PROPRIOCEPTION OF KNEE JOINTS WITH A LESION OF THE MEDIAL MENISCUS

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We assessed knee-joint proprioception in 23 patients with an isolated lesion of the medial meniscus. Thirteen patients were tested prior to their arthroscopic operation, and 10 patients were examined after partial arthroscopic resection of the injured meniscus.
As a control group we evaluated 30 healthy volunteers with clinically normal knee joints.
For documentation of the proprioceptive capabilities we performed a special angle reproduction test which was described in the literature. Additionally the subjects were tested with and without a knee bandage, to test its influence on knee-joint proprioception.
Our results showed that preoperatively a significant deterioration in proprioception was present compared with the control group. We could not find any influence of the knee bandage on the proprioception of the injured knee. The postoperative group of patients showed a significantly better proprioceptive capability compared to the preoperative patients. The postoperative results also did not show any significant difference as compared to those of the control group.

Keywords : proprioception ; knee joint ; medial meniscus.
Mots-clés : proprioception ; genou ; ménisque interne.

INTRODUCTION

Clinical experience often shows little correspondence between the so-called objective functional tests and the subjective perception of a patient suffering from a knee-joint injury or after a knee-joint operation. Barrett (4), Beard *et al.* (6) and Skinner *et al.* (13) observed that frequently the results of standard clinical examinations carried out during postoperative check-ups of knee joints do not correlate with the subjective perception of the patient. However, they where able to show, that knee joint proprioception correlates highly with the subjective perception of the patient.

Several studies showed deterioration of the knee joint proprioception after rupture of the anterior cruciate ligament (6). The present study compares the proprioceptive capacities of knee joints of healthy subjects with those of patients suffering from an isolated rupture of the medial meniscus. Additionally, the effect of an elastic knee bandage on the knee-joint proprioception is analyzed.

MATERIAL AND METHODS

Test procedure : In order to document proprioceptive capacities, we used a technique modified from that of Barrett *et al.* (5). The subject was examined in the supine position. The extremity tested was positioned on a special splint in order to place the knee joint in the various angles (fig. 1). The splint supports the leg giving it stability and prevents rotation as well as lateral movements. The leg is relaxed during rest and also when the examiner sets the various angles. This is achieved mainly by lining the pans of the apparatus with soft foam rubber. The measurements were carried out on the bare leg, thus reducing additional external influences. The two handles enable the examiner to set the angles without having to manipulate the leg directly. The device makes it possible to set angle values ranging from 0° to 100° on the knee joint. A blind prevented the subject from visually checking the angle values (fig. 1).

During the measurements four predetermined angles were set on each leg in a randomized order. The starting

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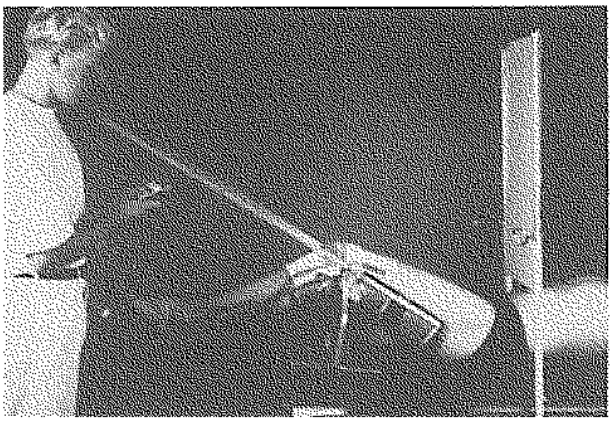

Fig. 1. — Examination situation with splint, blind and goniometer.

position for each measurement was the 0° position, which was reestablished for at least 5 seconds between each measurement. On the left leg the predetermined angles were 10°, 35°, 60°, 80°. On the right leg, the angles set were 15°, 30°, 50°, 75°. In every subject both legs were tested with and without a knee bandage (Genutrain-Bandage®).

In order to determine exactly the angles set, an electric goniometer (Penny & Giles ADU 301®) was used. The subject was asked to reproduce each of the angles, which were passively given by the examiner, on a manual goniometer. The difference between the angle given and the angle set by the subject was regarded as a relative measurement of the proprioception of the tested knee joint.

Since a learning effect was to be avoided, the order of the angle values set was randomized as well as the decisions whether the test was first carried out on the right or the left knee, with or without a bandage.

For the same reason it was not possible to compare the proprioception of the same patients pre- and postoperatively. We expected that otherwise the learning effect, which was also described by Barrett *et al.* (5) in 1991, would have distorted the postoperative results.

We only measured patients without much pain. That is very important, because we wanted to show a potential deterioration of the proprioceptive capability of the knee joint after a meniscus rupture. Sell *et al.* (12) showed a strong correlation between pain and deterioration of the knee-joint proprioception, which was independent of the state of proprioceptive structures. We therefore believe that pain would also have distorted the results in our testgroup.

Control group and patient group: The control group consisted of 30 subjects (10 women, 20 men). The average age in the control group was 33.6 years. Volunteers' history was free from any knee injury or chronic complaints. In addition, all subjects underwent a standardized clinical examination in order to exclude unknown pathologic findings. For the control group and subjects with knee-joint injuries the following criteria for withdrawal from the study were determined: rheumatologic diseases, cardiovascular conditions, neurologic diseases (Parkinson, Alzheimer, polyneuropathy, dementia), metabolic vascular diseases with a neurologic aspect (diabetes mellitus, arteriosclerosis), tumor patients treated with chemotherapy, alcoholics, drug addicts; we also excluded subjects who felt pain during the test because of their injuries.

The patient group consisted of 23 persons with arthroscopically-proven meniscal lesions. Thirteen patients with a medial meniscus rupture were examined prior to arthroscopy. This group consisted of five women and eight men with an average age of 35.6 years (19-47 years). Ten patients were examined after partial arthroscopic resection of the medial meniscus. Six of them were women; five were men. The average age of this group was 32.4 years (18-43 years). Postoperative examinations were performed 6 months after surgery.

RESULTS

Control group

The angle deviation without a bandage was 7.8° (SD = 2.8°). No significant difference could be found between the right (7.8° ± 3.3°) and the left leg (7.8° ± 4.3°). With a knee bandage the angle deviation could be reduced significantly ($p < 0.02$) to 6.1° (SD = 2.5°). There was no significant difference between the right (6.4° ± 3.5°) and the left leg (5.8° ± 3.0°) (fig. 2). No significant dif-

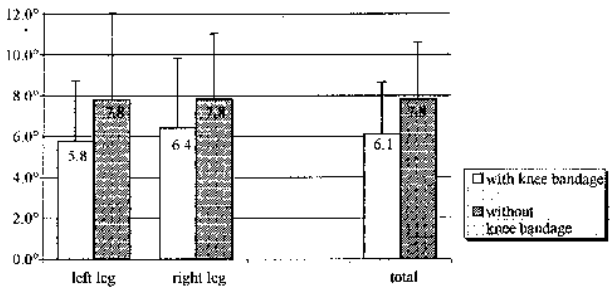

Fig. 2. — Angle deviation of the control group.

ference was found between the results in male and female subjects, with or without a knee bandage. We will therefore not further differentiate between the left and the right leg or between men and women.

Patient group

Preoperative measurements in patients with a medial meniscus rupture : Without a bandage we found an angle deviation in the injured leg of 11.5° (SD = 5.9°). This is a significant difference ($p < 0.01$) compared to the control group (7.8°). The measurements of the contralateral leg (9.9° ± 6.6°) showed no significant difference from the control group. With a knee bandage the angle deviation of the injured knee joint was 11.7° (SD = 7.2°). The measurements in the healthy contralateral leg showed a deviation of 8.6° (SD = 5.1°). Compared with the results achieved without a bandage, no significant differences can be seen (fig. 3).

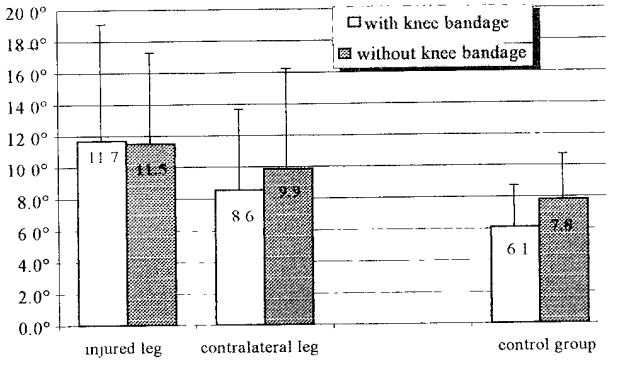

Fig. 3. — Estimation errors measured preoperatively in the injured and the healthy leg with and without a bandage compared to the control group.

Postoperative measurements of patients suffering from a medial meniscus rupture : The angle deviation of the injured leg was 6.9° (SD = 3.3°) without a bandage. With a bandage the average estimation error was 7.8° (SD = 4.1°). However, this difference is not significant. A significant difference in the value of the control group (7.8°) was not found either. The healthy contralateral leg showed a deviation of 8.8° (SD = 4.0°) in the test. There was no significant difference in the result of the injured leg. With a knee bandage this

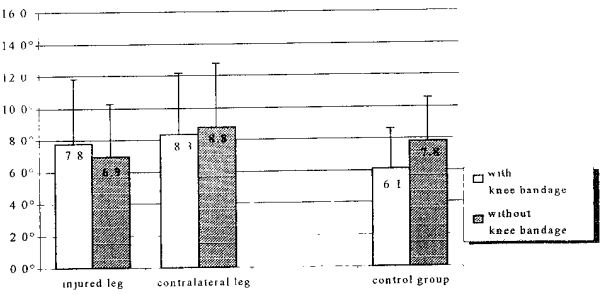

Fig. 4. — Average angle deviation of the injured and the healthy leg compared to the control group, measured postoperatively with and without a bandage.

value (8.3° ± 3.9°) hardly changes. A significant difference was not detected here either (fig. 4).

Pre- and postoperative comparison of the results of patients with a meniscus rupture : Whereas the angle deviation of the injured leg was 11.5° (SD = 5.9°) prior to an arthroscopic partial meniscus resection, it was significantly reduced ($p < 0.05$) to 6.9° (SD = 3.3°) after the operation. Measurements with a knee bandage also show a postoperative reduction of the estimation error. The decrease from 11.7° (SD = 7.2°) to 7,8° (SD = 4.1°) is not significant, but it is just below the 5% level (fig. 5).

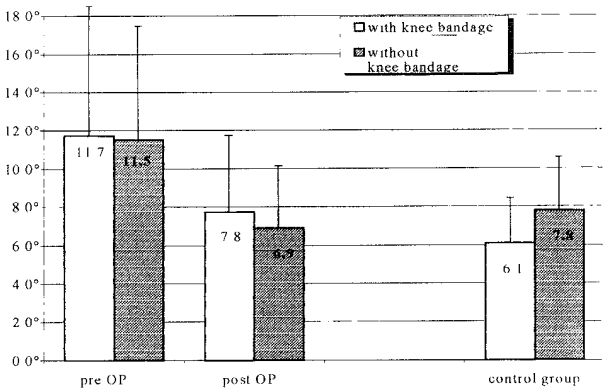

Fig. 5. — Angle deviation with and without a knee bandage : a comparison of pre- and postoperative results.

DISCUSSION

In line with other authors we were unable to observe differences between the proprioception of the dominant and the nondominant leg or between men and women (2, 3, 5, 7). Only Sell *et al.* (12), found significantly better results with men.

With a meniscus lesion the position sense of the injured knee joint deteriorates significantly. The contralateral knee joint does not show a similar deterioration. There are no studies with which these results can be compared directly. Still, the results can be understood in the light of other publications. Animal studies could prove the existence of nerve receptors within the meniscus. In 1978 O'Connor and McConnaugey (10) found Ruffini corpuscles (type-I receptor) and Pacini corpuscles (type-II receptors) in the menisci of cats, mainly in the horns and the insertion point of the meniscofemoral ligament. They found type-I receptors mainly in the posterior horn of the medial meniscus. Type-II receptors were shown mainly near blood vessels at the posterior horn of the lateral meniscus and the insertion point of the meniscofemoral ligament.

O'Connor (9) confirmed these results after tests with dog knee joints. He also showed nerve receptors in the meniscus, mostly at the insertion points of the meniscotibial- and meniscofemoral ligaments (fig. 7). Schultz *et al.* (11) could not find nerve receptors when studying human menisci ; Kennedy *et al.* (8) detected nerve tissue in the perimeniscal connective tissue of human knee joints.

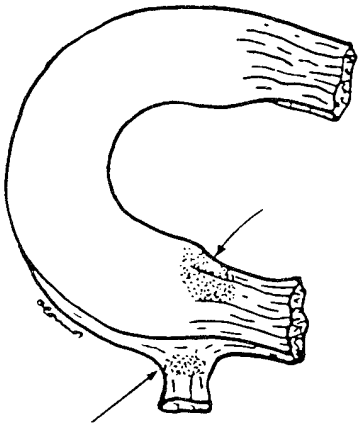

Fig. 6. — Lateral meniscus of a left dog knee joint. Most nerve receptors were identified in the marked regions (9).

In 1992 Assimakopoulos *et al.* (1) identified free nerve endings in the peripheral and the medial thirds of the meniscal body, and three types of encapsulated mechanoreceptors were found in the anterior and posterior horns. The authors considered that menisci receive and transmit proprioceptive information and therefore contribute to the function of deep sensibility.

The results of this study, however, support the assumption that due to the lesion of the medial meniscus the proprioceptive function of the knee joint was affected. We were able to demonstrate that the use of a knee bandage does not lead to better proprioceptive results. Still we can say that after a partial arthroscopic meniscus resection the proprioception of the injured knee joint is significantly improved compared to the preoperative situation. Differences in the proprioceptive performance of the healthy control group could not be recognized either.

This phenomenon can be explained in two ways. The operation drastically reduced the nociceptive stimulus so that the proprioceptors of the joint could produce their afferents without the interference of the stimulus. One can also imagine that a meniscus rupture does not fully destroy the proprioceptive receptors and fibers ; it just damages them. These neural structures could have had irregular discharge patterns, thus interfering with the proprioception of the knee joint as a whole by superimposing on the afferents from other neuroproprioceptive structures of the knee joint. This assumption would mean that the rupture did not destroy so many proprioceptors that the knee joint could not compensate for the loss. Instead, uncontrolled afferents interfered with the healthy receptors. This can explain the uselessness of a bandage and the success in clearing the proprioceptive disturbance through a resection of the injured meniscus. Of course, the theory is an assumption which must be subjected to further histologic and neurophysiologic studies. Still, from our point of view this idea appears logical, taking into account these findings and references in the specialist literature.

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SAMENVATTING

J. JEROSCH, M. PRYMKA, W. H. M. CASTRO. Proprioceptie van het kniegewricht met letsel van de mediale meniscus.

Bij 23 patiënten met een geisoleerd letsel van de mediale meniscus werd de proprioceptie van het kniegewricht gemeten. Dertien patiënten werden voor de arthroscopie onderzocht en 10 patiënten na een arthroscopische partiele resectie van de gelaedeerde meniscus. Als controle groep werden 30 gezonde vrijwilligers met een bij klinisch onderzoek normaal kniegewricht onderzocht. De proprioceptie werd met een speciale in de literatuur beschreven test gemeten. Om de invloed van een kniebandage op de proprioceptie te meten werden de deelnemers aan dit onderzoek met en zonder een kniebandage getest.
De resultaten toonden preoperatief een significante afname van de proprioceptie in vergelijking met de controle groep. Een invloed van de kniebandage op de proprioceptie van de gelaedeerde knie kon niet worden aangetoond. In vergelijking met de preoperatieve patiënten vertoonde de postoperatieve patiëntengroep een significant betere proprioceptie. Het postoperatieve resultaat vertoonde echter geen verschil met het resultaat van de controle groep.

RÉSUMÉ

J. JEROSCH, M. PRYMKA, W. H. M. CASTRO. Proprioception du genou présentant une lésion du ménisque interne.

Les auteurs ont évalué la proprioception du genou chez 23 patients qui présentaient une lésion isolée du ménisque interne. Treize patients ont été testés avant leur traitement arthroscopique, et dix autres ont été testés six mois après méniscectomie partielle par technique arthroscopique. Un groupe contrôle comprenait 30 volontaires sains dont les genoux étaient cliniquement indemnes de tout problème.
L'évaluation de la proprioception a été effectuée en utilisant un test de reproduction d'angle décrit dans la littérature. En outre, ce test a été réalisé avec et sans bandage du genou, pour évaluer l'influence de celui-ci sur la proprioception du genou. Les résultats ont montré une détérioration significative de la proprioception chez les patients porteurs d'une lésion méniscale non encore opérée. Le port d'un bandage n'a eu aucune influence sur la proprioception des genoux étudiés. La proprioception était significativement meilleure chez les patients étudiés après traitement d'une lésion méniscale que dans le groupe des patients présentant une lésion et non encore traités.
Les résultats enregistrés chez les patients opérés ne différaient pas significativement des résultats obtenus dans le groupe témoin.