ORIGINAL PAPER

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Anterior knee pain syndrome

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Abstract The aim of this study was to correlate the distribution of substance-P nerve fibres within the knee joint in 20 patients complaining of anterior knee pain syndrome, with the clinical picture, patellar motion, power of the quadriceps mechanism, and the psychological profile. A comparison was made with 2 similar groups of patients with knee problems (patients with osteoarthritis and patients with anterior cruciate ligament rupture or meniscal lesions), and with a further group of 20 healthy volunteers. The results suggest that anterior knee pain might be a psychosomatic syndrome associated with sub-clinical patellar instability and with little if any relation to levels of physical activity.

Résumé Le but de cette recherche est d'établir la corrélation entre la distribution de la substance P de fibres nerveuses de l'articulation du genou avec l'aspect clinique, le mouvement de la rotule, l'évaluation des muscles extenseurs et la personnalité des malades. Le groupe examiné a été comparé avec 3 groupes de contrôle: 20 malades avec le genou arthrosique, 20 malades avec une rupture du ligament croisé antérieur ou une lésion du ménisque et 20 personnes en bonne santé. Les résultats de cette recherche suggèrent que le syndrome de la douleur antérieure du genou paraît être un syndrome psychosomatique avec l'instabilité subclinique de la rotule laquelle ne dépend pas du niveau de l'activité du patient.

Introduction

Although anterior knee pain syndrome often occurs in adolescents and is much more common in girls, the source of the pain remains unclear [14]. The purpose of

this study was to correlate a number of factors, including substance-P nerve fibres in the knee joint, patellar motion and the power of the quadriceps mechanism, with the clinical picture and the personality characteristics of patients with anterior knee pain.

Material and methods

I studied 20 patients (24 knees) with anterior knee pain. None of these patients had any abnormalities of pelvic geometry, femoral anteversion, malalignment of the knee, external tibial torsion, or hindfoot position, and none gave a history of trauma or of patellar dislocation. The average age of the patients was 18.8 years (range 15 to 23 years), they were all female and they all reported the same activity level. No specific causal sporting activity was noted. The clinical picture was of tenderness on firm palpation of the medial side of the patello-femoral joint, complaints of pain during squatting or prolonged sitting with a flexed knee, and on running or climbing stairs. Pain had occurred over a period of between 8 months and 5 years, and had first appeared at 14.3 years (± 4.8 years of age). The left knee was involved in 6 patients, the right knee in 10 patients, and in 4 patients both knees were symptomatic.

This group of young women was compared with 3 other groups: 20 patients (16 females and 4 males) with an average age of 64.3 years (range 55 to 74 years) with osteoarthritic (OA) knees; 20 patients (14 females, 6 males) with an average age of 18.6 years (range 15 to 25 years) with anterior cruciate ligament rupture or a meniscal lesion and no history of pain in the anterior compartment; and 20 healthy volunteers (18 females, 2 males) whose average age was 19.4 years (range 15 to 25) were used as "controls".

All patients gave their informed consent to participating in the investigation and all underwent arthroscopy, radiography, MRI scan and ultrasound examination of the knee joint.

Immuno-histochemistry was used to assess the articular cartilage of the patella and peripheral tissue including the medial and lateral retinacula, the synovium and the infrapatellar fat pat in all groups except the volunteers. An indirect StreptABComplex/HRP technique was employed for immuno-histochemistry. The preparation and staining of tissue sections for immuno-histochemistry (DAKO StreptABComplex/HRP Duet Mouse/Rabbit) was carried out as described in an earlier report [18]. Statistical analysis was done with the ONE WAY ANOVA test, and this was then corrected with the LSD test, at the level of significance ($P < 0.05$).

A psychological profile was produced using the Minnesota Multiphasic Personality Inventory (566 questions version). The Beck Depression Scale (BDS) was used to assess any depression.

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The computerised MMPI scale was used to estimate and analyse the results and has been described in an earlier report [19]. Statistical analysis was performed using the Student-*t* test where $P < 0.05$ was considered statistically significant.

Results

No trochlear dysplasia or abnormal patellar position was seen on radiography in the main study group of young women, but the most common patellar configuration was type II [17]. At arthroscopy, chondral changes were most often seen in the area of the medial ridge with equal extension onto the medial and lateral patellar facets. Chondral lesions were only seen in the patello-femoral joint. Chondral lesions of the 1st degree were seen in 19 knees, and 12 of these were associated with subluxation of the patella. Chondral lesions of the 2nd degree but no subluxation were seen in 2 knees. Knees with chondral lesions but no subluxation appeared to have a longer history of symptoms.

Five patterns of patellar mal-alignment were identified on MRI. These were: tilt, lateralisation, medialisation, tilt and lateralisation, and lateral to medial instability. In symptomatic knees, muscle contraction was responsible for tilt of the patella. The decrease of the patella tilt angle (PTA) was statistically significant in extension ($P < 0.05$) and at 10° of flexion ($P < 0.05$). Images taken without contraction showed no significant difference of PTA between symptomatic patients and the control group. In symptomatic knees, muscle contraction did not have any statistically significant effect on the congruence angle (CA) in extension and at 10° of flexion. At 20° of flexion without muscle contraction the CA was significantly higher than in the control group ($P < 0.05$).

Contraction of the thigh muscles in 30° of knee flexion increased the CA (Table 1). This lateral deviation was statistically significant ($P < 0.05$). There were no significant differences in the sulcus angle (SA) between symptomatic and non-symptomatic patients.

Ultrasonograph revealed that the mean percentage increase of the transverse diameter of the extensor muscles in isotonic contraction with a secondary load, when compared with that measured in relaxation, amounted to 56.2% for rectus femoris, 46.0% for vastus medialis, and 47.5% for vastus lateralis. In the patients with anterior knee pain these values amounted to 24.9% for rectus femoris, 34.7% for vastus medialis, and 43.2% for vastus lateralis (Table 2). The difference was only statistically significant for the rectus femoris ($P < 0.0001$).

Using immuno-histochemistry techniques, nerve fibres immuno-reactive for substance-P were found in the fat pad, retinaculum and synovium, but no examinations were made on the articular cartilage of the patella. Substance-P nerve fibres were more common in patients with anterior knee pain, and when this group was compared to those in the group with ACL or meniscus lesions, neuropeptide-containing fibres were more often seen in the medial retinaculum ($P < 0.005$) and in the fat pad ($P < 0.001$). There were no differences in the distribution of substance-P nerve fibres between the patients with ACL or meniscus lesions and the patients with osteoarthritis.

In the 'psychological profile', significant differences were observed in the paranoia subscale (Pa_2) and in the ego strength scale (ES) ($P < 0.01$). Patients with anterior knee pain and their matched controls differed in the paranoia scale (Pa) ($P < 0.02$), as well as in the social introversion subscale (SI_5), in schizophrenia (SC_{2C}), in the

Table 1 Mean values and standard deviations of congruence angle (CA), patella tilt angle (PTA) and sulcus angle (SA) at various angles of knee flexion, with thigh muscle contraction in anterior knee pain group of patients and in control group

Anterior knee pain group				Control group		
Angle of flexion	CA with contraction	PTA with contraction	SA	CA with contraction	PTA with contraction	SA
0°	-1.3 ± 15.0	8.3 ± 6.4	150.8 ± 5.6	-8.4 ± 15.2	15.9 ± 4.8	149.2 ± 5.3
10°	-0.5 ± 17.0	8.3 ± 6.4	148.4 ± 6.3	-10.2 ± 13.3	16.5 ± 5.8	148.7 ± 3.3
20°	0.5 ± 18.3	9.5 ± 7.9	144.3 ± 7.5	-13.9 ± 10.6	16.9 ± 6.9	146.6 ± 3.6
30°	1.5 ± 20.5	10.5 ± 8.9	140.8 ± 8.3	-16.3 ± 10.8	16.8 ± 7.7	144.5 ± 3.4

Table 2 Percentage differences of the transverse measurement of rectus femoris and vastus intermedius (RF) in patients with the anterior knee pain syndrome (AKPS) and in the control group in the phase of isotonic contraction "secondarily loaded" to the resting position

	Patients			Controls	Healthy knees Total
	Diseased knees	Healthy knees	Total		
N	24	16	40	40	56
Min.	14	32	14	40	32
Median	22.5	49.0	32.0	52.5	52.0
Max	38	100	100	82	100
x	24.9	52.9	36.0	56.2	55.3
s	7.7	21.7	20.2	11.0	14.6
v	31.0%	41.2%	55.9%	19.6%	26.3%

Comparisons

- all diseased knees with AKPS healthy knees (control group) $P < 0.00001$
- healthy knees (patients with AKPS) healthy knees (control group) $P > 0.05$

hostility scale (HOS) and in the manifest anxiety scale (MAS) ($P < 0.05$). Comparisons of the severity of depression using the Beck Depression Inventory showed a similar pattern.

Discussion

Until the 1970's pain in the anterior part of the knee joint was thought to be due to chondromalacia of the patella but arthroscopic changes in the patella are not closely related to clinical symptoms, and pathological changes may be found in patients without symptoms [1, 3, 7]. Hyaline cartilage does not contain nerve endings. Therefore it is thought that damage to the cartilage produces increased pressure on the sub-cartilage layer. Anatomical changes in the shape of the patella, or disorders in the extensor function of the knee, are considered by many authors as obvious reasons for pain [5, 6, 8, 15]. Overloading as a result of everyday activity, rapid growth, disorders in the movement of the patella (determined as Q angle or lateralisation index of the patella) are closely related to the intensity of the clinical symptoms.

At full extension the patella is not in contact with the femoral articular surface. At 30° of flexion the inferior aspect of the patella is in contact with the upper part of the femoral condyles. During the first 30° of knee flexion the extensor mechanism is responsible for the stability of the patello-femoral joint. Ficat [4] considered that anterior knee pain was a result of increased lateral pressure due to de-synchronisation of the movements of the patella connected with a change in the pressure of the lateral retinaculum on the knee. The results of this study based on ultrasound examination revealed that patellar mal-alignment occurs as a result of quadriceps malfunction which in turn is due to weakness of the rectus femoris and of the vastus medialis muscles.

Although McKechnie-Jarvis and Boobyer [12] found an increase in the Q angle of between 2 and 4 degrees in girls with pain around the patella compared to the normal population, the Q angle in my group of patients was normal. Weakness of the vastus medialis and the rectus femoris muscles does not compensate for the static tension of the patellar ligament, the peripheral insertion of which moves laterally during knee extension due to external tibial rotation. Based on the studies of Lieb [11] it can be assumed that the most efficient axis is parallel to the femoral diaphysis but with 10° of lateral deviation. A minor anatomical imbalance of the quadriceps muscle leads to patellar mal-alignment and this was clearly visible in this study in the kinematic and dynamic MRI investigations of the patello-femoral joint. This patellar mal-alignment was multi-directional and contraction of the muscles caused tilt of the patella in symptomatic knees, with a significant decrease of the PTA in extension and in 10° of flexion. Contraction of the thigh muscle in 30° of flexion increased the CA. This data from the control group agrees with Kujala et al. [10] who found no difference in the mean value of lateral patella

displacement with or without contraction in extension. In addition, contraction of the thigh muscles in normal individuals does not have any influence on patellar position at 30° of knee flexion. The results in my study suggest that in symptomatic knees the effect of muscle contraction at 30° of knee flexion is more significant than reported in previous studies.

MRI revealed that tilt and lateralisation of the patella was often present in symptomatic knees. These findings are strongly related to the immuno-histochemical investigation. Nerve fibres immuno-reactive for SP were found in all the joint tissues which were examined and these included the fat pad, retinaculum and synovium, but they were not observed in the articular cartilage of the patella. Whereas Wojtys et al. [20] found that the SP fibres seemed to occur more often in the lateral retinaculum than in medial, I found an equal distribution of neuropeptide nerve fibres in the lateral and medial retinaculum of patients without anterior knee pain, and statistically more often in the medial retinaculum and fat pad of patients with anterior knee pain. This, together with the finding that tilt and lateralisation were more often seen in patients with anterior knee pain, may be put a new angle on the actual cause of knee pain. Patellar instability due to quadriceps weakness during the first 20°–30° of knee flexion caused an impingement phenomenon between the fat pad and the medial retinaculum and this produced pain. Although Krompinger and Fulkerson [9] and Morscher [13] described good results following lateral release, my findings might explain why a lateral release is not always successful in relieving anterior knee pain.

Pain in the anterior knee pain syndrome is chronic in character, and it is widely appreciated that the "psychological state" of the patient may modify the perception of pain, and may exacerbate or even cause the sensation of pain. While there is no evidence supporting the beneficial effect of psychotherapy in chronic pain conditions [16], many authors consider depression to be the most common cause of chronic pain. This study focused on the situations where correlations between pain and personality have been demonstrated, and these situations include anxiety, depression, aggression/hostility and dependency. Patients with anterior knee pain in this study showed more stress symptoms as well as significantly higher levels of hostility and aggression than the volunteers in the control group, and this supports the conclusions of Carlsson et al. [2]. On the basis of this study it appears that anterior knee pain is a psychosomatic syndrome associated with subclinical patellar instability often due to an imbalance of the rectus femoris and the vastus medialis, with pain originating in the fat pad and the medial retinaculum due to an impingement phenomenon.

References

1. Abernethy PJ, Townsend PR, Rose RM (1978) Is chondromalacia patella a separate clinical entity? *J Bone Joint Surg [Br]* 60:205–208
2. Carlsson AM, Werner S, Mattlar CE (1993) Personality in patients with long-term patello-femoral pain syndrome. *Knee Surg Sports Traumatol Arthrosc* 1:178–183
3. Casscells SW (1978) Gross pathological changes in the knee joint of the aged individual. *Clin Orthop* 132:225–232
4. Ficat RP, Philippe J, Cuzaco JP (1972) Le syndrome de hyperpression externe de la rotule (SHPE) *J Radiol Electrol* 53:845–849
5. Grabiner MD, Koh TJ, Draganich LF (1994) Neuromechanics of the patello-femoral joint. *Med Sci Sports Exerc* 26:10–21
6. Hungerford DS, Barry M (1979) Biomechanics of the patello-femoral joint. *Clin Orthop* 144:9–15
7. Hvid I, Anderson LI, Schmidt H (1981) Chondromalacia patella: the relation to abnormal patello-femoral joint mechanics. *Acta Orthop Scand* 52:661–666
8. Insall J, Bullogh PJ, Burstein AH (1979) Proximal tube realignment of the patella for chondromalacia patella. *Clin Orthop* 144:63–69
9. Krompinger WJ, Fulkerson JP (1983) Lateral retinacular release for intractable lateral retinacular pain. *Clin Orthop* 179:191–193
10. Kujala UM, Osterman K, Korman M (1983) Patellar motion analysed by magnetic resonance imaging. *Acta Orthop Scand* 60:13–16
11. Lieb FJ, Perry J (1968) Quadriceps function. An anatomical and mechanical study using amputated limbs. *J Bone Joint Surg [Am]* 50:1535–1548
12. Mackechnie-Jarvis A, Boobyer GN (1984) Chondromalacia in adolescents: its relationship to limb maltorsion in 692 knees. *J Bone Joint Surg [Br]* 66:279–285
13. Morscher E (1978) Osteotomy of the patella in chondromalacia. *Arch Orthop Trauma Surg* 92:139–147
14. Nimon G, Murray D, Sandow M, Goodfellow J (1998) Natural history of anterior knee pain: a 14- to 20-year follow-up of non-operative management. *J Paediatr Orthop* 18:118–122
15. Outerbridge RE (1961) The etiology of chondromalacia patella. *J Bone Joint Surg [Br]* 43:752–757
16. Slater MA, Doctor JN, Pruitt SD, Atkinson JH (1997) The clinical significance of behavioural treatment for chronic low back pain: an evaluation of effectiveness. *Pain* 71:257–263
17. Wiberg G (1941) Roentgenographic and anatomic studies on the patello-femoral joint with special reference to chondromalacia patella. *Acta Orthop Scand* 12:319–410
18. Witonski D, Wagrowska-Danilewicz M (1999) Distribution of substance-P nerve fibres in the knee joint in patients with anterior knee pain syndrome. A preliminary report. *Knee Surg Sports Traumatol Arthroscopy* 7(3):177–183
19. Witonski D, Karlinska I, Musial A (1998) Personality characteristics in patients with anterior knee pain syndrome. *Med Sci Monit* 4:1019–1023
20. Wojtys EM, Beaman DN, Glover RA, Janda D (1990) Innervation of the human knee joint by substance-P fibres. *Arthroscopy* 6:254–263