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KNEE DISORDERS IN CARPET AND FLOOR LAYERS AND PAINTERS

Part II: Knee Symptoms and Patellofemoral Indices

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ABSTRACT. One hundred and sixty-eight carpet and floor layers and 146 painters were examined with the aid of a questionnaire, clinical tests of the patellofemoral joint, a knee exertion test and measurements of patellofemoral indices. Carpet and floor layers reported previous knee conditions more frequently than painters. Patellofemoral tenderness was not related to occupation, patellofemoral indices or perceived knee conditions. On the contrary, pain in the knee exertion test of 50 squats was related to perceived knee injuries and pain on compression of the patella. Exertion test seems to be more accurate than traditional clinical tests in the screening of knee lesions.

Key words: occupation, knee load, patellofemoral joint.

INTRODUCTION

Kneeling work postures are an important occupational knee loading factor (5). Carpet and floor layers who kneel frequently and experience repetitive minor injuries to their knees form one of the occupations with high knee morbidity (3). The knee disorders that are most often associated with kneeling work are meniscal lesions (7), osteoarthrosis of the knee (13) and prepatellar bursitis (21). The relation between work load and chondromalacia patellae remains obscure (18).

Mechanical factors, such as malalignment of the patellofemoral joint and repetitive minor trauma to the patellar joint surface are regarded as the most important causes of the "patellofemoral pain syndrome" and "chondromalacia of the patella" (1, 9). The diagnosis of chomdromalacia is usually reserved for cases in whom softening of the patellar joint surface is verified in a knee operation or arthroscopy (2). Criteria for the patellofemoral pain syndrome are retropatellar knee pain and findings in the manual examination of the patellofemoral joint (11, 20).

The effects of occupational knee load on the patellofemoral joint were studied in workers in two occupations of the construction industry (i.e. carpet and floor layers who are known to kneel frequently in their work, and painters who seldom adopt kneeling positions).

SUBJECTS AND METHODS

Subjects

The selection, age distribution and anthropometric data of 168 carpet and floor layers and 146 painters were described in the first part of the study (15).

Questionnaire

Working history was evaluated from questions on number of years in current occupation and average work hours in a week. The subjects reported the use of knee pads and they were asked to indicate their opinion of the knee pads on a 7-cm long visual analogue scale ranging from "knee pads totally prevent hitting and rubbing of the knees" to "knee pads do not prevent hitting and rubbing of the knees at all". For the analysis the scores were approximated to the nearest centimeter.

Previous knee morbidity was assessed from responses to questions on knee disorders verified by a physician, knee injuries treated by a physician and sudden swelling of the knee.

Clinical examination

Principles of the clinical examination and the patellar compression test were presented in the first part of the study (15). The subject was also asked to indicate if he felt any pain when the patellar margins were palpated. The retropatellar crepitation was recorded by feeling the patella during passive flexion and extension of the knee and increased crepitation was recorded. With the knee extended and relaxed the patella was pushed to the medial and lateral directions, and the patellar mobility was estimated as decreased, normal or increased.

Tightness of the knee extensor muscles was tested by pushing the ankle of the relaxed subject in a prone position towards the buttock (rectus femoris stretching test), and a

distance smaller than 10 cm between the ankle and the buttock was regarded normal.

In an exertion test the subject was asked to squat 50 times at a free tempo without pauses. The intensity of knee pain was then recorded on a 5-cm long visual analogue scale ranging from "no pain" to "worst possible pain." For the analysis the scores were approximated to the nearest centimeter.

Radiography

Three projections were used in radiographic examination of the patellofemoral joint. The four radiographic indices, which are shown in Fig. 1, were measured among 165 carpet and floor layers and 141 painters. For the tangential radiographs the subject lay supine, knees supported to 30° flexion and the radiation source placed below the top of the examination table. The lateral patellofemoral angle (LPA) (17) and the lateral patellar displacement (LPD) (4) were measured from tangential radiographs. The ratio of patellar tendon length to patellar length (LT/LP) was measured from lateral radiographs that were taken with the subject lying on his side and the knee semiflexed (10). In the frontal radiographs the subject stood with feet together and the quadriceps muscle relaxed. The tibial tuberosities were marked with lead shots. The radiographic quadriceps angle (Q angle) (6) was determined as the angle between the lines from the center of the patella to the direction of the distal femoral diaphysis and from the center of the patella to the tibial tuberosity.

Photography

The Q angle was also measured from photographs in which the subjects were standing, with the feet parallel and 10 cm apart, knees fully extended and quadriceps muscles relaxed. The tibial tuberosity, the center of the patella and the anterior superior iliac spine were marked with a piece of tape. The Q-angle between the lines from iliac spine to center of the patella and from center of the patella to tibial tuberosity was measured from the photograph.

Statistical methods

Pearson's correlation coefficients were used in assessing the reliability of the anatomic measurements. The significance of the occupational differences was tested with Student's *t*-test for continuous variables and with the chi-square test for discrete variables.

Reliability of the methods

One physician (J.K.) measured all of the radiographic and photographic variables and also repeated the measurements on 28 randomly selected subjects. The knees were radiographed only once, and therefore the reliability could only be tested by making two independent measurements from the same radiographs. With the photographic method the procedure was repeated in full, including the marking of anatomic landmarks, the positioning of the subject and the taking of photographs.

Two measurements from the same radiographs had better reliability than the entirely repeated photographic measurements (Table I). The correlation between the values of the photographic and radiographic measurements was 0.39.

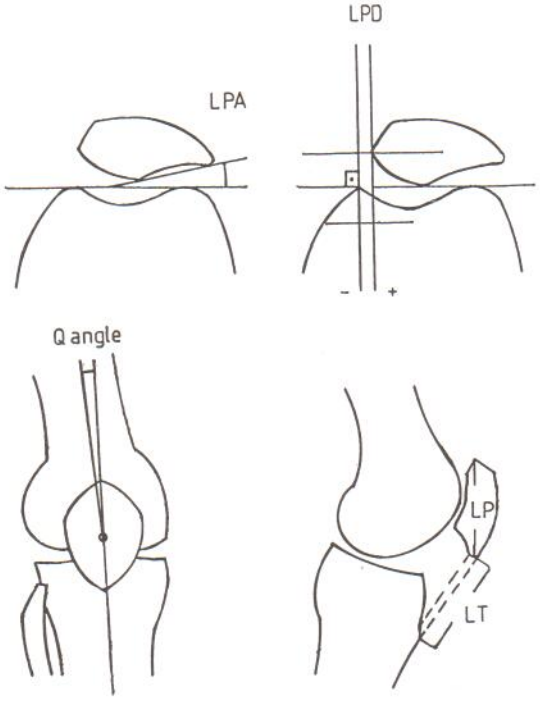

Fig. 1. The radiographic indices. LPA = lateral patellofemoral angle, LPD = lateral patellofemoral displacement, LT/LP = ratio of patellar tendon length to patellar length.

RESULTS

Occupational knee load and knee protects

Most of the subjects had started working in their current occupation in their twenties. The average weekly work time was 40 hours in both occupations. Eighty-two percent of the painters estimated that they had worked in kneeling or squatting postures less than one third of their working time. Carpet and floor layers estimated that their average daily working time in kneeling posture with both knees on the floor was four hours.

Table I. *Correlation coefficients (r) between repeated measurements of the patellofemoral indices for 56 knees*

LDP = lateral patellofemoral displacement, LPA = lateral patellofemoral angle, LT/LP = ratio of patellar tendon length to patellar length

Indices	*r*
LPD	0.95
LPA	0.92
LT/LP	0.98
Radiographic Q angle #	0.89
Photographic Q angle # #	0.78

Intra-assay reliability. # # Inter-assay reliability.

Ninety-three percent of the carpet and floor layers used knee protects, usually a rectangular piece of foam plastic, or felt in a knee pocket attached to the work trousers. The mean for visual analogue scale for the knee pad efficiency was 2 (SD 1.5), when 0 indicated the best possible and 7 the worst possible protective value.

Previous knee conditions

Knee accidents treated by a physician were reported by 44% of the carpet and floor layers and 25% of the painters ($p < 0.01$). Respective figures for sudden knee swelling were 51 and 26% ($p < 0.001$).

Clinical examination

Pain on compression of the patella, tenderness in patellar margins and crepitation of the patella was noted equally in the two groups. The carpet and floor layers had increased patellar mobility and normal tightness in rectus femoris stretching test more frequently than the painters (Table II).

Patellofemoral indices

The Q angle was greater ($p < 0.05$) and the LPA smaller ($p < 0.05$) among carpet and floor layers than among painters (Table III).

The mean for the LT/LP ratio was 1.04 (SD 0.14) in the knees with increased patellar mobility and 0.99 (SD 0.14) in the other knees ($p < 0.05$).

Tightness in the rectus femoris stretching test was related to the LT/LP ratio of the carpet and floor layers but not to that of the painters. The carpet and floor layers had a mean LT/LP of 1.01 (SD 0.14) for the knees with a normal rectus femoris stretching test and a mean LT/LP of 0.96 (SD 0.18) for the knees with a tight rectus femoris stretching test ($p < 0.01$).

The patellofemoral indices were not related to perceived previous knee conditions or findings in the manual examination of the patellofemoral joint.

Table II. *Prevalence of clinical findings in the knees of the workers*

Percent of knees

	Carpet and floor layers' knees ($n = 334$) (%)	Painters knees ($n = 292$) (%)
Pain on compression of the patella	18	17
Crepitation of the patella	15	14
Tenderness on patellar margins - medially	5	7
- laterally	2	1
Increased mobility of the patella	24	13 *
Tightness in the Ely's test	8	19 **

* $p < 0.05$. ** $p < 0.01$.

Table III. *Values of the patellofemoral indices by occupation*

LPA = lateral patellofemoral angle, LPD = lateral patellofemoral displacement, LT/LP = ratio of patellar tendon length to patellar length

	Carpet and floor layers ($n = 330$)		Painters ($n = 282$)	
	Mean	SD	Mean	SD
LPA (degrees)	12.6	4.0	13.3	4.0 *
LPD (mm)	0.1	2.4	0.3	2.2
LT/LP	1.0	0.2	1.0	0.1
Radiographic Q angle (degrees)	10.1	4.4	9.5	3.4 *
Photographic Q-angle (degrees)	14.0	6.1	14.8	6.5

* $p < 0.05$.

Knee exertion test

The frequency of reported knee accidents or acute traumatic knee swelling was related to knee pain in the exertion test but was not related to the findings in the manual examination of the patellofemoral joint. In 43% of the knees exertion pain (scores 1–5) was indicated by the subjects who had reported a knee accident, while the figure was 28% for the other subjects ($p < 0.001$). Correspondingly, for 47% of the knees, exertion pain was indicated by the subjects who had experienced knee hydrops, while the figure was 27% for those who had not ($p < 0.001$). Exertion pain (scores 1–5) was reported in 80% of the knees that had pain on compression of the patella and in 60% of all other knees ($p < 0.001$).

DISCUSSION

The two occupational groups reported knee

conditions frequently, which is in agreement with the previously reported high knee morbidity among the workers in the house building trade (4, 22).

A work analysis has revealed that in their typical tasks, carpet and floor layers were kneeling approximately 42% of the time used to perform their typical tasks, whereas painters only occasionally kneel in their work (14). Kneeling work postures may have increased carpet and floor layers' risk of knee injuries and knee swelling.

Men with high knee load and those with knee symptoms were possibly more interested in participating in the study and knee morbidity in the studied occupations may be over-estimated. On the other hand, the workers with knee trouble may have left their physically heavy occupation; carpet and floor layers obviously more likely than painters. The drop-out selection may have caused an under-estimation of occupational differences in some clinical entities, e.g. patellofemoral tenderness.

Our values of the patellofemoral indices LPA, LPD and LT/LP were similar to those that have been reported for healthy subjects (10, 16). Within this variation the indices were not related to patellofemoral tenderness or knee exertion pain in either occupation. The small occupational differences in patellofemoral indices may be related to stretching of the knee extensor muscles and the patellar ligaments in carpet and floor layers' kneeling work.

The Q angle has usually been measured with goniometric or photographic methods. The measurements include some technical problems and slightly different values have been reported for healthy men (1, 8, 19). We did not find previous reports on the radiographic method of measuring the Q angle. The associations between the radiographic Q angle and patellofemoral symptoms need further examinations.

The rectus femoris stretching test has been used in the evaluation of muscle tightness in anterior aspect of the thigh. Our results indicate that also a small LT/LP ratio is related to tightness in the rectus femoris stretching test.

The traumatic origin of the patellofemoral pain syndrome is generally accepted. In this study, kneeling postures and knee injuries were markedly more frequent among carpet and floor layers than among painters, but no difference between the occupations was noted in patellofemoral tenderness. On the other hand, knee injuries and patellofemoral tenderness were related to pain in an exertion test of 50 squats, which may be more sensitive for post-traumatic knee lesions and patellofemoral changes (12) than manual examination.

Almost all carpet and floor layers had used knee pads and for this reason the effect of protective devices on the knee disorders cannot be reliably estimated on the basis of this study. Carpet and floor layers estimated the protective role of the knee pads to be rather good. Knee pads should be taken to wider use in other occupations where kneeling work postures are frequent.

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