SESSION 4: RISK FACTORS—PHYSICAL ACTIVITY

Osteoarthrosis of the knee and physical load from occupation

Eva Vingård

The knee is a weight bearing joint with importance in gait, stance, bending, stooping, and squatting. It is rather unstable and dependent on support from ligaments and strong muscles. There are two joints in the knee, the femorotibial and the femoropatellar. On both inner and outer side of the joint there are strong ligaments and in the centrum of the femorotibial joint are the cruciate ligaments that give stability and assist in the normal mechanical function of the knee. The menisci are curved, fibrocartilaginous structures that lie between the femoral condyles and the tibial plateau. The knee joint is stabilised and powerfully motored by muscles that cross the joint from origin above the hip joint and from the shaft of the femur to insert on bony structures below the knee joint. Around the joint there is a synovial capsule and the joint is protected by several bursae. All these structures are easily hurt in trauma and overuse, and knee pain needing conservative treatment or surgery is rather common.

Background
Osteoarthrosis is a common degenerative joint disorder where the cartilage is more or less destroyed and the structure of the underlying bone is affected. Sometimes there are few symptoms, but it usually causes suffering, change in work pattern, and decreased quality of life. The joint changes can be seen on x-ray and the patient seeks medical care because of pain and diminished range of movement. In severe cases the endpoint can be a stiff joint. The surgical technique of replacing a destroyed joint with a prosthesis is developing.

Individual risk factors

AGE
The occurrence of arthrosis increases with age. Investigations of roentgenological osteoarthrosis of the knee have been performed in different populations. The prevalences vary. The explanation may be ethnic differences or variations in investigation techniques and diagnostic criteria.

CONGENITAL AND DEVELOPMENTAL DISEASES AND CHANGES
In the knee joint there are varus and valgus deformations giving an uneven distribution of forces through the joint. This may be important for arthrosis development.

HEREDITARY FACTORS
Osteoarthrosis in three or more joints are called generalised and has a hereditary pattern. Hereditary factors are not thought to be important in osteoarthrosis of the knee.

OVERWEIGHT
Overweight can cause knee osteoarthrosis. This has been shown in population studies from the USA. The association was strongest for women, but was also present for men.

TRAUMA
Trauma, especially if it interferes with the mechanics and circulation of the joint and ligaments, and meniscus injuries in the knee can give a premature osteoarthrosis.

SEX
Osteoarthrosis of the knee is probably more common among women than men.

OESTROGEN USE
From a study on female participants in the Framingham study, conclusions were drawn that oestrogen use in women is associated with a modest but insignificant protective effect against osteoarthrosis of the knee.

Mechanical load

EXPERIMENTAL STUDIES
Experimental studies in monkeys, rabbits, dogs, and sheep have shown that compression forces on a joint, especially in an extreme position, with or without a simultaneous oscillating load give changes in the cartilage and bone similar to that of osteoarthrosis in humans.

WORK LOAD FACTORS
In the 1950s coal miners in England were investigated. Men from this occupational group aged 40 to 50 years had an higher prevalence of osteoarthrosis of the knee compared to men in more sedentary occupations (table). In another English study from 1968 dockers were found to have more osteoarthrosis of the knee than civil servants in sedentary occupations.

In Sweden Lindberg and Montgomery investigated workers of up to 65 years of age in
a shipyard and compared them to office workers and teachers.15 Among shipyard workers 3.9% had gonarthrosis, compared with 1.5% among office workers and teachers.

In Finland Wickström compared concrete reinforcement workers with painters but no differences in disability resulting from knee problems were found.16 In a later Finnish study knee disorders in carpet and floor layers and painters were compared.17 Reported knee pain, knee accidents, and treatment regimens for the knees, as well as osteophytes around the patella, were more common among carpet and floor layers than among the painters. The authors suggest that kneeling work increases the risk of knee disorders and the radiographic changes that occur might be an initial sign of knee degeneration and later osteoarthrosis.

In the USA, factors associated with osteoarthrosis of the knee in the first national Health and Nutrition Examination Survey (HANES I) were cross sectionally examined in 5193 men and women aged 35 to 74 years, 315 of whom had x ray diagnosed osteoarthrosis of the knee.4 In investigating occupational load the authors characterised the physical demands and knee bending stress from occupational titles in US Department of Labor Dictionary of occupational titles. Current occupational data were available for 88% of the men and 52% of the women. The risk of developing osteoarthrosis of the knee for those whose work involved a lot of knee bending was more than doubled for both men and women. When controlling for age and weight in the statistical analysis, it was found that 32% of the osteoarthrosis of the knee occurring in these workers was attributable to occupation.

In the Framingham study in the USA, subjects from a town outside Boston have been followed over 40 years.5 Occupational status was reported at every biennial examination from number 1 (1948-51) to number 6 (1958-61), and radiographic osteoarthrosis of the knee was documented between 1983 and 1985. Each subject’s job was characterised by its level of physical demands and whether it was associated with knee bending. The risk of developing osteoarthrosis of the knee was doubled for men with a lot of knee bending and at least medium physical demands in their occupation. A dose-response relation was also found in this group. Among women the analyses were limited by a small number of jobs requiring both bending and physical demands.

In a study from California the roles of physical activity, obesity, and knee injury were evaluated on the development of severe osteoarthrosis of the knee.18 Forty six persons with gonarthrosis and 46 healthy controls from the same community were investigated. The persons with osteoarthrosis were two to three times more likely than controls to have performed moderate to heavy work earlier in life, 3.5 times more likely to have been obese at the age of 20, and almost five times more likely to have had a knee injury. There was no difference in the reporting of leisure time activities in the two groups.

In a register based cohort study from Sweden,19 subjects were studied who were born between 1905 and 1945, resided in 13 of the 24 counties of Sweden in 1980, and reported the same blue collar occupation in the censuses of both 1960 and 1970. Blue collar occupations were classified as giving high (more than average) or low (less than average) load on the lower extremity. The study population was observed during 1981, 1982, and 1983 for hospital care for osteoarthrosis of the knee. Fire fighters, farmers, and construction workers in particular among men, and cleaners among women, had an increased relative risk of developing osteoarthrosis of the knee.

Cooper and coworkers in England performed a population based case-control study including 109 men and women with osteoarthrosis of the knee and 218 healthy controls.20 Lifelong occupational history was obtained at interview. Exposure in the subjects’ main job to squatting, kneeling, stair climbing, weight lifting, walking, standing, sitting, and driving were assessed. Osteoarthrosis of the knee was more common in the subjects whose main job entailed squatting, kneeling, or climbing stairs.

**Discussion**

It is difficult to study the causes of osteoarthrosis of the knee. The onset of the disorder is usually hard to pinpoint, the development is probably slow and insidious, and the end point, for research purposes, can vary from slight x ray signs to symptomatic disorders that require surgery. These shortcomings cause problems of interpretation and comparison between studies. Osteoarthrosis is common in every population and one must remember that among healthy people with no known predisposing factors the disorder still exists, just as it does in those with exposure to known risk factors.

**Selection**

Differences of persons to different occupations on the basis of their health has been recognised for a long time and was described by Ramazzini in 1700.21 The selection effect was named the “healthy worker effect” for the first time in a study of rubber workers by McMichael and coworkers in 1974.22 These investigators concluded that “there is a strong selection process at play, wherein, to be employable in an industrial workforce, an individual must be relatively healthy and active. This selection factor acts to produce a ‘healthy worker effect’, such that, in an industry free of significant life-shortening hazards, death rates within the workforce in question will be less

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### Table: Osteoarthrosis of the Knee

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Total workers</th>
<th>None</th>
<th>Slight</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miners</td>
<td>84</td>
<td>45(54%)</td>
<td>34(40%)</td>
<td>5(6%)</td>
</tr>
<tr>
<td>Manual workers</td>
<td>45</td>
<td>35(78%)</td>
<td>9(20%)</td>
<td>1(2%)</td>
</tr>
<tr>
<td>Office workers</td>
<td>42</td>
<td>32(76%)</td>
<td>10(24%)</td>
<td>0(0%)</td>
</tr>
</tbody>
</table>

From reference 23.
than the general population. Individuals whose health does not meet the requirements for the specific industry do not enter that industry; those whose health deteriorates below that level do not remain in the industry."

Another uncertainty could arise if a person exposed to harmful predisposing factors was particularly likely to attend for medical care for some other reason, and thus be included. When trying to evaluate the causal relations or lack of them one must consider carefully how the study sample was chosen.

EXPOSURE ASSESSMENT
Good exposure data are much wanted but seldom provided in research on causes for musculoskeletal disorders. Occupational titles are often used and according to the disorder studied different occupations are classified as giving different exposures. For example being an assembly line seamstress might mean having a high load on the neck and shoulder region but a low load on the knees. Classification into heavy and light occupations with no further subdivision is in most studies of little use and gives only low grade information. If occupational titles alone are used a misclassification might occur. For more detailed information, interviews or questionnaires, or both, are used. In studies with retrospective data it is obviously difficult to remember the level of exposure precisely, especially many years afterwards, and misclassification due to memory deficit can occur.

Two of the above mentioned studies have prospective designs. The Framingham study used occupational titles with assessment of special tasks in that occupation over 10 years and measured the outcome more than 20 years later. The register study from Sweden used occupational titles at two different occasions with a 10 year interval and measured outcome more then 10 years later. The NHANES study is cross sectional and the others are retrospective in design. One can conclude that the exposure assessments in all the studies are superficial and crude. Most of the assessments probably include substantial numbers of subjects who are misclassified. In spite of that, increased risks for many exposures have been found, with odds ratios of between 2 to 7. One may assume that there are other risk factors as well, and that the true risk incurred by the known risk factors is even more pronounced. Further studies with more sophisticated exposure assessments are needed to answer that.

CONFOUNDING
A confounding variable is risk factor for the disorder under study that interacts with the exposure. For osteoarthrosis of the knee, age, earlier trauma, gender, sports activities, body mass index, and congenital and developmental disorders could be confounding variables. In any study it is very important to take all possible confounding variables into consideration in the statistical analysis. All studies in this review except the register based study have taken most of these factors into consideration.

Conclusions
The aetiology of osteoarthrosis of the knee is complex and multifactorial. However, in recent studies from different countries physical load from occupations such as kneeling, squatting, and generally heavy loading have been strongly associated with osteoarthrosis of the knee and are probably contributing causes for the development of premature osteoarthrosis.

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