

Ministry of Defence

Synopsis of Causation

Osteoarthritis of the Knee

Author: Dr Tony Fisher, Medical Author, Medical Text, Edinburgh
Validator: Mr Malcolm Glasgow, Norfolk and Norwich University Hospital, Norwich

September 2008

Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

The Ministry of Defence accepts full responsibility for the contents of this synopsis, and for any claims for loss, damage or injury arising from the use of this synopsis by the Ministry of Defence.

1. Definition

- 1.1. Osteoarthritis of the knee (syn: osteoarthrosis of the knee, gonarthrosis) is a common degenerative condition affecting the knee joint. It may occur as a primary disorder with no evident initiating cause, or it may arise as a result of some other condition such as a previous injury or infection, as a consequence of malformation or mal-alignment of the joint, or due to overloading of the joint as in obesity.
- 1.2. The key pathological features of osteoarthritis of the knee are no different to those in any other affected joint; namely focal destruction of articular cartilage, followed by changes in subchondral bone.
- 1.3. The condition of osteoarthritis is given general consideration in the relevant Synopsis *Osteoarthritis*.

2. Clinical features

- 2.1. Osteoarthritis is more common in the knee than in other major joints but clinically significant osteoarthritis of knee is rare before the age of 50. The age- and sex-standardised incidence rate for clinical osteoarthritis is approximately 240 cases per 100,000. The prevalence of osteoarthritis of the knee is approximately 30 percent among those of 75 years and older and is higher for men than women up to age 45 years, after which the reverse is true.
- 2.2. The classic presenting symptom is pain which may be accompanied by [crepitus](#) and swelling of the joint. Progressive restriction of movement and eventually a fixed flexion deformity are also commonly observed in the later stages. Pain is often most marked first thing in the morning and eases with activity; there are however multiple patterns of pain in osteoarthritis including those with an almost complete predominance of night pain.
- 2.3. Osteoarthritis can affect any or all of the three compartments of the knee; namely the medial, lateral and patello-femoral compartments. Isolated osteoarthritis of these components of the joint produce slightly different symptom-patterns. For example patients frequently describe pain on the inside or outside of the knee if unicompartmental arthritis of the medial or lateral compartment respectively is the cause of their symptoms. [Varus](#) or [valgus](#) deformity is a good indicator of isolated medial or lateral compartment osteoarthritis.
- 2.4. Not all patients with patello-femoral arthritis have osteoarthritis in the other compartments; arthritis may develop at different times and with separate causes in the different compartments of the knee. Isolated patello-femoral arthritis occurs in up to 10% of patients with osteoarthritis. Patients are more likely to complain of anterior knee pain, with particular difficulties when descending stairs or when rising from a seated position after prolonged sitting.
- 2.5. The most significant radiological sign of osteoarthritis is narrowing of the joint space, due to loss of the articular cartilage. Osteophytes may frequently be observed in addition to bone cysts and bone sclerosis. Radiological changes correlate poorly with the degree of severity of symptoms.

3. Aetiology

- 3.1. **Primary osteoarthritis of the knee** The cause of so-called “primary” or [idiopathic](#) osteoarthritis of the knee is unknown, although it is believed that genetic, hormonal and constitutional factors probably all play a part.^{1,2,3,4} One concept held by many workers is that mechanical stresses injure the [chondrocyte](#), causing it to release degradative enzymes that result in the breakdown of connective tissue.

- 3.2. **Secondary osteoarthritis of the knee** “Secondary” osteoarthritis of the knee may occur as a result of mechanical factors, which include obesity, partial or complete [meniscectomy](#), femoral [osteonecrosis](#), lower extremity trauma, ligamentous laxity, and lower extremity malalignment.
 - 3.2.1. **Obesity** There is a clear association between osteoarthritis of the knee and obesity, as measured by the body mass index (BMI). The risk of osteoarthritis of the knee increases progressively with the extent to which the BMI exceeds the normal.⁵ Conversely, weight-reduction is considered to be a practical adjuvant treatment in the rehabilitation of patients with the condition.⁶ Some studies suggest that the association may at least in part be due to metabolic, rather than purely mechanical factors.

 - 3.2.2. **Abnormal alignment** Results from a number of studies suggest that abnormal alignment also leads to abnormal contact stress, both in the tibio-femoral and in the patello-femoral compartments of the knee.^{7,8,9}

 - 3.2.3. **Malalignment following fracture** Fractures of the tibial shaft and plateau may lead to subsequent lower extremity malalignment, and in turn this may cause abnormal stresses on the knee joint surfaces. For instance, residual [varus](#) angulation increases contact stresses across the medial compartment of the knee. For this reason, most clinicians would not accept more than 10 degrees of angulation in tibial shaft fractures.

 - 3.2.4. **Tibial plateau fractures** Tibial plateau fractures may also lead to osteoarthritis as a result of direct articular cartilage damage and bony distortion caused by the intra-articular fracture.

 - 3.2.5. **Acute knee injury** There is a probable association between previous significant knee injury and the later development of osteoarthritis in the joint.^{10,11,12} However, some authorities take the view that while trauma to the joint may initiate the osteoarthritic process, progression is a consequence of constitutionally impaired intrinsic repair capacity.¹³

 - 3.2.6. **[Meniscectomy](#)** Surgical removal of a meniscus following knee injury represents a

significant risk factor for tibio-femoral osteoarthritis.¹⁴ Contact stresses between the femur and tibia are increased with removal of the meniscus and greater force is transferred directly to the tibial articular surface. The joint also becomes less congruent and is not able to disperse the forces across the joint. Both of these factors can cause damage to the articular cartilage and subsequent development of osteoarthritis. The relationship of degenerate meniscal pathology as seen in the 45+ age group is less certain as some authorities have suggested that the development of degenerative meniscal pathology may be associated with incipient osteoarthritis, thus signalling the first symptom of the disease.¹⁵

- 3.2.7. **Other surgical procedures** There is no evidence that investigative procedures such as arthroscopy are a risk factor for osteoarthritis of the knee. Major surgery is in general only undertaken in the context of trauma to the joint, and if osteoarthritis ensues it is likely to be a consequence of the injury itself and not the surgical procedure.
- 3.2.8. **Ligamentous laxity** Ligamentous laxity is frequently implicated in the development of osteoarthritis. **Anterior cruciate laxity** will result in excessive anterior movement of the tibia on the femur, leading to increased shear forces and subsequent damage to the articular cartilage. There is also a close association between anterior cruciate instability and the development of meniscal pathology, resulting ultimately in the loss of intact meniscal substance which will result in increased liability to osteoarthritis. The picture with regard to **posterior cruciate laxity** is less clear, but it has been suggested that there is an increased liability to patello-femoral osteoarthritis in chronic posterior cruciate instability. Patellar dislocation, [subluxation](#) or significant mal-tracking will also predispose to the development of patello-femoral osteoarthritis.
- 3.2.9. **Torsional deformities** Torsional deformities of the tibia and femur may be associated with the onset of degenerative changes. The torsion may be present on the tibial or femoral surfaces of the joint. This may lead to [varus](#) angulation and increased contact stresses across the articular cartilage of the medial joint space, with resulting accelerated medial compartment osteoarthritis.
- 3.2.10. **Dysplastic lateral femoral condyle** Usually, a [genu valgum](#) deformity is the result of a congenitally [dysplastic](#) lateral femoral condyle, which causes pathological loading of the lateral compartment of the knee and subsequent bone and cartilage destruction.
- 3.2.11. **Inflammatory joint disease** Secondary osteoarthritis may develop as a sequel of inflammatory joint disease such as rheumatoid arthritis, acute bacterial joint infection (septic arthritis), or tuberculous arthritis. Tissue breakdown by degradative enzymes is followed by suppression of [proteoglycan](#) synthesis, and immobility contributes further to cartilage breakdown.¹⁶
- 3.2.12. **Spontaneous [osteonecrosis](#) of the femoral condyle** This is a disorder that typically

occurs in women older than 55 years, and it presents with the acute onset of pain. Lateral compartment degenerative disease may be the ultimate complication of spontaneous [osteonecrosis](#) of the lateral femoral condyle. The condition is typified by a very rapid deterioration from minor symptoms to gross disability with deformity.

- 3.2.13. **Miscellaneous disorders** A number of metabolic diseases may result in osteoarthritis. They include haemachromatosis, Wilson's disease and gouty arthritis, and in all these conditions there is crystal deposition within the joint. Other diseases which predispose to osteoarthritis include diabetes mellitus and acromegaly.
- 3.3. **Occupational factors** There is some evidence that the nature of the patient's occupation has an influence on the development of osteoarthritis, and in one large survey, in which osteoarthritis of the knee was present in one-third of the patients sampled, excess prevalence was found in agricultural workers and unskilled labourers.¹⁷ Other research appears to support the hypothesis that prolonged heavy physical loading increases the risk of osteoarthritis of the knee.^{18,19} In a longitudinal study in which a large population was followed over 40 years, the rates of severe radiographic osteoarthritis of the knee were higher among men whose occupation involved knee bending and at least medium physical demands.²⁰
- 3.4. In another population-based case-control study, 109 men and women with painful, radiographically-confirmed knee osteoarthritis were compared with 218 controls who had no knee pain and had normal X-rays. It was concluded that the risk of osteoarthritis of the knee was significantly greater in subjects whose main job entailed more than 30 minutes a day squatting, or kneeling, or involved climbing more than 10 flights of stairs per day.²¹ Similar conclusions were reached by the authors of a more recent study in which 518 individuals with osteoarthritis of the knee were compared with an equal number of matched controls. It was found that risk was elevated in those subjects who reported prolonged kneeling or squatting, walking more than 2 miles a day and regularly lifting weights of at least 25 kg in the course of their work. The risk was further increased in obese individuals (body mass index greater than 30 kg/m²).²²
- 3.5. In contrast, in a survey of 402 patients undergoing total hip replacement or total knee replacement for osteoarthritis, the occupational history of the subjects was investigated. The aims of the study were to determine and compare the aetiological background, clinical patterns and radiological features of idiopathic osteoarthritis of the hip and the knee warranting arthroplasty. Although farming was the most common occupation of patients presenting for total hip replacement and total knee replacement, a large proportion were administrators and teachers, suggesting that those in lighter occupations are also vulnerable to osteoarthritis of the hip and knee. The authors conclude that obesity and heavy occupation, factors traditionally considered relevant to the development of degenerative changes in hips and knees, are not mandatory to the development of severe, symptomatic osteoarthritis and highlight the importance of a constitutional predisposition to osteoarthritis of these joints.²³
- 3.6. **Participation in sports** Certain sporting activities appear to carry a risk of the development of later knee osteoarthritis, particularly skiing and soccer. For example in a review carried out

to study the long-term sequelae of soccer the authors conclude that a long-term soccer career seems to increase the risk for early development of osteoarthritis in the lower extremity. The sport constitutes a risk for osteoarthritis in two different ways. First because of the increased risk for knee injuries inherent at all levels of the game, such as meniscus and anterior cruciate ligament injuries and second, by the high loading on hip and knee joints that occurs in the sport. It is notable however that the subjects studied had a long-term soccer career and the authors point out that the risk for these undesirable effects are higher in top-level players.²⁴

3.7. There is no scientifically validated evidence to show that regular exercise and recreational pursuits, including jogging and running, are associated with an increased incidence of the condition.²⁵

3.8. **Environmental factors** There is also no evidence that exposure to adverse climatic influences, such as low or variable temperatures, wet or damp conditions have any influence on the development of osteoarthritis.

4. Prognosis

- 4.1. Osteoarthritis of the knee is a degenerative disease and spontaneous resolution does not occur. However once established, the condition can remain relatively stable for some years. Although reports vary widely, long-term studies suggest that clinical and radiological deterioration occurs in one-third to two-thirds of patients.

5. Summary

- 5.1. Osteoarthritis of the knee is a degenerative condition which may develop without apparent cause or may be secondary to a number of factors, particularly age, obesity, malalignment and previous trauma.
- 5.2. There is some evidence that occupations associated with prolonged heavy physical loading can influence the development of osteoarthritis of the knee, although individuals who are engaged in lighter occupations can also be vulnerable.
- 5.3. Certain sporting activities played at the highest level appear to carry a risk of the development of later knee osteoarthritis, as does a history of knee injury sustained in the course of sporting activities. Following meniscectomy, most studies have reported an increased frequency of subsequent OA. However, there is no evidence that regular exercise, recreational pursuits, or exposure to adverse climatic or other environmental influences have any effect.

6. Related Synopses

Osteoarthritis – General

Osteoarthritis of the Hip

Anterior Knee Pain

Chondromalacia Patellae

Internal Derangement of the Knee

7. Glossary

| | |
|---|--|
| chondrocyte | Differentiated cell responsible for secretion of matrix of cartilage. |
| crepitus | A sensation of grating during movement of a joint. |
| dysplastic | Abnormally developed. |
| hypertrophic osteophytic spurring | Overgrowth of bone. |
| idiopathic | Of unknown cause. |
| meniscectomy | Surgical removal of one of the crescent-shaped cartilages of the knee. |
| osteonecrosis | A condition in which a derangement of the blood supply to an area of bone leads to cell death and subsequent degenerative changes. |
| proteoglycan | A complex of protein and polysaccharide characteristic of bone and cartilage, important in determining the compressive stiffness of articular cartilage. |
| subchondral cyst | A cystic formation in the bone underlying the cartilage of a joint. |
| subluxation | Abnormal movement of one of the bones comprising a joint. |
| valgus angulation of the knee (genu valgum) | “Knock-knee” deformity. |
| varus angulation of the knee (genu varum) | “Bowling” of the knee. The opposite of genu valgum. |

8. References

- ¹ Dumond H, Presle N, Terlain B, et al. Evidence for a key role of leptin in osteoarthritis. *Arthritis Rheum*. 2003;48(11):3118-29.
- ² Aigner T, Dudhia J. Genomics of osteoarthritis. *Curr Opin Rheumatol*. 2003;15(5):634-40.
- ³ Richette P, Corvol M, Bardin T. Estrogens, cartilage and osteoarthritis. *Joint Bone Spine*. 2003;70(4):257-62.
- ⁴ Hunter DJ, March L, Sambrook PN. Knee osteoarthritis: The influence of environmental factors. *Clin Exp Rheumatol*. 2002;20(1):93-100.
- ⁵ Coggon D, Reading I, Croft P, et al. Knee osteoarthritis and obesity. *Int J Obes Relat Metab Disord* 2001;25(5):622-7.
- ⁶ Huang MH, Chen CH, Chen TW, et al. The effects of weight reduction on the rehabilitation of patients with knee osteoarthritis and obesity. *Arthritis Care Res* 2000;13(6):398-405.
- ⁷ Elahi S, Cahue S, Felson DT, et al: The association between varus-valgus alignment and patello-femoral osteoarthritis. *Arthritis Rheum* 2000 Aug; 43(8): 1874-80.
- ⁸ Mizuno Y, Kumagai M, Mattessich SM, et al: Q-angle influences tibio-femoral and patello-femoral kinematics. *J Orthop Res* 2001;19(5):834-40.
- ⁹ Cooke D, Scudamore A, Li J, et al. Axial lower-limb alignment: comparison of knee geometry in normal volunteers and osteoarthritis patients. *Osteoarthritis Cartilage* 1997;5(1):39-47.
- ¹⁰ Wilder FV, Hall BJ, Barrett JP Jr, Lemrow NB. History of acute knee injury and osteoarthritis of the knee: a prospective epidemiological assessment. The Clearwater Osteoarthritis Study. *Osteoarthritis Cartilage* 2002;10(8):611-6.
- ¹¹ Gelber AC, Hochberg MC, Mead LA et al. Joint injury in young adults and risk for subsequent knee and hip osteoarthritis. *Ann Intern Med* 2000;133(5):321-8.
- ¹² Jensen CH, Rofail S. Knee injury and obesity in patients undergoing total knee replacement: a retrospective study in 115 patients. *J Orthop Sci* 1999;4(1):5-7.
- ¹³ Cooper C, Snow S, McAlindon TE et al. Risk factors for the incidence and progression of radiographic knee osteoarthritis. *Arthritis Rheum* 2000;43(5):995-1000.
- ¹⁴ Roos H, Lauren M, Adalberth T et al. Knee osteoarthritis after meniscectomy: prevalence of radiographic changes after twenty-one years, compared with matched controls. *Arthritis Rheum* 1998;41(4):687-93.
- ¹⁵ Englund M, Roos EM, Lohmander LS. Impact of type of meniscal tear on radiographic and symptomatic knee osteoarthritis: a sixteen-year followup of meniscectomy with matched controls. *Arthritis Rheum* 2003;48(8):2178-87.
- ¹⁶ Mankin HJ, Brandt KD. Pathogenesis of osteoarthritis. In: Ruddy S, Harris ED, Sledge CB, editors. *Kelley's textbook of rheumatology*. 6th Ed. Philadelphia: WB Saunders Company; 2001. p. 1391-1408.
- ¹⁷ Rossignol M, Leclerc A, Hilliquin P, et al. Primary osteoarthritis and occupations: a national cross sectional survey of 10,412 symptomatic patients. *Occup Environ Med* 2003;60(11):882-6.
- ¹⁸ Manninen P, Heliovaara M, Riihimaki H, Suoma-Iainen). Physical workload and the risk of severe knee osteoarthritis. *Scand J Work Environ Health* 2002;28(1):25-32.
- ¹⁹ Felson DT. Do occupation-related physical factors contribute to arthritis? *Baillière's Clinical Rheumatology* 1994;8(1):63-77.
- ²⁰ Felson DT, Hannan MT, Naimark A, et al. Occupational physical demands, knee bending, and knee osteoarthritis: results from the Framingham study. *J Rheumatol* 1991;18:1587-92.
- ²¹ Cooper C, McAlindon T, Coggon D, et al. Occupational activity and osteoarthritis of the knee. *Ann Rheum Dis* 1994;53:90-3.
- ²² Coggon D, Croft P, Kellingray S, et al. Occupational physical activities and osteoarthritis of the knee. *Arthritis Rheum* 2000;43(7):1443-9.
- ²³ Chitnavis J, Sinsheimer JS, Suchard MA, et al. End-stage coxarthrosis and gonarthrosis. Aetiology, clinical patterns and radiological features of idiopathic osteoarthritis. *Rheumatology* 2000;39:612-619.
- ²⁴ Roos H. Are there long-term sequelae from soccer? *Clin Sports Med* 1998;17(4):819-31.
- ²⁵ Sutton AJ, Muir KR, Mockett S, Fentem P. A case-control study to investigate the relation between low and moderate levels of physical activity and osteoarthritis of the knee using data collected as part of the Allied Dunbar National Fitness Survey. *Ann Rheum Dis* 2001;60(8):756-64.