and will be accompanied with an increase in percentages of flap and horizontal tears.

Discussion

According to a summary provided by Aiello the prevalence of meniscal tears associated with acute ACL tears varies between 35 and 78% occurring in the vascularised outer one third of the posterior horn. Some studies suggest that lateral meniscal tears occur slightly more frequently than medial in knees with acute ACL injuries with an average distribution of 56% lateral and 44% medial.

The case series papers reviewed here provide consistent evidence that the most of these tears were of the longitudinal type and located peripherally. The prevalence of meniscal tears associated with chronic ACL tears increases in the medial compartment with time and these tears are more often degenerative and complex and are therefore less amenable to surgery. In the chronic setting then, medial tears become more common.

Typically ACL tears occur in younger people in the acute setting when degeneracy would be unexpected; Poehling found the highest prevalence of peripheral longitudinal tears to be in females in the 11 – 20 age group and in men 21 – 30 years. Most subjects with ACL injuries in the studies reviewed here were of mean age less than 30; The ACC data indicates that most ACL arthroscopic surgery takes place in the 20 to 30 years olds (Fig 4).

A comparison has been made of the histology of longitudinal displaced bucket handle tears in the avascular portion of the medial compartment between those with an intact ACL and those with ACL deficient knees. Meister found that tears associated with intact ACL ligaments may occur secondary to pre-existing, ongoing and underlying disease processes and may only be a symptom of early degenerative disease. Similarly Nawata has investigated MRI imaging of meniscal degeneration in young subjects to determine patterns between ACL deficient and stable knees. The frequency of intrameniscal signal anomalies adjacent to the tear was significantly lower in ACL-deficient knees than in ACL-stable knees and there was a close correlation between the imaging anomalies and the presence of histological lesions (fissures, degeneration) within meniscal tissues adjacent to the tear. The authors suggested that the higher frequency of intrameniscal degenerative changes adjacent to the tear in ACL stable knees might be caused by pre-existing meniscal degeneration or a longer time from injury to MRI.
Conclusion

It is concluded that the peripheral longitudinal tear is the archetypal traumatic tear that occurs in association with injuries to the ACL in younger people when degeneracy is not expected, at least in the acute situation. If ACL injuries are left and become chronic further tearing will occur to the meniscus and these will usually be in the medial compartment and be more often of a degenerate classification. The evidence in this section identifies a particular situation which provides evidence that peripheral longitudinal tears are indeed typically of traumatic origin. It also provides some evidence that degenerate tears may arise after ACL trauma if treatment is not adequate.

Papers reviewed

1. Poehling\textsuperscript{24} has reviewed the findings of 10,117 knee arthroscopies in the United States which revealed 6039 tears; 71% were in males (see 5.1). Slightly more than one-third of patients had meniscal injuries associated with an ACL tear. They found that peripheral and radial tears had a prevalence analogous to that of those tears in the presence of an ACL injury. On this basis they concluded that peripheral and radial tears were most likely to be of traumatic origin whereas horizontal, oblique and complex tears were likely to be of degenerative origin. This was a large case series reporting data from 17 medical centres across 15 states - Sign level = 3

2. Keene has provided some Australian data on the meniscal status of those undergoing anterior cruciate ligament reconstruction acutely (less than 6 weeks from injury), subchronically (6 weeks to 12 months from injury), and chronically (more than 12 months from injury)\textsuperscript{38}. Age and gender data was not given. They found that the commonest tear was the longitudinal vertical split of the medial meniscus; the % incidence of tears was as follows:

<table>
<thead>
<tr>
<th>Type of tear</th>
<th>Acute (52) within 6 weeks</th>
<th>Subchronic (49) 6 weeks to 12 months</th>
<th>Chronic (75) &gt;12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal; (medial, lateral)</td>
<td>92%, 77%</td>
<td>81%, 64%</td>
<td>76%, 41%</td>
</tr>
<tr>
<td>Radial</td>
<td>4, 3</td>
<td>3, 27</td>
<td>6, 28</td>
</tr>
<tr>
<td>Flap</td>
<td>4, 15</td>
<td>16, 9</td>
<td>9, 13</td>
</tr>
<tr>
<td>Horizontal</td>
<td>Nil, 6</td>
<td>Nil, Nil</td>
<td>2, 13</td>
</tr>
<tr>
<td>% of medial menisci torn (approx only - figs., taken from graph)</td>
<td>42 65</td>
<td>75</td>
<td></td>
</tr>
</tbody>
</table>

There was an increasing incidence of meniscal tears as the injury became more chronic (81% acute to 89% chronic), with a significant increase in medial meniscal tears; the incidence of lateral meniscal tears remained relatively constant. Case series - Sign level = 3
3. In 1997 Bellabara\textsuperscript{39} conducted a meta-analysis of patterns of meniscal injuries in ACL deficient knees reviewing up to 20 case series papers per topic. A predominance of lateral meniscal tears was demonstrated with acute ACL rupture (56% v. 44%), whereas the incidence of medial meniscal tears increased significantly with chronic ACL insufficiency (70% medial v. 30% lateral). The percentage of repairable meniscal tears was higher on the medial than the lateral side and decreased overall with the chronicity of ACL insufficiency. The likelihood of a successful meniscal repair was enhanced significantly when combined with ACL reconstruction. An uncritical review of case series studies. Case series - Sign level = 2-

4. Vinson\textsuperscript{40} has studied the prevalence of ACL tears when a peripheral vertical tear was detected in the meniscus by MRI. They reviewed retrospectively 200 knee examinations (50% female, mean age 49). The prevalence of ACL tear, reconstruction, or deficiency in knees with meniscal tears of the peripheral vertical type was 82.4% compared to 9.3% with other types of meniscal tears (9.3%). They concluded that peripheral vertical meniscal tears, particularly when involving the posterior horn, are highly associated with ACL tear, deficiency, or reconstruction. Case series - Sign level = 3

5. Tandogan\textsuperscript{41} has also reported case series data on 764 patients with ACL tears (10.5% female, mean age 27 years). The mean time from injury (TFI) was 19.8 months (range 0.2-360 months). Thirty-seven percent had medial meniscal tears, 16% had lateral meniscal tears, and 20% had tears of both menisci. The most common tear types were longitudinal tears in the posterior and middle horns of both menisci (medial tears, 78% longitudinal, 8% flap, 13% radial, 1% complex; lateral tears 72%, 13%, 8%, 7%). Tears of the lateral meniscus were more centrally located than those of the medial meniscus. The odds of having a medial meniscal tear at 2 to 5 years TFI were 2.2 times higher than the odds in the first year post-injury, and the odds at >5 years were 5.9 times higher than at 0 to 12 months TFI. The frequency of lateral meniscal tear remained fairly constant at 2 years TFI. Multivariate analysis demonstrated that TFI and age were equally important predictors of lateral meniscal tears and of grade 3 or 4 chondral lesions; however, TFI was the better predictor of medial meniscal tear. Case series - Sign level = 3

6. Smith\textsuperscript{35} has studied the location of meniscal tears associated with ACL injuries by reviewing 575 tears in 475 patients; mean age 25.4, 36% female. Peripheral tears accounted for 60.7% of all tears. 93.9% of tears involved the posterior horns; 99.4% of the medial tears and 87.8% lateral. Case series - Sign level = 3

7. Meister in a small case-control study\textsuperscript{36} has investigated the histological appearance of meniscal tissue taken from young patients with longitudinal displaced bucket handle tears in the avascular region of the medial meniscus and compared the tissue from knees in which the ACL was intact with that from ACL deficient knees (24 acute patients with displaced longitudinal bucket handle tears in the avascular part of the medial meniscus in ACL deficient knees, 37.5% female, mean age 26.5: 20 patients with similar tears in ACL intact group, 40% female, mean age 30.4). They consistently found along the tear edges from ACL intact knees evidence of degenerative processes. The authors concluded that tears associated with intact ACL ligaments may occur secondary to pre-existing, ongoing and underlying disease processes and may only be a symptom of early degenerative disease. Age of the tear from injury did not significantly effect results (p>.02). They also note that their observations would account for the lower rates of
healing of torn menisci seen in those with ACL – intact knees compared to that in those with ACL deficient knees. The findings are based on a small case series and though of case – control design the paper must be regarded of low evidential quality. Case series - Sign level = 3

8. A study has been made by MRI imaging of meniscal degeneration in young subjects to determine patterns in ACL deficient and stable knees. In group one, there were 54 torn menisci in 53 patients with ACL stable knees (mean age 29.2); 27 patients had had a clear episode of trauma and in these average time from initial injury to MRI was 3.9 years. In group 2 there were 98 torn menisci in 67 patients with torn ACL (mean age 25.7) average time from injury to MRI was 1.5 years. The frequency of intrameniscal signal anomalies adjacent to the tear was significantly lower in ACL-deficient knees than in ACL-stable knees (P = 0.0022) and there was a close correlation between the imaging anomalies and the presence of histological lesions (fissures, degeneration) within meniscal tissues adjacent to the tear. The authors suggested that the higher frequency of intrameniscal degenerative changes adjacent to the tear in ACL stable knees might be caused by pre-existing meniscal degeneration or a longer time from injury to MRI. A low quality case control type comparison based on selection from a case series. Case series - Sign level = 3

4.3. Relation of tear type to other trauma classifications (not specifically ACL)

There are a few papers that have investigated the association of tear type with specific trauma that did not confine their study to those with ACL tears. These papers are reviewed here, with the intention of finding evidence in these populations that certain types of tears are associated with a history of acute trauma.

**Evidence Statement**

- There is some evidence from a cohort study and number of case series studies that longitudinal tears/bucket handle/vertical tears predominately occur due to specific injury events and horizontal due to degeneration but these classifications are by no means exclusive.

**Discussion**

Six studies were reviewed that investigated association of a specific trauma event with tear type. The quality of evidence is only moderate but there is some evidence for a tendency for longitudinal, bucket handle and radial tears to be more commonly associated with an acute traumatic event than that of horizontal and flap. The best evidence comes from the cohort study by Bok who showed that recent trauma was strongly related to the group of radial, longitudinal and complex tears but not significantly related to horizontal tears. Hede found that bucket handle tears were strongly associated with trauma and peripheral tears were equally
distributed between those who reported a definite traumatic event and those who did not; Zanetti\textsuperscript{44} found that all symptomatic displaced tears were associated with trauma.

There is also a suggestion that degeneration in the meniscus predisposes certain subjects to injury\textsuperscript{32} so that complex tears though degenerate in nature will be found after traumatic injury\textsuperscript{45}.

Horizontal tears are more commonly associated with advancing age but their occurrence is quite common even in those less than 30. This being the case, it is not surprising that they will also be found in knees following trauma, however there association with specific trauma events is much less common than that of the typical vertical tears. The association of flap tears with trauma is more ambiguous. Complex tears, though classed as degenerate, occur quite frequently in subjects able to identify a classic traumatic event but whether this is attributable solely to the event or to exacerbation of a pre-existing degenerate tear is open to debate.

Conclusions

It is concluded that there is some evidence that longitudinal/bucket handle/vertical/ tears and radial tears are more commonly associated with specific trauma events than that of horizontal tears. Complex and flap tears are also found after trauma as well as in degenerate menisci. However the classification into traumatic and degenerate based on the evidence in this section is not clear cut and there is a significant degree of overlap between the classifications.

Papers reviewed

1. Boks\textsuperscript{42} has reported the results of a study on 134 patients referred from GP practices after acute knee trauma (mean age 40.8, range 18-65, 45% female). Patients requiring immediate hospital referral or with fracture were excluded. They were particularly interested in investigating the type of knee lesions that were associated with trauma and not present in the asymptomatic knee. Multivariate analysis showed that recent trauma was strongly related to the group of radial, longitudinal and complex tears (OR 2.1, 95% CI 1.3-6.3) but not significantly related to horizontal tears. A history of old trauma was also more strongly related to radial, longitudinal and complex tears (OR 8.6, 95% CI 3.1-23.8) than horizontal tears. They concluded that radial, longitudinal, and complex meniscal tears were strongly related to trauma, whereas horizontal meniscal tears may have been pre-existent in many cases. This was a prospective cohort study. Cohort/crosssectional study - Sign level = 2-

2. Drosos\textsuperscript{32} has reviewed his arthroscopy cases (1236 patients) that dealt with meniscal injuries in subjects with normal x-rays (mean age 39 for all groups). 32.4% had sustained a sports injury, 28.8% a non-sport injury and 28.8% had no specific incident accounting for the injury. 71% of cases were linked to specific trauma events. He found that medial meniscus tears accounted for 63.8 to 77% of all tears depending on group. Incidence of traumatic tears (longitudinal, bucket handle) were respectively in the sport, non sport and 'no identifiable injury' groups, 56%, 38.2% and 18.6%. Incidence of degenerative tears (horizontal, flap and complex) were comparably, 42.5%, 60% and 81%. It was suggested that degenerative change may be a much more important underlying factor predisposing to injury at a much younger age than usually recognised and considered that degeneration may start simply as a result of repetitive micro-trauma and mechanical stresses caused by normal activities of daily living in conjunction with age change. A case/control - like analysis with groups selected from a case series; Case series - Sign level = 3
3. Hede\textsuperscript{43} has reviewed the findings of 1215 persons treated for a meniscal lesion to compare tear types found in the group (mean age 36, range 3 – 83; 33% female). Those with ligament laxity were excluded. In 77% of men and 64% of woman the onset of symptoms was associated with knee injury. They showed that bucket handle tears were significantly more often associated with a traumatic event than with a non-traumatic event (35% of all traumatic tears v. 18% of non traumatic)(p<.001), whereas peripheral (34% v. 35%), horizontal (2.2% v. 3.7%), parrot-beak 12% v. 15%), contusion (3.5% v. 8.8%) and others (13% v. 20%) were not significantly different. Case series - Sign level = 3

4. Zanetti\textsuperscript{44} has studied by MRI the occurrence of tears in the symptomatic and asymptomatic knee in 100 patients (mean age, 42.7 years; range, 18-73 years) referred for suspected meniscal tears (includes those with ACL injuries). In 45 patients symptoms had started with distinct trauma. They reported that symptomatic partial thickness tears were commonly not associated with trauma, symptomatic full thickness tears were equally distributed between patients with and without trauma whereas all symptomatic displaced tears were associated with trauma. The numbers tended to be small though. A prospective within subject, case-control study of good design but the numbers were small Case series - Sign level = 3

5. Burnett\textsuperscript{46} has reviewed a case series of 217 arthroscopic meniscectomies specifically to determine the relevance of history of injury to tear type (included ACL injuries, mean age 32). The results were –

<table>
<thead>
<tr>
<th>Tear type</th>
<th>Mean age at arthroscopy</th>
<th>% arising with no history of trauma</th>
<th>Total number of tears</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical longitudinal (bucket handle)</td>
<td>27</td>
<td>9</td>
<td>117</td>
</tr>
<tr>
<td>Radial tears</td>
<td>29</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>Horizontal</td>
<td>32</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>Flap</td>
<td>36</td>
<td>22</td>
<td>69</td>
</tr>
</tbody>
</table>

This was an analysis of a smaller case series so the evidence is of poorer quality but the data suggest that small percentages of longitudinal and radial tears typically thought of as traumatic in origin can occur in a younger group in the absence of a specific history of injury. Horizontal tears all occurred in the absence of an injury history while about one fifth of flap tears occurred in a slightly older group without an history of injury. A small case series. Sign level = 3

6. Noble\textsuperscript{45} showed in a prospective case series study of 200 patients (includes ACL injuries) for meniscectomy that horizontal tears were common in the younger; 24.6% of all
horizontal tears were found in those 20-29. Their onset was acute and traumatic in 54% of cases and insidious in 38.6%. In contrast only 19% of those with vertical or oblique tears did not report a history of trauma beyond a trivial domestic event. Case series - Sign level = 3

4.4. Degenerative tears are often found in both the symptomatic and asymptomatic knee

In this section the evidence is reviewed for the hypothesis that degenerate tears occur with similar frequencies in both knees inferring that their occurrence is likely to reflect a systemic degenerative disease/ageing process. Conversely evidence is reviewed that tears of the traumatic type are more likely to occur unilaterally, in the symptomatic knee.

Evidence Statement

- There is some evidence from studies of low/moderate quality that degenerate tears occur with high frequency bilaterally in the symptomatic knee and asymptomatic knee of the same person, whereas traumatic tears are more commonly found unilaterally in the symptomatic knee.

Discussion

Three studies have been reviewed that investigated the prevalence of tears in a symptomatic knee and in the contralateral, asymptomatic knee, two essentially case-series in nature and one a cross-sectional survey. These studies have an inbuilt advantage for some purposes in that they automatically have a within person, paired comparison. Here they are useful for providing evidence that particular pathology is systemic rather than due to an external event such as traumatic injury.

The data presented in the three studies is qualitatively consistent though the numbers are small. Tears classed as degenerative occur with high frequency in both the symptomatic knee and the contralateral, asymptomatic knee. These tears included horizontal, oblique and a degenerate meniscus.

Zanetti found that displaced tears were found only in the symptomatic knee and Boks found as a group, radial, longitudinal and complex tears to be more commonly present in the symptomatic knee.

An MRI study (Negandank) found that subjects with a meniscal tear in one knee also had increased MRI signal intensity in the asymptomatic knee. Evidence of MRI detected degeneracy was present from age 30 and found in both those that were active and sedentary. It was concluded that there was a segment of their population that had pre-existing meniscal degeneration predisposing them to traumatic or spontaneous meniscal tears. It is possible then that the higher percentage of complex tears sometimes found in symptomatic knees may be due to the presence of pre-existing degeneration.
Conclusion

The papers reviewed suggest that the high prevalence of horizontal and oblique tears in both asymptomatic and the contralateral symptomatic side is indicative of them being part of a common degenerative process that is distinct from a traumatic causation and provides further evidence for a distinction in classification between traumatic and degenerative tears. Complex tears however are found in both symptomatic and asymptomatic knees.

Papers reviewed

1. Zanetti has studied by MRI the occurrence of tears in the symptomatic and asymptomatic knee in 100 patients (mean age, 42.7 years; range, 18-73 years) referred for suspected meniscal tears. In 45 patients symptoms had started with distinct trauma. They found that meniscal tears were present in 57% of symptomatic knees and in 36% contralateral asymptomatic knees. Of those with a tear on the symptomatic side there was a 67% chance of a tear in the asymptomatic knee. Horizontal and oblique tears were much more common in the medial compartment than the lateral. The prevalence in the medial compartment of horizontal and oblique tears did not differ between the symptomatic and asymptomatic knees whereas vertical and complex tears did \( p<0.004 \) (see table). All symptomatic displaced tears were associated with trauma whereas symptomatic full thickness tears were evenly distributed between patients with and without trauma. The data also show that horizontal and oblique tears are extremely common in both symptomatic and asymptomatic knees. A study based on cases series. Numbers tend to be small and subjects were selected from a case series. Case series - Sign level = 3

<table>
<thead>
<tr>
<th>Type of tear</th>
<th>Prevalence on symptomatic side</th>
<th>Prevalence on asymptomatic side</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal or oblique partial thickness</td>
<td>32%</td>
<td>29%</td>
<td>NS</td>
</tr>
<tr>
<td>Vertical, radial, complex full thickness, displaced</td>
<td>12</td>
<td>2</td>
<td>.004</td>
</tr>
<tr>
<td>Lateral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal or oblique partial thickness</td>
<td>11</td>
<td>8</td>
<td>NS</td>
</tr>
<tr>
<td>Vertical, radial, complex full thickness, displaced</td>
<td>2</td>
<td>0</td>
<td>NS</td>
</tr>
</tbody>
</table>
Boks has reported the results of a cross-sectional survey from a prospective cohort study on 134 patients who visited a GP practices after knee trauma (mean age 40.8, 45% female). They were particularly interested in investigating the type of knee lesions that were associated with trauma and not present in the asymptomatic, contralateral knee. Degenerative meniscal tears were more common in the medial meniscus than the lateral; in symptomatic knees 52% were medial and 21% lateral; in the contralateral knee, medial 55% v. lateral 17%. Degenerative tears were equally distributed between symptomatic knees and contralateral knees: A degenerative meniscus was found in 52% of symptomatic knees and 55.3% of non-symptomatic knees, horizontal tears in 14% v. 14.4%, and radial, longitudinal and complex in 11.8% v. 3.0%. While vertical tears were much more common in the symptomatic knee overall the incidence of tears did not significantly differ between knees (p=.052). Cohort study Sign level = 3

1. Boks has reported the results of a cross-sectional survey from a prospective cohort study on 134 patients who visited a GP practices after knee trauma (mean age 40.8, 45% female). They were particularly interested in investigating the type of knee lesions that were associated with trauma and not present in the asymptomatic, contralateral knee. Degenerative meniscal tears were more common in the medial meniscus than the lateral; in symptomatic knees 52% were medial and 21% lateral; in the contralateral knee, medial 55% v. lateral 17%. Degenerative tears were equally distributed between symptomatic knees and contralateral knees: A degenerative meniscus was found in 52% of symptomatic knees and 55.3% of non-symptomatic knees, horizontal tears in 14% v. 14.4%, and radial, longitudinal and complex in 11.8% v. 3.0%. While vertical tears were much more common in the symptomatic knee overall the incidence of tears did not significantly differ between knees (p=.052). Cohort study Sign level = 3

2. Negendank conducted a MRI study to determine the degree of meniscal degeneration in asymptomatic knees. They investigated 20 patients with documented meniscal tears in one knee but an asymptomatic contralateral knee, mean age 40.9, 20% female; 18 normal controls, mean age 42.9, 45% female; and 15 patients with symptomatic nonmeniscal knee disorders, mean age 39.2, 73% female. They found that the degenerative changes involved primarily the posterior segment of the medial meniscus. Most subjects with documented meniscal tears in one knee had MR signals in the asymptomatic contralateral knee that reflected a more advanced degree of meniscal degeneration than in the age-comparable normal controls or patients with nonmeniscal knee disorders. After adjustment for potential confounding variables the MRI mean scores for degeneration in the asymptomatic knee of patients with meniscal disease were significantly higher than those of normal controls (p = 0.021) and nonmeniscal disease patients (p = 0.019). The bilateral pathology was observed for both those with traumatic tears and degenerate. They concluded that there was a segment of their population that had pre-existing meniscal degeneration predisposing them to traumatic or spontaneous meniscal tears. A study based on case series - Sign level = 3

4.5. Association of meniscal tears with body mass index (BMI)

Evidence has been sought on the relationship of tears to BMI to find if there is an association between the two variables which could be further interpreted as evidence of a non-traumatic injury causation for certain types of tears.

Evidence Statement.

- There is good evidence from one community based cohort study and two case-control studies that prevalence of tears is strongly associated with BMI. Each of these studies were on middle aged to older subjects and therefore likely to refer mainly to degenerate tears rather than traumatic.
Discussion

Three studies of moderate to high quality show strong, statistically significant correlations between BMI and the presence of meniscal tears or the requirement for meniscal surgery. One of the studies found the correlation to be confined to woman. The studies did not identify the types of tear although they were highly likely to be largely degenerative as two of the populations studied had mean ages in the 60’s and the third in the mid forties. Whether obesity is a risk factor for traumatic tears in younger people is not known.

Conclusion

It is concluded that the prevalence of tears in middle aged to older subjects is strongly associated with obesity. It would seem reasonable to conclude also that this association is for tears of a degenerate classification rather than traumatic.

Papers reviewed

1. Englund\footnote{5} in his study of the middle aged to older American population (Framingham cohort) found that women with at least one meniscal tear had a higher BMI than women without meniscal damage but among men there was no difference. High quality cohort study - Sign level = 2++

2. Ding\footnote{21} showed that in a middle aged Australian population (mean age 47) the mean BMI in those without tears was 25.4 v. 27.6 in those with tears. Ding has also showed that meniscal extrusion at baseline was associated with BMI\footnote{48}; meniscal extrusion was found in 18% of obese subjects v 4% of non obese subjects. Cohort study - Sign level = 2-

3. Ford\footnote{49} in a large case - control study has shown a dose-response relationship between BMI and requirement for meniscal surgery in those 50-79 years of age\footnote{49}. The percentage of subjects with OA is not stated. Age-adjusted odds ratios for likelihood of meniscal surgery among those with a BMI of \( >/\leq 40.00 \) were 15.0 for men, and 25.1 for women. All odds ratios for men and women equal to, or over 27.5 and 25 respectively were statistically significantly elevated. Case control like study Sign level = 2-

4.6. Association of meniscal tears and related pathology with osteoarthritis

Introduction

Osteoarthritis (OA) is a disease characterized by degeneration of cartilage and the underlying bone, the disease eventually leading to pain and stiffness. The knee is one of the commonest joints affected but OA is also commonly found in the hand, hip and spine\footnote{50}.

OA is common in the population. The Centres for Disease Control and Prevention report that the prevalence of knee OA in the United States is 16 per 100 adults aged 45 and over; 18.7% for female and 13.5% male\footnote{50}.

According to Suter\footnote{51} one in two Americans will likely develop symptomatic knee osteoarthritis, more than 60% will have MRI to evaluate their knee pain and according to Bhattacharyya's
work, as many as 91% of older subjects with symptomatic OA will be then found to also have a meniscal tear. OA is irreversible with current medical treatments.

It would seem highly likely then, due to the high prevalence of OA in the population that significant numbers of ACC clients undergoing arthroscopy of the knee are doing so for surgery to the meniscus in a knee that already has a significant degree of OA. The question arises if such surgery is fairly attributable solely to a traumatic injury event and therefore compensable by ACC, or part of a degenerative process associated with the aging/disease and normal ‘wear and tear’. In this case, treatment may be more appropriately paid for as a part of the public health system.

In this section the evidence is sought for the nature of the association of meniscal tears, particular types of meniscal tears and meniscal extrusion with OA and the degree to which such tears may associated with OA rather than with traumatic injury.

### Evidence Statements

- There is excellent evidence from a variety of studies that meniscal tears are highly associated with the presence of OA. One United States study found that 91% of subjects with symptomatic OA (mean age 61) had meniscal tears.

- There is good evidence that degenerative tears, particularly horizontal tears, complex tears and degenerate menisci are more strongly associated with the presence of OA than other tears. In one study the percentage of horizontal tears increased from 18.4% where no OA was present to 61.5% for grade 3 OA.

- A prospective cohort study has shown that the presence of a meniscal tear at baseline in middle aged to older subjects is a potent predictor over 30 months for the development of radiographic knee OA. Moreover new or further meniscal damage developed over the 30 months in 57% of case knees compared to only 6% of controls.

- Subjects with degenerative meniscal tears in the index knee had radiographic knee OA more frequently 20 years later than did patients with other tears both in the index knee and contralateral knee. There is some evidence that even the development of hand OA will be greater in those who had degenerate meniscal tears 20 years earlier.

- There is some evidence that severity of meniscal tearing is associated with increased prevalence of OA; in older subjects those with minor tears were 3 times more likely to develop OA over 30 months than those without, those with severe tears were 7.9 times more likely to do so.

- Cohort studies have found that medial meniscal extrusion is also associated with development of OA over periods of 2 years to 30 months.
Discussion

There are multiple lines of evidence that meniscal tearing and meniscal degeneration is strongly related to the development of OA. The evidence for this is as follows:

Strength of the association of tears (in general) with OA

There is excellent evidence from cohort studies, case control studies, cross-sectional studies and a wide variety of case series reports of a close association between the presence of OA and meniscal tears. Bhattacharyya for example found that tears were present in 76% of older asymptomatic subjects (mid sixties) but were more common in the patients with symptomatic osteoarthritis (91%). Case series data suggest that those with central and marginal knee osteophytes are more likely to have a meniscal tear than those without. Englund has concluded that that normal menisci are rarely found in knees with OA, instead they are often torn, macerated or totally destroyed. While tear type (degenerative or traumatic) was not specifically stated in these studies it is highly likely from what is known about the age relationship with tears that the great majority were of a degenerative type.

Further, case series data suggest that MRI signal measurements in cartilage are higher in those with meniscal tears than those without, suggesting that degeneracy is a parallel process if not part of a common process.

Association with particular types of tear

There is good evidence that particular types of tear are more strongly associated with OA than others. Noble in his histological case series studies has shown that the coincidence of horizontal cleavage lesion and osteoarthritis are frequent. The percentage of horizontal tears increased from 18.4% where no OA was present to 61.5% for grade 3 OA.

Englund in a cohort study that investigated the link between the development of hand OA and knee OA found that those who developed hand OA had a higher incidence of degenerative types of meniscal tears (flap, horizontal, complex and tears in a meniscus with degenerative changes) 20 years earlier than did patients without hand OA (47% with vs 26% without). The subjects with degenerative meniscal tears in the index knee had radiographic knee OA more frequently 20 years later than did patients with other tears both in the index knee and in the contra lateral knee. They suggested that a degenerative tear may be regarded as an early signal of susceptibility to osteoarthritic disease.

There is some evidence from a retrospective cross-sectional study that flap and other degenerative tears will be associated with more advanced OA changes than other types. Case series studies generally support this view. For example complex and horizontal cleavage meniscal tears were more highly associated with an increased incidence and severity of cartilage degeneration compared with other types of meniscal tears. Tsai found that OA was observed in 52% of all medial degenerative tears (mean age was approximately 52), compared to 3% for bucket handle; flap though was found in 14% of cases.

A smaller case series review has shown that medial meniscal root tears in 97% of patients examined displayed a strong association with degenerative joint disease and cartilage defects of the medial femoral condyle.
Association with severity of tearing

There is some evidence that presence of OA is linked not only to the presence of tearing but also to severity of tearing. Bhattacharyya\(^7\) reported in a case control study that those with severe OA had a 100% prevalence of tears and there was a correlation between radiographic grade of OA and presence of tears. Englund\(^53\) found in older subjects that those with minor tears were 3 times more likely to develop OA over 30 months than those without; those with severe tears were 7.9 times more likely to do so.

Association with progression of OA

There is excellent evidence from prospective cohort studies that those with meniscal tears at baseline will in the following years go on to develop radiographically detectable OA as well as symptomatic OA. Englund\(^53\) found in older subjects, followed for 30 months, that meniscal damage (any tear, maceration or destruction) at baseline was more frequent in those who developed symptomatic OA than for control knees (54% v. 18%); those with a meniscal tear at baseline were 5.7 times more likely to develop OA than those without. Moreover meniscal damage developed over the 30 months in 57% of case knees and 6% of controls. It was concluded that a meniscal tear in middle aged to older subjects was a potent risk factor for the development of OA.

Englund\(^59\) has also shown that subjects with degenerative meniscal tears in the index knee had radiographic knee OA more frequently 20 years later than did those with other types of tears both in the index knee and in the contralateral knee. They suggested that a degenerative tear may be regarded as an early signal of susceptibility to osteoarthritic disease. They also showed that those who developed hand OA had a higher incidence of degenerative types of meniscal tears (flap, horizontal, complex and tears in a meniscus with degenerative changes) 20 years earlier than did patients without hand OA.

Other studies provide some evidence for the following associations:

- A smaller cohort study has reported that cartilage loss has been observed to be greater in those with severe medial tears over two years\(^54\).
- According to Roos\(^60\) in younger subjects the development of OA occurs about 15 years after injury to the meniscus whereas in those over 30 it occurs within 5 years.
- Hunter\(^62\) followed subjects with symptomatic knee OA and of mean age 66.2 years for 30 months. They found that in the medial tibiofemoral joint, each measure of meniscal malposition (medial subluxation, proportion of coverage, meniscal height, anterior subluxation, meniscal damage) was associated with an increased risk of cartilage loss.
- The association of meniscal tears and OA is however not invariable. In case series studies on cadavers Noble\(^4\) has shown that 38% of severely degenerate (grade 3) joint compartments contained a meniscus which was normal macroscopically and two additional studies have shown that normal articular cartilage can be associated with marked meniscal tearing\(^63\) \(^64\).
Meniscal extrusion and OA

Cohort studies have found that medial meniscal extrusion is also associated with development of OA over periods of 2 years as assessed by medial cartilage volume loss. Roemer in a high quality cohort study (MOST longitudinal study) showed in subjects of mean age 61 years and with a low radiographic score at baseline that over the following 30 months, meniscal tears and extrusion were risk factors for fast cartilage loss.

In addition a high quality prospective cohort study has shown that in older subjects (50 – 79 years of age) meniscal extrusion significantly more often developed in those who also developed OA over 30 months.

Costa found that substantial medial meniscus extrusion (> 3 mm) is associated with major tearing and with severe meniscal degeneration, extensive tear, complex tear, large radial tear, and tear involving the meniscal root.

Additional discussion for this section

The specific causes of OA are not known but it is now recognised that it is a disease of the whole joint with genetic and systemic components. There is some suggestion in the literature that unilateral knee OA has a different pathogenic mechanism from bilateral OA. It would seem that OA is now conceived as the result of a complex process that includes a range of stresses on articular cartilage including on one hand, obesity, anatomic variables and cumulative past, acute and chronic injuries, including microtrauma as a result of the activities of daily living; and on the other hand, changes in cartilage physiology that include aging, genetic, metabolic and inflammatory processes. A meta-analysis suggests that the main risk factors for OA are, obesity, previous knee trauma, OA of the hand, female gender and older age. Body mass index is a major risk factor: it has been calculated that in a population where 25% are obese, 29% of knee OA could be potentially prevented.

The review above of the evidence of association of meniscal tears/pathology and OA shows that the OA and meniscal tears are inextricably linked in a manner that is yet to be fully understood.

The key point to be made from the point of view of this paper though is that there is good evidence that those tears generally classed as degenerative (degenerative meaning flap, horizontal, complex and a meniscus with degenerative changes) are the tears that are closely associated with OA and the development of OA. This association does not hold as strongly for other types of tear at least in a relative sense with the possible exception of medial meniscal root tears. This is further evidence that tears commonly known as degenerative are indeed so.

Finally questions arise as to whether or not tears contribute in a causative manner to OA and if OA causes meniscal tearing. There is no definitive answer that can be given at this time to these questions: many older subjects with tears will go on to develop OA, and those who develop OA will also develop tears. There is good evidence from cadaver studies that advanced OA can occur in the absence of tears and range of other degenerative pathologies such as bone marrow lesions are also associated with the development of OA. There is no evidence that a meniscal tear is a necessary prerequisite to OA. It seems likely that they are part of similar or parallel degenerative processes.
Meniscal tears and knee pain and stiffness.

While it is not directly part of the brief of this report it is important to note that degenerative meniscal tears are not commonly implicated as a cause of knee pain and stiffness. According to Bhattacharyya's cartilage lesions, synovial inflammation and periarticular muscle strain have all been implicated in the etiology of knee pain; the role of meniscal tears has not been documented. A key paper in this regard is that of Englund's. He has reported on 3,026 individuals 50 years of age or older who had or were at high risk of developing knee osteoarthritis. Case knees (n = 110) were those with no pain, aching, or stiffness on most days at baseline, but that had developed frequent pain, aching, or stiffness at 15 months. Control knees (n = 220) were drawn randomly from knees with no frequent symptoms at baseline that did not become case knees. When considering the co-occurrence of OA, they found no independent association between meniscal damage and the development of frequent knee symptoms (OR 1.05, 95% CI 0.80-1.37). They concluded that in middle-aged and older adults, any association between meniscal damage and the development of frequent knee pain seems to be present because both pain and meniscal damage are related to OA and not because of a direct link between pain and meniscal damage.

Conclusion

The fact that degenerative types of tear are associated so strongly with the degenerative disease of OA would suggest that the association is due to related pathological responses to a range of adverse environmental and systemic factors. The implication of the evidence is that degenerative meniscal tears presenting in association with OA are not typically due to traumatic injury and therefore not compensable.

Papers reviewed

Cohort studies and case/control studies

1. Ding has reported from his findings based on an Australian prospective cohort study that the presence of osteophytes and other indices of pathological change may be causally related to meniscal extrusion. Meniscal extrusion at baseline was also associated with greater loss of knee cartilage over 2 years. Prospective cohort study - Sign level = 2-

2. Berthiaume in a small cohort study found that over 75% of a group of patients with primary symptomatic osteoarthritis had meniscal damage (MRI changes, tear or extrusion). Subsequent cartilage volume loss over the following two years was much more marked in those with severe medial tears compared to those without tears. They concluded that meniscal tear and extrusion is associated with progression of symptomatic knee osteoarthritis. Prospective cohort - Sign level = 2-

3. Englund has in a prospective, case-control study investigated in older subjects if meniscal damage at baseline not treated by surgery would lead to OA 30 months later. They found that patients without OA at baseline but who went onto develop it over 30 months were more likely to have tears and degeneration, tibiofemoral cartilage lesions, and meniscal lesions. Meniscal damage at baseline was more frequent in case knees (those with symptomatic OA) than control knees (54% v. 18%, p<0.001). Those with
minor tears were 3 times more likely to develop OA over 30 months than those without; those with severe tears were 7.9 times more likely to do so. Meniscal damage developed over the 30 months in 57% of case knees and 6% of controls. Meniscal extrusion developed in 40% of case knees and 2% of controls. The authors concluded that in knees without surgery, meniscal damage is a potent risk factor for the development of radiographic OA in this age group. A quality prospective cohort study – Sign level = 2++

4. While meniscal tears are common in asymptomatic subjects they are more prevalent in those with OA. Bhattacharyya in a case-control study found that tears were present in 76% of older asymptomatic subjects (mid sixties) but were more common in the patients with symptomatic osteoarthritis (91%). In the group with symptomatic osteoarthritis, a higher Kellgren-Lawrence radiographic grade was correlated with a higher frequency of meniscal tears. Those with severe OA had a 100% prevalence of tears and there was a correlation between radiographic grade of OA and presence of tears. A case-control design of moderate quality. Sign level = 2-

5. Hunter followed 257 subjects with symptomatic knee OA and of mean age 66.2 years for 30 months. They found that in the medial tibiofemoral joint, each measure of meniscal malposition (medial subluxation, proportion of coverage, meniscal height, anterior subluxation, meniscal damage) was associated with an increased risk of cartilage loss. The association of meniscal damage with cartilage loss was strongest in the medial compartment; results were similar in the lateral compartment but magnitude of risk was smaller. A high quality prospective cohort study. Sign level = 2++

6. Englund has reported a retrospective study on subjects who had meniscectomies 20 years earlier that investigated the link between development of hand OA and knee OA and found that –
   a. Those who developed hand OA had a higher incidence of degenerative types of meniscal tears (flap, horizontal, complex and tears in a meniscus with degenerative changes) 20 years earlier than did patients without hand OA (47% with v 26% without, p=0.006)
   b. Subjects with degenerative meniscal tears in the index knee had radiographic knee OA both in the index knee (p<0.001) and in the contralateral knee (p<0.039) more frequently 20 years later than did patients with other types of tears.

They suggested that a degenerative tear may be regarded as an early signal of susceptibility to osteoarthritic disease. A moderate quality retrospective cohort study - Sign level = 2+

7. It has been shown in subjects of mean age 61 years (MOST longitudinal study) and low radiographic scores at baseline that meniscal tears and extrusion were risk factors for fast cartilage loss over the following 30 months (Roemer). A high quality cohort study - Sign level = 2++
Case series and cross-sectional studies

8. In a cross-sectional retrospective study on 1012 subjects, Roos\(^60\) has found that for patients who sustained an isolated meniscus injury between the ages of 17 and 30, the average time until development of radiological signs of OA was about 15 years, while for those who had the same injury over the age of 30, the corresponding time interval was only about 5 years. Roos showed that patients with a tear of the cruciate ligament isolated or combined with a tear or collateral ligament injuries show radiologic signs of OA at a younger age than patients with a meniscus tear only. Flap and degenerative tears were associated with more advanced OA changes than other types even with a comparative time between injury and examination (no data was presented for this). Evidential quality of this study is moderate. Sign level = 2-

9. Christoforakis\(^33\) has evaluated whether horizontal cleavage and complex meniscus tears, are associated with an increased incidence of cartilage damage, in comparison with patients having other patterns of meniscal tearing. The former had an increased incidence of chondral lesions, increased severity (type III and IV Outerbridge classification) of chondral lesions and an increased incidence of patients having more than 1 chondral lesion (65.3\% v 33\%, respectively). They concluded that complex and horizontal cleavage meniscal tears are highly associated with an increased incidence and severity of cartilage degeneration compared with other types of meniscal tears. Case series - Sign level = 3

10. Lee\(^61\) found 39 patients with medial meniscal root tear (mean age 59, 38 without a history of trauma; 87\% female) from a case series of 884 patients. At arthroscopy, 36 were observed to be radial tears and 3 complex tears. The medial meniscal root tears displayed a strong association with degenerative joint disease in 97\% of cases (38/39); cartilage defects of the medial femoral condyle and medial meniscal extrusions (> or =3 mm) occurred in 89\% of cases and 67\%, respectively. Case series - Sign level = 3

11. Hayes\(^55\) has studied the prevalence of cartilage defects in a random selection of subjects from a larger study cohort (117 women of mean age, 46 years). Large bone marrow edema lesions were common in the 'pain and OA' knee group who had significantly more defects of cartilage; meniscal tears; and osteophytes, subchondral cysts, sclerosis, joint effusion, and synovitis. Defects of cartilage, osteophytes, sclerosis, meniscal or ligamentous tears, joint effusion, and synovitis were strongly related to increasing Kellgren-Lawrence grade. They concluded that in middle-aged women, there were significant associations between pain, radiographic severity of OA of the knee, and seven MR imaging-identified parameters including meniscal tears. A cross-sectional study drawn from a cohort - Sign level = 2-

12. Tsai\(^34\) also reported his case series on 356 subjects all who had clinical symptoms of internal derangement of the knee, such as meniscal damage, cruciate ligament injury or osteoarthritis. Osteoarthritis was observed in 52\% of all those with medial degenerative tears (mean age was approximately 52), compared to 3\% for bucket handle and 14\% for flap. Case series - Sign level = 3

13. In patients (mean age 65) with clinical symptoms of OA\(^58\), T2, MRI measurements suggestive of degenerative changes were higher in the cartilage of those with meniscal tears compared to those without. Meniscal abnormalities were found in all 37 patients
and tears in 76%. The findings support the theory of an association of OA with damage to both menisci and cartilage. Case series – Sign level = 3

14. Noble in his histological studies has also shown that the coincidence of horizontal cleavage lesion and osteoarthritis are frequent. The percentage of horizontal tears increased from 18.4% where no OA was present to 61.5% for grade 3 OA. Of the massive horizontal lesions 42.5% were in joint compartments showing grade 3 OA. 15 of the 39 severely degenerate (grade 3) joint compartments contained a meniscus which was normal macroscopically. This finding was confirmed in an additional study which also showed that normal articular cartilage could be associated with marked meniscal tears. Case series – Sign level = 3

15. Casscells studied histologically, 116 knees from cadavers (av., age 70, 65% male) and 100 samples taken from knees during arthroscopy (av., age 35, 72% male) that had some pathological changes. In 60% of the combined series of cadaver and arthroscoped knees, the meniscal changes could not be correlated with the condition of the articular cartilage. In the remaining 40% there was a coexisting pathology in the meniscus and the articular cartilage; a cause and effect relationship could not be established though. Case series – Sign level = 3

16. Costa in a case series on 105 subjects of mean age 56 found that substantial medial meniscus extrusion (> 3 mm) was associated with major tearing and with severe meniscal degeneration, extensive tear, complex tear, large radial tear, and tear involving the meniscal root. A case series report – Sign level = 3

17. McCauley has reported a case series study which suggests that patients with central osteophytes (29 of 193 patients) were more likely to have a meniscal tear, but were not more likely to have an anterior cruciate ligament tear. Tears occurred in 69% of patients with central osteophytes and 53% of those with marginal osteophytes alone. A case series study - Sign level = 3

4.7. Outcomes after meniscectomy/repair of the meniscus

If degenerate tears and and/or a degenerate meniscus is a reflection of a pathological process underway in a knee joint it would seem reasonable to expect there to be evidence that outcomes after meniscectomy/repair in such a meniscus would result in poorer outcomes than would occur were meniscectomy and repair is done for traumatic tears in an otherwise healthy joint. In this section the evidence from nine papers is reviewed.

Evidence statement

- There is some evidence from retrospective, cohort/case series studies that meniscectomy/repair results in worse longer term outcomes for the patient if the surgery was conducted for a tear that was degenerate or in a meniscus that was degenerate. However the evidence is only moderate.
Discussion.

Englund\textsuperscript{19,72} has reported two studies on essentially the same cohort. In the first, reviewing 205 patients of mean age at surgery of 36 he reported that 14 years after partial or subtotal meniscectomy the outcomes as measured by a range of clinical and subjective scores were significantly worse for those who had horizontal, flap and tears in a degenerate meniscus than for those with longitudinal tears. At 16 years post surgery, degenerative meniscal tears were shown to be associated with the development of OA. These studies were conducted in a well defined larger cohort and at face value would seem to indicate that long-term outcomes are worse for those who have meniscectomy for tears that are classed as degenerate.

In addition to these two related studies seven other studies were reviewed some with few patients and all essentially case series. Four studies reported worse outcomes for some variables in those patients who had surgery in menisci with degenerate tears or degenerate menisci compared to those with non-degenerate menisci (Osti\textsuperscript{73}, Menetry\textsuperscript{74}, Fauno\textsuperscript{75} Shelbourne\textsuperscript{76}) and three found no difference for the variables they measured (Allen\textsuperscript{77}, Rockborn\textsuperscript{78}, Ahn\textsuperscript{79}).

These seven studies were widely varying; these included variations with respect to age, numbers, length of follow up, the compartments considered (lateral, medial and both), the type of tear and degeneracy considered, whether the surgical intervention were repair or resection, the location of the tears (in the vascular or avascular zones) and the outcomes measured. Some were poorly reported.

Conclusion

It is concluded that Englund's two related studies provide some evidence that meniscectomy in a meniscus which is degenerate or contains degenerate tears will result in worse long-term clinical and subjective outcomes for the patient than in those who have had similar surgery for traumatic tears. This evidence may again provide some support for the hypothesis that degenerate tears typically have a non-traumatic causation and may be regarded as part of a disease process in the knee joint. The studies other than those of Englund's are more equivocal though, but this is perhaps not surprising in view of their heterogeneity.

Papers reviewed

1. Englund\textsuperscript{19} reviewed 205 patients (22% female, mean age at surgery 36) with stable knees who had had an isolated unilateral meniscectomy (partial or subtotal) 14 years earlier. They found that those with a degenerative tear (horizontal, flap and tears in a degenerate meniscus) had significantly worse outcomes (WOMAC, SF36 and KOOS) than individuals with a traumatic (longitudinal) tear (P < or = 0.001). When unmatched subgroups and age- and sex-matched patients with degenerative or traumatic lesions were analysed, the same result was found for the knee-specific outcome score and SF-36 (excluding social functioning). The mean score differences between the two groups for KOOS ranged from 6 to 18/100 points (p<.02). They concluded that long-term outcome of meniscal injury appears to be determined largely by the type of tear and suggested that a tear in a meniscus with degenerative changes might be regarded as the first sign of OA in the joint. An outcome study from a larger patient series – A retrospective cohort study - Sign level = 2-

2. Englund in a second study\textsuperscript{72} (basically the same cohort as before\textsuperscript{19}) investigated long-term (16 years) radiographic and patient-relevant outcomes after isolated limited meniscectomy
with regard to type of meniscal tear and extent of surgical resection using a case-control design involving 155 patients with intact cruciate ligaments and mean age 54 at followup. A control group was recruited to allow calculation of relative risk. At follow up 43% had radiographic OA (15% had joint cartilage changes at baseline). In a multivariate model, degenerative meniscal tears were associated with both radiographic OA (P = 0.030) and combined radiographic and symptomatic OA (P < or = 0.015). The RRs for combined radiographic and symptomatic OA after degenerative and traumatic types of meniscal tear were 7.0 (95% confidence interval [95% CI] 2.1-23.5) and 2.7 (95% CI 0.9-7.7), respectively, compared with matched controls. They concluded that an isolated meniscal tear treated by limited meniscectomy is associated with a high risk of radiographic and symptomatic tibiofemoral OA at 16-year followup. A retrospective cohort study – Sign level = 2.

3. Ahn\textsuperscript{79} has investigated outcomes after repair surgery for tears of the medial meniscus at the posterior horn in knees with deficient ACLs by reviewing his case series of 311 knees. A second-look arthroscopy was performed at a mean of 37.7 months postoperatively in 140 patients; 66% had simple longitudinal tears and 34% complex. Age at surgery was 30 years; 10% female. On multivariate analysis healing was not associated with tear type though it was at univariate analysis (p<.001). Tears in the red-white zone had poorer rates of healing (P<04). Case series - Sign level = 3

4. Shelbourne\textsuperscript{76} has retrospectively reviewed the records of 155 patients who had isolated bucket-handle, medial meniscal tears involving 50% or more of the circumference of the meniscus, and anterior cruciate ligament tears. Tears were classed as degenerate if they had both vertical and horizontal component. Tears were either repaired (56, 30 non-degenerative, 26 degenerative; mean age 21) or resected (99, partial meniscectomy, mean age 23.9). Patients were evaluated at a mean follow-up of 6 to 8 years after surgery. In the repair group, the mean subjective score (Noyes score) of 93.9 for nondegenerative menisci was significantly better than the 87.1 (P=.02) for degenerate menisci. There was no difference in those having partial meniscectomy. They concluded that in the repair group patients with degenerative tears had significantly lower subjective scores than those with nondegenerative tears. Case series - Sign level = 3

5. Fauno\textsuperscript{75} has conducted a follow-up study at an average of 8.5 years to clarify the clinical and radiological long-term consequences of arthroscopic meniscus resection in 136 patients who had unilateral arthroscopic resection of an isolated meniscal tear. 82 had flap tears (17% lateral) and 54 bucket handle (10% lateral). The mean age of the flap tear group was 35 and 21% were female, the corresponding figures for the bucket handle group were 31 years and 33% female. Rearthroscopy was conducted significantly more often in the flap tear group (p = .008), pain after exercise was more common (p=.016) and return to sport took significantly longer (P=.001). Return to work was not significantly different as were a number of other parameters. Case series - Sign level = 3

6. Menetrey\textsuperscript{74} has assessed the outcome of arthroscopic partial medial meniscectomy in patients over fifty years of age. They reviewed 32 patients at an average time of 6 years who had undergone arthroscopic medial partial meniscectomy (average age 60, 34% female). Patients were divided into two groups: 12 with non-degenerative meniscal tears and 20 with a degenerative meniscus (horizontal tears multiple fibrillations and fissures). Outcomes
measured were, HSS knee score (Hospital for Special Surgery Score), a satisfaction score and weight bearing x-rays. Arthroscopic medial meniscectomy in older patients as judged by the HSS score provided 90% good results six years after a non-degenerate meniscal tear, but only 20% of good results after a degenerative meniscal tear (p=0.009); average satisfaction score 9.3 v. 5.2 (p=0.007); radiographic changes 25% v. 74%. Case series - Sign level = 3

7. Rockborn has reviewed outcomes from 60 male patients (mean age 30) with stable knees who had arthroscopic meniscectomy (partial or subtotal), 12 – 15 years previously. Patients were divided into 2 subsets; One - normal cartilage in both medial and lateral compartments; Two - Cartilage fibrillation including more than half of the weight bearing area on the injured side. In subset one, 24 tears were medial and 8 lateral; in subset two the corresponding figures were 25 and 6. 12 tears were classed as traumatic and 18 degenerative in each subset. Patients with severe cartilage changes were excluded. Specific trauma accounted for 88% of the tears. Outcomes measured included the knee function (Lysholm Score), activity (Tegner scale) and the Ahlback Arthrosis grade score. The frequency of radiographic changes did not differ between the two groups irrespective of the type of meniscectomy performed. Traumatic or degenerative tear types did not appear to effect outcome. Case series - Sign level = 3

8. Allen has reviewed the occurrence of late degenerative changes following meniscectomy (types of meniscectomy not described). A total of 210 patients were followed up at a mean time of 17 years. Age at operation ranged from 13 to 67 years (mean age not given nor % female); 55% had vertical tears, 38% horizontal, cysts 8.2%, doubtful tear or degeneration 7.4% and normal 13%. Outcome was assessed by long leg radiographs taken of both knees and other scoring systems. Radiological degeneration was seen in 18%, while 7% had significant symptoms and signs. There was no significant difference in the incidence of radiological OA between those with different types of tear. There was a higher incidence of OA after lateral meniscectomy compared to medial but this was not statistically significant. Case series - Sign level = 3

9. Arthroscopic partial lateral meniscectomies performed for isolated meniscal tears, without associated ligamentous injury, in 41 athletes (mean age 26, 34% female) have been reviewed by Osti for clinical and functional outcome. 90% reported previous trauma to the knee. Follow-up was at a mean time of 3 years. Patient outcomes depended on type of meniscal tear and presence/absence of an articular cartilaginous lesion. Athletes who had isolated, longitudinal type tears of the lateral meniscus had the best outcome: 100% achieved excellent/good results and averaged 41 days to return to full sports activities. Athletes with complex meniscal tears and tears associated with articular cartilaginous lesions had the poorest results, achieving 79% and 64% excellent/good results, respectively, and averaging 64 and 78 days for return to full sports activities (p<0.001). Case series - Sign level = 3

4.8. Association of degenerative tears with certain occupations

There are a few reports in the literature that meniscal tears and degeneracy are associated with particular occupations including that of floor layers and miners. Of these, one paper is reviewed as a way of noting this aspect.
Evidence Statement. One paper has been reviewed that provides some evidence suggesting that floor layers have a higher prevalence of degenerative tears than graphic designers but this increased prevalence does not result in increased levels of pain or discomfort.

Discussion and conclusion

While some caution is required in interpreting this paper it would seem reasonable to conclude that repeated kneeling in occupational settings is associated with increased risk of degeneracy in the meniscus as detected by MRI. There is no evidence that the relationship is causal though it is suggestive of such. This and other similar papers may have relevance to work-related gradual process claims.

Perhaps the most important point from the perspective of this paper is that the over half of the graphic designers also had bilateral MRI degenerate grade 3 signals indicative of tearing in their menisci, so if there is an increased risk for some occupations it is a relative increase over a high prevalence already found in the general population which is not readily attributable to work practice per se. Further the higher incidence of degenerate tears is not reflected in an increased incidence of symptoms and is therefore of little clinical relevance in this age group.

Paper reviewed

1. Rytter has evaluated the association between occupational kneeling and degenerative meniscal tears in a cross-sectional study of cases and controls. The study included 92 male floor layers and 49 male graphic designers, with a mean age of 55.6 years (range 42-70 yrs). Using MRI they found that degenerative tears were significantly more prevalent in the medial meniscus among floor layers than among graphic designers and significantly more floor layers had medial tears in both knees. 75.8% of floor layers and 57.7% of graphic designers had bilateral meniscal tears (grade 3 signal intensity, MRI). Tears extending to the tibial aspect and localized in the middle and posterior one-third of the medial meniscus were most prevalent. Lateral meniscal tears were predominantly unilateral and the prevalence of lateral tears did not differ between the two study groups. They concluded that occupational kneeling increases the risk of degenerative tears in the medial but not the lateral menisci in both knees. While it was shown that degenerative tears were more frequently found in the floor layers there was no difference in the frequency of symptoms. A case-control design - Sign level = 2-.
5. Discussion and conclusions to the entire paper

Legal Background

Based on our understanding of a legal opinion provided to Research there are at least three factors related to causation that are important to consider before surgery is approved:

1. The cause of the injury/disease
2. The balance of probabilities in relation to causation
3. The factors in the individual case.

1. Causation

The relevance of causation has two important aspects for ACC; Firstly under ACC’s legislation, cover for compensation and treatment is restricted to pathologies arising from personal injury. Personal injury has under the Act these defined causation exclusions (While these clauses refer to cover it is generally accepted that they are relevant in an ongoing entitlement context); –

“Personal injury does not include personal injury caused wholly or substantially by a gradual process, disease, or infection...”

and

“Personal injury does not include -

(a) personal injury caused wholly or substantially by the ageing process...”

(Section 26(2) and (4) of the Injury Prevention, Rehabilitation, and Compensation Act 2001 (the IPRC Act))

Secondly any injury/disease arising other than directly and substantially from a traumatic event may have components which dictate a course of clinical treatment markedly different from that arising solely from a traumatic injury. For example the presence of meniscal tears and advanced osteoarthritis in an older person’s knee will probably suggest a course of treatment substantially different from that of a traumatic meniscal tear in the knee of a younger person. Even if determining causation for cover and entitlement was not an issue, understanding causation is important to choosing appropriate treatment options. (While treatment is not the focus of this paper some relevant notes on this in relation to meniscal tears are included towards the end of this discussion).

2. The balance of probabilities

The legal opinion sets out some of the principles distilled by the District Court taken from the decision in Coleman (decision 18/2007).

- If the appellant can demonstrate on a probability basis that the need for the operation arose substantially from the accident, then the appellant must go on and demonstrate that need for the entitlement was not caused wholly or substantially by ‘the ageing process’. The onus of
proof of this step is upon the appellant upon a balance of probabilities. What is necessary is a critical analytical assessment of the original injury in the light of the medical reports.”

It would seem then that in deciding whether entitlement is due, ACC is required to consider the balance of probabilities in relation to evidence on causation and in the case of meniscal tears to decide whether or not the tear is substantially due to degeneration or to traumatic injury.

3. The factors in the individual case

Finally it is necessary for ACC to consider the individual case rather than to apply global rules. As noted in the Coleman decision above 'What is necessary is a critical analytical assessment of the original injury in the light of the medical reports'. This is obviously reasonable as the determination of causation and its probabilities will be dependent on a range of clinical factors that vary from person to person.

In this discussion the evidence is summarised to show that tears commonly known in the literature as degenerative tears are correctly so designated and could in many cases be fairly described as wholly or substantially caused by a gradual process or disease and/or that they arise substantially by the ageing process. In doing so the evidence on the balance of probabilities is emphasised.

Evidence on causation

In this paper an attempt has been made to justify the classification of tear types into degenerate and traumatic, degenerate tears being horizontal, flap, complex and a degenerate meniscus and traumatic being vertical tears (longitudinal, radial and bucket handle). The evidence set out in each of the eight sections above is summarised here as follows:-

1. Age (4.1): There is high quality evidence from a cohort study which shows that tears and meniscal degeneration increase in frequency with age. This evidence is supported by a range of cases series studies including histological studies and direct observation at surgery covering populations in many different countries.

The prevalence of grade 2 signal changes indicative of early degeneration was already 24.1% at the posterior horn of the medial meniscus in a young population of health professionals of mean age 28⁶. Grade three changes indicative of tears had a prevalence of 76% in one study on older asymptomatic subjects (mean age 67) and reached 91% in those with symptomatic osteoarthritis (91%)⁷.

A repeated, and generally consistent observation is that the mean age of those who present with horizontal, flap, complex or degenerate menisci are 10 to 20 years older than those presenting with longitudinal, bucket handle or radial tears which are generally found in the younger adults.

2. ACL injuries (4.2): There is good evidence, consistent across a range of case series studies that 70 to 90% of tears associated with acute ACL injuries are peripheral, longitudinal tears. The percentage of flap and horizontal tears is small. As time from injury increases and the ACL tear becomes chronic, the percentage of tears in the medial compartment increase and will be accompanied with an increase in percentages of flap and horizontal tears.
3. Other traumatic events (not specifically ACL) (4.3): There is some evidence from a cohort study and number of case series studies that longitudinal/bucket handle/vertical tears predominately occur due to specific injury events and horizontal tears due to degeneration but these classifications are by no means exclusive.

4. Occurrence in symptomatic and asymptomatic knees (5.4): There is some evidence from studies of relatively low quality that degenerate tears occur with high frequency bilaterally in the symptomatic knee and the asymptomatic knee of the same person, whereas traumatic tears are more commonly found unilaterally in the symptomatic knee.

5. Body mass index (4.5): There is good evidence that prevalence of tears is strongly associated with BMI. These tears are likely to be mainly degenerate in nature.

6. Osteoarthritis (OA) (4.6): There is excellent evidence from a variety of studies that degenerative tears particularly horizontal tears, complex tears and degenerate menisci are more strongly associated with the presence of OA than other tears. In one study the percentage of horizontal tears increased from 18.4% where no OA was present to 61.5% for grade 3 OA.

A meniscal tear at baseline in middle aged to older subjects is a potent predictor for the development of radiographic knee OA within 30 months; and those with OA at baseline but without tears are at higher risk of subsequently developing degenerate tears. The presence of degenerative knee tears may also partially predict the onset of hand OA.

7. Outcomes after meniscectomy (4.7): There is some evidence from retrospective, cohort/case series studies that meniscectomy/repair results in worse longer term outcomes for the patient if the surgery was conducted for a tear that was degenerate, or in a meniscus that was degenerate. However the evidence is not compelling.

8. Specific occupations (4.8): One paper has been reviewed that provides some evidence suggesting that floor layers have a higher prevalence of degenerate tears than graphic designers but this increased prevalence did not result in increased levels of pain or discomfort.

This body of evidence taken as a whole makes a compelling case for a dichotomous classification of tears in to those predominately of a degenerative causation and those of predominately of traumatic causation. This classification though is not absolute for there is a suggestion that in certain cases a traumatic injury may exacerbate areas of lower grade degeneracy in a meniscus creating frank tears that reach the meniscal surface and/or contribute to additional meniscal maceration: A prospective study detailing this was not found, but there is evidence that degenerate tears are found after sporting injuries and others have raised the hypothesis for which they believe there is some evidence, that there is a segment of the population who have pre-existing meniscal degeneration which predisposes them to traumatic or spontaneous degenerate tearing.

There is excellent evidence that degenerate tears are extremely common in the general population. The Framingham data suggest that about one third of knees in those over 50 years of age in the general population have degenerate tears and at a mean age 53, 53% of male graphic designers in a Danish study had degenerate tears.

These degenerate tears are typically asymptomatic. In Rytter's study, graphic designers with a 57% prevalence of medial meniscal tears did not have a significantly different prevalence of
knee complaints than the floor layers with a tear prevalence of 67%, nor was there any
difference in complaints between those with tears and those without, even though about 50% of
the total population surveyed reported knee complaints. Englund in his study found that knee
pain was related to OA not the tear per se\textsuperscript{71}.

There is excellent evidence that degenerate tears are most common on the posterior horn of the
medial meniscus and that they are strongly associated there with the presence of OA. The
degenerate tear is in fact so common in the elderly with moderate OA it has been suggested that
it is pointless to conduct an MRI to show their presence\textsuperscript{2}.

Degenerate meniscal tears though are not benign and in at-risk populations significant
numbers of subjects with such tears will go onto develop OA; whether the tear is partly
causative of this development in certain subjects or merely a reflection of a systemic disease
process is not known.

The balance of probabilities

There is good evidence that degenerative changes in the meniscus are well under way in many
subjects under 30 years of age and that by 50 and 60 years of age, full, degenerative tears are
common place in at least one third of subjects and in some populations prevalence is over 50%.
These changes may predispose certain individuals to further tearing following further minor
trauma but the increased risk such degeneration poses is not known. Unless these changes are
associated with the presence of OA such degeneration is often asymptomatic, disability is not
obvious and the condition itself is probably not of central concern to ACC.

When OA is present it is a different matter. Not only is the prevalence of degenerative tears
increased further but significant pain and stiffness from the OA can become disabling. It has
been suggested that ACC is currently paying for a significant number of knee arthroscopies
undertaken to resect the degenerate meniscus, remove loose bodies and osteophytes and debride
the chondral surface on the assumption that this is treating a personal injury.

It is suggested that degenerate tears in middle aged to older subjects, especially those associated
with OA are in a general sense not compensable under ACC’s legislation, the pathological
processes at play being, on the balance of probabilities, substantially attributable to advancing
age and disease and not trauma.

Further, even if this was not the case the evidence suggests that in many cases any attempt to
arthroscopically treat the degenerate tear in the middle aged to older person and ameliorate OA
disease progression and knee symptoms associated with the OA will be without clinical benefit
to the patient (see below).

One exception to ACC’s liability for OA may arise where there is an old knee injury. It has been
shown that an old injury raises risk of OA three fold\textsuperscript{70} and in this case ACC may have a liability.
However if partial meniscectomy took place for that injury there will be an increased risk of
OA\textsuperscript{82}; If the partial meniscectomy took place in a meniscus that already had a degenerate tear
then the risk of OA is likely to be increased further\textsuperscript{19}.

Where an old injury is not an issue and in the absence of other signs of recent trauma, it seems
probable that ACC has no or little liability for treatment of meniscal tears in the presence of
significant OA since it is substantially a disease process common in the older population.
Outcomes after arthroscopy for patients with OA

Even if it were decided that degenerative meniscal tears in the presence of OA and the absence of a traumatic injury were compensable by ACC the literature seems to suggest now that arthroscopic surgery is not usually an appropriate intervention for the older subject with meniscal tearing and significant OA.

Felson\(^{83}\) has reviewed two RCTs that have examined outcomes from arthroscopy for knee OA. The first by Mosely\(^{84}\) compared outcomes from three groups, lavage (lavage and removal of unstable tears), debridement (shaving rough articular cartilage, removing loose debris and trimming torn or degenerated meniscal fragments) and placebo (sham surgery). No efficacy of arthroscopic debridement or lavage over sham surgery was seen as much as three years after surgery. This trial was strongly criticized and lead to a second lead by Kirkley\(^{85}\), who examined outcomes in a more broad sample of subjects. Debridement with lavage (including synovectomy, excision of degenerative tears in the meniscus and fragments of cartilage, and excision of osteophytes) was compared with no surgery, with all patients receiving optimized additional therapy including physical therapy. There was no difference in outcomes with respect to pain or mechanical symptoms at one or two years.

Felson drew attention to an editorial by Marx\(^{86}\), a prominent orthopaedic surgeon whose paper accompanied Kirkley’s paper: Marx gave two scenarios and suggested that arthroscopy would be indicated in a patient with mild or no osteoarthritis, who had an acute injury involving twisting of the knee, whose symptoms date clearly to that injury and where an MRI demonstrated a remediable lesion likely due to the injury,. Marx’s other case concerned an older lady with advanced OA and co-existent meniscal tears in which case he stated that arthroscopy would be of no value.

Felson himself concluded that the failure of arthroscopy to be effective suggests that all the elements of that treatment are ineffective including the surgical treatment of stable degenerative tears that are commonly present. He concluded that arthroscopy for OA has now been convincingly demonstrated to be ineffective and should not be carried out. The only exception would be where there was evidence of recent trauma and a symptomatic meniscal tear.

Englund\(^{9}\) believes that while persons with meniscal damage without surgery are at high risk of developing knee OA there is no evidence that current surgical techniques reduce this risk. He stated that even in painful knees, surgery is a questionable alternative in those above 50.

Factors to be considered when determining an individual case.

Some examples for accepting/rejecting individual cases for knee arthroscopy

- The subject presenting is under 30 years of age and presents a peripheral longitudinal tear with other ligamentous injuries particularly ACL injuries; this is the classic traumatic injury.

- An older person presents with advanced OA and degenerate tearing/degenerate meniscus and the claim is made that it is due to an old injury. In this case the OA should be unilateral and therefore OA as detected by x-ray should not be present or of low grade in the asymptomatic knee. Other mitigating factors effecting ACC’s liability would include consideration of the presence of OA in joints other than the knee and degree of obesity.
A person of middle age presents with knee OA and degenerate meniscal tears on the posterior horn of the medial meniscus. It is claimed that painful symptoms arose after a traumatic event. Some relevant factors for determining liability are consideration of the following to determine the balance of probabilities: the grade of OA should be measured by radiography and if of a grade >=2 the case is unlikely to be compensable; the type of tear as revealed by MRI; the degree of obesity is relevant; degenerate meniscal tears are not typically a cause of pain itself when OA is present; the evidence of other injury in the affected knee especially ligamentous injury; An MRI of the asymptomatic knee will reveal the underlying degree of degeneracy; any evidence of OA in any other joint especially that of the hand will further confirm evidence of systemic OA which will emphasise the weight to attach to the OA; partial meniscectomy is not likely to halt the progression of OA if this is contributing to the problem.

Conclusions

It has been suggested that ACC is currently paying for a number of arthroscopies undertaken in knees with significant levels of OA, to resect the degenerate meniscus, remove loose bodies and osteophytes and debride the chondral surface on the assumption that this is treating a personal injury rather than a disease. This assumption is probably ill-founded. If this is so ACC is funding a number of surgical cases contrary to its legislative mandate.

The evidence would suggest that arthroscopy undertaken for resection of degenerate tears associated with OA should not typically be regarded as compensable under ACC’s legislation, the pathological processes at play, being on the balance of probabilities substantially attributable to advancing age and disease and not to trauma.

If this evidence is agreed to be sufficient it has significant implications for ACC funding and could result in the transfer of costs from ACC into the public/private health systems.

It is suggested that some of the issues ACC may consider addressing are –

- It is important for ACC to reliably estimate the number of meniscectomies being done in knee joints with advanced OA. Further analysis of ACC and NZHIS data and DHB coding practices will help but may not be definitive. It may be necessary to investigate the potential of an audit of case notes.

- Development of a standard for information required when a meniscal surgery is requested which might include results from weight bearing x-rays and grading of any OA present, description, location and severity of tears if MRI is done, state of the non-injured knee, presence of OA and/or pain at other body joints, BMI, evidence of other relevant acute trauma - hemiarthrosis, possible torn collateral ligaments, ruptured ACL and other pathology.

- Receiving a separate report from the radiologist.

- Development or introduction of a coding system that is sufficiently descriptive of what is done at arthroscopy and the principal diagnosis for the surgery.

- The development and use of a surgical knee register in association with the Ministry and the College of Orthopaedic Surgeons using standard codes/terminology to describe...
diagnosis including tear type, grades of OA, other pathology, procedures undertaken and recording outcome scores such as EQ-5D and WOMAC

- Requesting x-rays and MRI for the asymptomatic knee when disputes arise
- Independent verification of cause of injury in cases likely to be contentious
- Development of an addendum to the ACC Knee Guideline which sets out the basic requirements that should be met for ACC to be the funder in cases where injuries are said to have occurred in knees where OA is present. The addendum may also address the evidence for interventions in such cases when ACC is the funder.
Appendix One. MRI classification scheme as used by Crues

Grade 0 = normal
Grade 1 = intrameniscal focus of signal
Grade 2 = intrameniscal linear or wedge-shaped signal
Grade 3 = linear or globular signal extending to an articular surface

Appendix Two. Level of evidence in the SIGN system

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</thead>
<tbody>
<tr>
<td>1++</td>
<td>High quality meta-analyses, systematic review of RCTs, or RCTs with a very low risk of bias</td>
</tr>
<tr>
<td>1+</td>
<td>Well conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias</td>
</tr>
<tr>
<td>1-</td>
<td>Meta-analyses, systematic reviews of RCTs or RCTs with a high risk of bias</td>
</tr>
<tr>
<td>2++</td>
<td>High quality systematic reviews of case-control or cohort studies. High quality case-control or cohort studies with a very low risk of confounding, bias or chance and a high probability that the relationship is causal</td>
</tr>
<tr>
<td>2+</td>
<td>Well conducted case control or cohort studies with a low risk of confounding, bias or chance and a moderate probability that the relationship is causal</td>
</tr>
<tr>
<td>2-</td>
<td>Case control or cohort studies with a high risk of confounding, bias or chance and a significant risk that the relationship is not causal.</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytic studies</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>
References


52. Zhang W. Risk factors of knee osteoarthritis - excellent evidence but little has been done. Osteoarthritis and Cartilage 18(1)(pp 1-2), 2010


81. Mercier M. Memorandum, Comment on Statuory wording - meaning of substantially (a legal opinion). 2010.

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