

The knee : a sophisticated joint

Citation for published version (APA):

Huson, A. (1987). The knee : a sophisticated joint. *Nederlands militair geneeskundig tijdschrift*, 40, 53-55.

Document status and date:

Published: 01/01/1987

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
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HET INTERNATIONAAL CONGRES "SPORTSMEDICINE AND FOOTBALL"



Een van de kenmerken van de tegenwoordige tijd is de grote belangstelling voor de sport, zowel van de zijde van de actieve deelnemers als van de toeschouwers. Van de verschillende takken van sport is het voetbal wel een van de populairste. Recente tellingen wijzen uit dat over de gehele wereld tussen de 36 en 40 miljoen spelers zijn geregistreerd.

In Nederland is voetballen zeker de grootste tak van sport; circa 1 miljoen personen zijn lid van een der bij de Koninklijke Nederlandse Voetbal Bond aangesloten verenigingen.

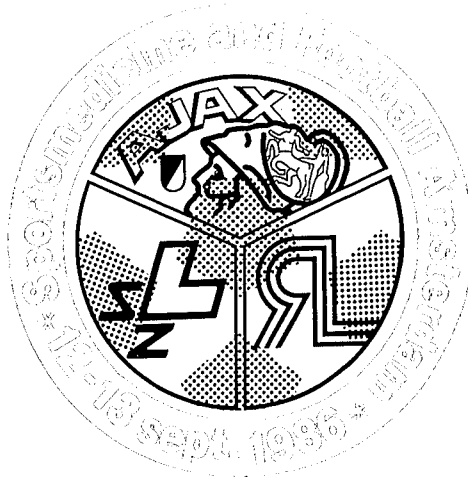
Voetbal is een typische contactsport, waarbij snelheid, kracht en behendigheid aan de dag komen. Bovendien is voetbal een echte buitensport, wat inhoudt dat de weersomstandigheden van invloed kunnen zijn op het spel en de spelers. Dit alles leidt er toe dat de kans op blessures groot is, zoals men op het spreekuur of op de televisie regelmatig kan constateren. De door de spelers opgelopen kwetsuren kunnen aanleiding zijn voor een fors ziekteverzuim en gaan gepaard met aanzienlijke kosten binnen de gezondheidszorg.

Een optimale behandeling van de sportletsels en een juiste begeleiding van de gekwetste spelers, gepaard aan een verstandige preventie van voetbalongevallen, kan aanzienlijke consequenties hebben voor de gezondheidszorg, voor het ziekteverzuim en -primair - voor het (financiële) welzijn van de atleet, of dit nu een beroeps- dan wel een amateur-speler is.

Binnen dit perspectief organiseerden de A.F.C. "AJAX", het St. Lucas Ziekenhuis te Amsterdam en de afdeling heelkunde van het Academisch Ziekenhuis te Maastricht op 12 en 13 september 1986 een sportmedisch congres, met als titel "SPORTSMEDICINE AND FOOTBALL".

Tijdens dit congres werd door sprekers uit binnen- en buitenland een vijftigtal lezingen gehouden; bij de inleiders waren ook enkele Nederlandse officieren-arts. Het is niet mogelijk gebleken alle lezingen in de vorm van een boekwerk uit te geven. Wij prijzen ons gelukkig dat de redactie van het Nederlands Militair Geneeskundig Tijdschrift

door kapitein-arts
A.B. Stibbe



bereid is gebleken de meest interessante voordrachten in één afzonderlijke aflevering op te nemen. Hiermee wijst de redactie op haar belangstelling voor de ontwikkeling van de sportgeneeskunde in Nederland, en in engere zin binnen de krijgsmacht. Het is immers zo dat meer dan 25% van de patiënten op het militaire spreekuur klachten heeft van het steun- en bewegingsapparaat. Een toegenomen inzicht in de traumatologie van knie, enkel en achillespees, de hoofdonderwerpen van het congres, is van betekenis voor de medicus practicus en dus ook voor de militaire arts.

Dit speciale nummer van het Nederlands Militair Geneeskundig Tijdschrift is de afsluiting van een belangrijk congres, dat met 450 deelnemers uit alle delen van de wereld een succes kan worden genoemd.

Bij de samenstelling van de inhoud van dit nummer heeft de redactie, daarbij terzijde gestaan door enkele leden van het organisatiecomité van het congres, een bewuste keuze gemaakt. Deze keuze was lang

niet eenvoudig. Teneinde zo veel mogelijk artikelen te kunnen opnemen werd besloten het tijdschrift in een kleiner lettertype dan gebruikelijk te zetten, en de (vaak omvangrijke) literatuurlijsten niet op te nemen. De literatuurverwijzingen zijn wel opgenomen; degenen die prijs stellen op een literatuuropgave van een of meer der opgenomen voordrachten kan deze aanvragen bij de redactie van het tijdschrift en zal deze kosteloos ontvangen.

De lezingen zijn - hetzij in extenso dan wel in een verkorte versie - opgenomen in de taal waarin deze werden gehouden; dat zal voor onze lezers zeker geen probleem zijn.

Summary INTERNATIONAL CONGRES "SPORTSMEDICINE AND FOOTBALL"

On september 12 and 13, 1986, an international congress on Sportsmedicine and Football was held in Amsterdam under the auspices of the Amsterdam Football Club "AJAX", the St. Lucas Hospital of Amsterdam and the University Hospital of Maastricht. Some 50 lectures were held by speakers from various countries; among these were also a number of Dutch army surgeons. It was not possible to publish all lectures as one book. However the editor of the Netherlands Military Medical Journal, considering the importance of the subject for the military medical services, gave us the opportunity to publish a selection of the papers in one issue of his review. Making a good choice from so many excellent lectures proved to be a difficult task; with great regret we were forced to put aside a number of interesting speeches. In order to be able to present as many papers as possible, this special edition is printed in a smaller print, and the literature lists were omitted. Those readers wishing to obtain one or more literature lists are requested to write to the editor of this paper, who will send the lists free of charge.

* Sportarts, lid van het organisatiecomité van het congres "Sportsmedicine and Football".

THE KNEE: A SOPHISTICATED JOINT

A series of 2-D and 3-D kinematic models (see figures 1-5) has been developed to illustrate the close functional relationship between articular surface geometry and ligament fibres¹. The knee is an incongruous hinge and its incongruity is inevitable as soon as an additional rotation about a second axis is required. In incongruous joints, motions cannot be prescribed by the limited contact areas of the articular surfaces solely. Ligaments and muscles must have an essential guiding function too. An immobile hinge axis, however, requires ligament fibres that insert at the position of

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this axis. The many fibres of strong ligaments spread their insertions over a greater area and this must lead theoretically to the development of various systems of crossed or uncrossed "mooring" ligaments with moving axes. These crossed and uncrossed systems appear to have quite different kinematic features.

The intimate kinematic relationship between fibre arrangement and surface geometry

The crossed and uncrossed systems require different profiles for the male components to the effect that incongruity in the uncrossed systems is greatest. As force transmission will improve with an increase of the contact areas the crossed arrangement seems to be more favourable than the uncrossed one. Modelling shows that an infinite number of pairs of

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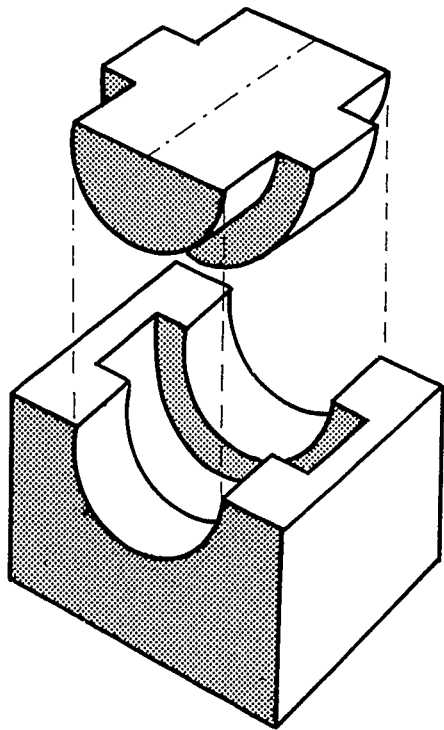


Figure 1. Model of a congruent hinge joint. Lateral stability is secured by a "groove-and-notch" geometry, while antero-posterior stability is provided by articular congruity.

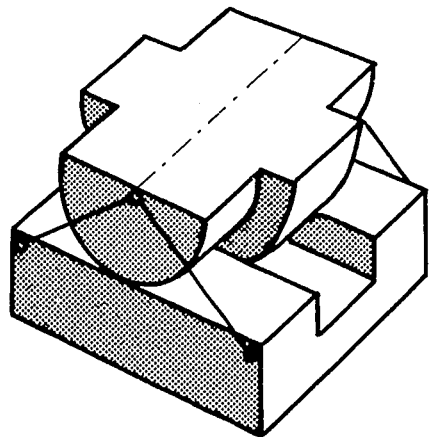


Figure 2. An incongruent hinge joint. Now an arrangement of oblique "mooring" ligaments is needed in order to obtain antero-posterior stability.

surface profiles can be combined with a single set of (un)crossed fibres. But each pair has mutually precisely tailored components which are not interchangeable.

If we start with one component - say the female one - the other can be generated by swinging the female profile to and from. Now all the positions of the swinging component appear to be tangent to a particular curve, called the envelope, which gives the desired appropriate profile of the male component (see figure 6). Struben² validated this idea by removing the tibial plateau on one side of a knee specimen and replacing it by a mouldable substance. Moving now the femur in flexion and extension the condyle of that particular side moulded a new tibial plateau and the

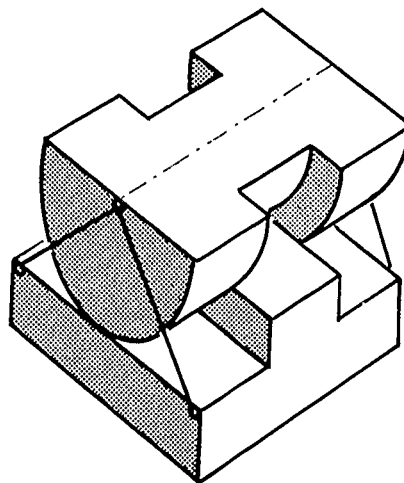


Figure 3. Inversion of the "groove-and-notch" geometry reshapes the male component into a bicondylar component.

Figure 5. The three-point insertion of the central ligaments has been re-arranged into a fourpoint insertion with crossed oblique ligaments. In order to keep the guiding

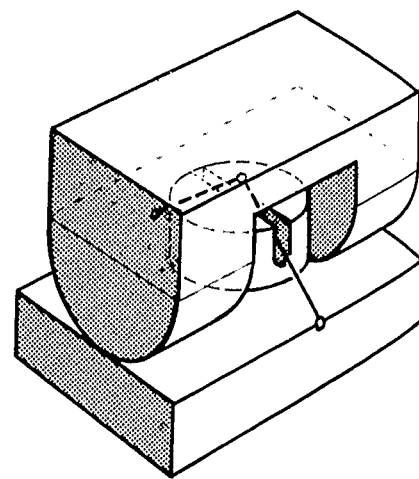
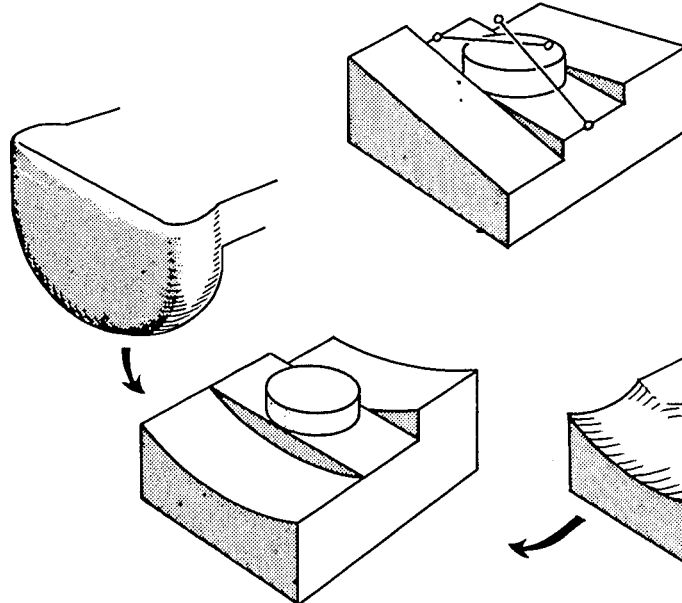


Figure 4. A central position of the oblique ligaments together with a stabilising disc results in the possibility of an additional vertical rotation.

ligaments under tension during rotation about a vertical axis at least one of the lower articular surfaces must be given an appropriate slant.



profiles of this reconstructed articular surface proved to be almost identical with the removed original one.

The kinematic behaviour of the instant rotation centre

One of the very interesting features of a system with a four-point insertion pattern like that of a crossed or uncrossed system is that the point of intersection of these fibres or of their extended lines is identical with the instant centre of rotation (ICR). Therefore, the pathways of successive positions of these ICRs can be produced easily. They are called centrodes and there is actually a pair of them rolling over each other.

The kinematic behaviour of the instant contact point

As soon as the position of the ICR is known the direction of motion of each point rotating about this centre can be easily established. It can be shown that only a point on the perpendicular from the ICR to the opposite

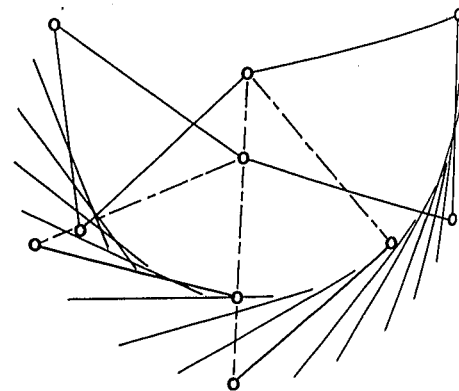


Figure 6. Successive positions of one of the components describe a curve called the envelope which is the kinematically appropriate contour of the other component.

contact surface will move exactly parallel over this surface. Therefore, ICR and contact point are kinematically closely related. The shift of the ICR along the centrodes dictates the motion of the contact point and it defines for this reason the roll-back and roll-forward of the femoral condyle. Besides, it defines also the instant velocity of the contact point. A quick roll-back during the first part and a slowing down in the last part of flexion can be explained by the concave shape of the tibial condyle.

It can be shown also that joint models with an uncrossed arrangement seem to have a roll-forward during flexion. Actually, this is a

backward roll combined with a much greater forward slip producing high shear rates between the contact surfaces. In contrast all the crossed types have a roll-back with comparatively lower shear rates.

The menisci

The presence of menisci which fill up the space resulting from the joint's incongruity increases the actual contact areas for force transmission. This effect depends on the integrity of their circular fibre reinforcement. Seedhom³ showed that about half of the force transmission can be taken by the menisci. A simple mathematical model

described by Sauren⁴ seems to support the experimental findings of Seedhom, even in a model with rather stiff articular surfaces.

Conclusion and summary

Modelling is an interesting tool for the study of joint kinematics. It shows that a (post-traumatic) change of the insertion pattern of ligament fibres as well as of the shape of the articular surface will result in a change of its kinematic behaviour. Such a change may produce jamming with a pathogenetic increase of intracartilaginous stress and strain.

MANAGEMENT OF THE ACUTE KNEE INJURY



The long term results of acute injuries depend of the early diagnosis. This statement is certainly important for the most frequent lesions, namely ligaments, menisci and intraarticular fractures. Depending on the lesion, secondary reconstructions are either not possible or the result is at least unpredictable and in the most cases worse than in case of primary treatment. The statement that nothing ruins good results as quickly as a long time follow up of secondary reconstructions might be right. The treatment of primary lesions may be age-dependent, but not the diagnostic evaluation. This diagnostic evaluation can be subdivided in history, clinical examination, X-ray, arthroscopy and examination under anaesthesia.

History

First of all one has to be informed about earlier knee injuries. Some patients don't remember earlier accidents and a preexistent

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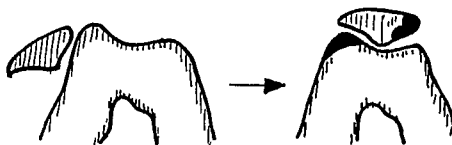


Fig. 2. Mechanism and localisation of chondral fracture in patellofemoral luxation.

instability might not have been functional for the particular patient and his sport activities. As long as the neuromuscular apparatus, the ligaments and the joint congruency are equilibrated we still talk about functional stability. There may be signs of instability without clinical symptoms. In many sports the

patient is not able to describe the accident mechanism. But he can tell us something about the severity: if it was a collision or an indirect force, if he was still able to continue his sport activities, if his knee was locked, if there was an immediate effusion etc. He might even have heard a pop and felt a dislocation. Well trained coaches and medical staff should be able to describe the accident, a description which leads to the most probable diagnosis.

Clinical examination

An early clinical examination immediately after the accident together with the history and the observation of the accident leads in 95% to a diagnosis. Many stability tests can be done directly after the accident, there is no muscle spasm, no effusion and the knee is less painful than after a few hours. The clinical examination always starts with the non-injured knee for comparison. The patient gets familiar with the examination and knows what is going to happen when his injured knee is touched.

Examination starts with inspection

An immediate effusion must be haemarthros and bleeding is the consequence of an intraarticular lesion. The most common reason (80%) is the anterior cruciate ligament (ACL) followed by a peripheral meniscal tear and finally the chondrofracture (fig. 1, 2). Nevertheless in a severe injury with tear of the capsular ligaments the haematoma evoids in the soft tissue, there is no intraarticular swelling. So complete luxations, spontaneously reduced, do not show a swelling of the articulation. Beside the cruciates, all ligament-insertions and the menisci can be palpated. Typical pain points are the adductortubercle on the medial side and the insertion of the arcuate complex at the lateral side. A painful joint line disappearing with flexion, is typical for a meniscus lesion: the same sensation can be provoked by small rotation movements. The patella dislocates normally laterally, reduces



Fig. 1. In an unexplained haemarthros with painful patellofemoral joint an axial pat.-fem. X-ray is indicated. The small shadow in the medial pat.-fem. joint line was due to this severe chondral fracture.

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