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REFLEX INHIBITION OF THE QUADRICEPS ELICITED FROM A SUBPERIOSTEAL TUMOUR OF THE FEMUR

By

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Inhibition of the thigh extensors is a recognized clinical finding in all manner of afflictions of the knee joint (accidental or surgical trauma, infection, etc.). This arthrogenic inhibition of the quadriceps muscle, which may rapidly atrophy as a result, has been traditionally attributed to a reflex mechanism. *Vulpian*'s (1875) theory about this has been repeatedly tested with animal experiments (*Raymond* 1890, *Deroche* 1890, *Hoffa* 1892, *Schiff & Zak* 1912, *Lippman & Selig* 1928) but without conclusive results. More recently, in the decerebrate cat, *Ekholm, Eklund & Skoglund* (1960) have demonstrated inhibition of the monosynaptic arc of the quadriceps induced by distension of the knee joint (artificial effusion). Support for the reflex theory has also been obtained from experiments on man: *Stener & Petersén* (1962) showed that the vastus medialis is reflexly inhibited when pain receptors are stimulated in the medial collateral ligament of the knee joint, and *de Andrade, Grant & Dixon* (1965) found that an increase in the intra-articular pressure in the knee joint induces reflex inhibition of the quadriceps muscle.

This report concerns a patient in whom pronounced atrophy of the quadriceps is believed to have been due to reflex inhibition of the muscle initiated by a subperiosteal femoral tumour situated near the knee joint.

CASE REPORT

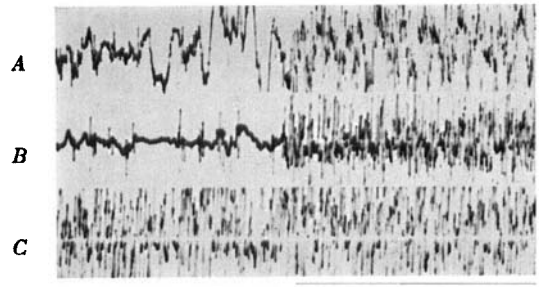
A 45-year-old man had a three-year history of pain in the right knee. On examination, a firm, tender lump, the size of half of a walnut, was palpated proximal to

Figure 1. A thin piece of bone can be seen protruding from the femur proximal to the lateral epicondyle, corresponding to the proximal border of the tumour.

the lateral femoral epicondyle; it was free in relation to the skin but had a deep attachment. An X-ray examination of this site revealed a thin piece of bone protruding from the femur (Figure 1). Extension and flexion of the knee joint elicited pain within, but not outside, the range of 30° to 60° of flexion. The quadriceps muscle had atrophied to a considerable extent. The circumference of the thigh 20 cm proximal to the knee joint was 3 cm less on the affected side.

Pressure on the tender lump was found to inhibit active extension in the knee joint. This was demonstrated both clinically and electromyographically. The patient sat on a table so that his thigh was supported but the lower leg hung freely over the edge; he was then asked to extend the knee as much as he could. When pressure was applied to the lump, he was quite unable to keep the leg in a horizontal position —the knee flexed against his will. Electromyography (Figure 2) showed that this inhibition affected the vastus lateralis and vastus medialis in particular, whereas the rectus femoris hardly changed at all.

At operation in a bloodless field (Figure 3), the lump proved to be a subperiosteal tumour of the femur. It was excised in toto together with the periosteum covering it on the superficial side (Figure 3, below, × 1.3) and cancellous bone on the deep



A = *Rectus femoris*
B = *Vastus lateralis* ——— = 0.5 sec.
C = *Vastus medialis* | = 100 μV

Figure 2. Electromyography of the rectus femoris, vastus lateralis and vastus medialis. Pressure on the tender lump (signal line) elicited marked inhibition of the voluntary activity in the vastus lateralis and vastus medialis but little change in the rectus femoris.

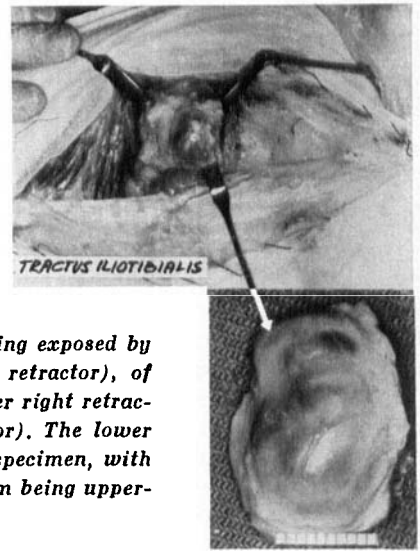


Figure 3. The operative field. The tumour is being exposed by retraction of the vastus lateralis (upper left retractor), of the synovial membrane of the knee joint (upper right retractor) and of the iliotibial band (lower retractor). The lower picture shows an enlargement of the excised specimen, with the surface of the tumour covered by periosteum being uppermost (scale in mm).

side. The tumour was sectioned and found to be lobulated and to consist of soft, greyish-red to dark red tissue.

Microscopic examination (Assoc. prof. *L. Angervall*) showed the tumour to be relatively acellular with pronounced degenerative changes and extensive necrosis and haemorrhage. Many of the cells were polygonal or star-shaped and had irregular nucleoli. No mitoses were seen. The tumour was mostly myxoid, although signs of intracellular hyaline formation were detectable here and there. The fibrous capsule (the periosteum) contained bone. The histological diagnosis was chondroma with regressive changes, possibly a chondromyxoid fibroma. There was no evidence of malignancy.

The postoperative course was uncomplicated and the function of the quadriceps improved rapidly. The patient was free of symptoms seven weeks after the operation and returned to full-time employment as a ship's mechanic.

DISCUSSION

Pressure exerted upon a tender lump, that subsequently proved to be a subperiosteal femoral tumour, elicited inhibition of active extension of the knee joint. It seems that this inhibition, which the patient could not counteract, was due to a reflex mechanism initiated by the stimulation of pain receptors.

A study of the patient's spontaneous pain showed that this was experienced during movements of the knee joint within but not outside the range of 30° to 60° of flexion. A possible explanation, illustrated in Figure 4, is that the iliotibial band irritated the tumour when it passed

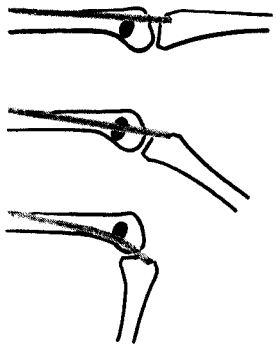


Figure 4. Diagram to illustrate how the iliotibial band may have had a mechanical effect on the tumour during flexion and extension of the knee joint within the range of 30° to 60° of flexion, i.e. the range within which pain was elicited.

over the latter's most prominent part during movements within this range. The finding of pronounced atrophy of the quadriceps could then be entirely or partly ascribed to this muscle having been subjected for a long time to reflex inbihition elicited by pain-inducing mechanical effect on the tumour. Such an explanation is supported by the fact that the function of the quadriceps rapidly improved after removal of the tumour.

Electromyography showed that the inhibition of the quadriceps affected the vastus lateralis and vastus medialis in particular, whereas the rectus femoris displayed little change. This difference may be due to the fact that the rectus femoris, besides being a knee extensor, is also involved in flexion of the hip. The reflex response, indicated by Figure 2, in fact conforms with the general flexion reflex that *Sherrington* (1910) has described as being elicited on painful stimulation of the lower extremity. In this reflex, which includes flexion of both the knee and the hip joint, the rectus femoris functions as a hip flexor rather than a knee extensor since it is activated at the same time as the vastus lateralis and vastus medialis are inhibited.

SUMMARY

Muscle wasting caused by nociceptive reflex motor inhibition is often seen following injury to the knee joint. The same phenomenon has been observed in a case of a subperiosteal cartilagionus tumour located proximal to the lateral femoral epicondyle. The tumour was tender on palpation, and pain was also experienced during movement of the knee joint within the range of 30° to 60° of flexion. The quadriceps muscle was atrophied to a great extent. Pressure on the tumour during active contraction of the quadriceps caused instantaneous loss of muscle

power. Similarly, electromyography showed that voluntary activity in the vastus lateralis and vastus medialis was inhibited after short latency by pressure on the tumour. On removal of the tumour, the pain disappeared and the function of the qudraceps improved rapidly.

The pain experienced during movement of the knee joint is explained by the location of the tumour in relation to the iliotibial band. Within the painful range mentioned, the iliotibial band exerted pressure on the tender tumour. It is probable that this mechanism elicited an inhibitory reflex, resulting in atrophy of the quadriceps.

RESUME

Une amyotrophie qui est le résultat d'une inhibition motrice élicitée par un réflexe nociceptif est souvent observée à la suite d'une lésion de l' articulation du genou. Le même phénomène a été constaté dans un cas de tumeur cartilagineuse sous-périostale localisée à l'épicondyle fémoral latéral. La tumeur était sensible à la palpation, et on a aussi constaté des douleurs durant les mouvements de l' articulation du genou entre 30 et 60 degrés de flexion. Le muscle quadriceps était fortement atrophié. La pression excercée sur la tumeur pendant une contraction active du quadriceps causa une perte instantanée de la force du muscle. De la même façon, l'électromyographie montrait que l'activité volontaire du vaste latéral et du vaste interne était empêchée, après une courte période de latence, par la pression sur la tumeur. La tumeur enlevèe, la douleur a disparu et la fonction du quadriceps s'est améliorée rapidement.

La douleur éprouvée durant les mouvements de l'articulation du genou entre les degrés mentionnés s'explique par la localisation de la tumeur par rapport au ligament ilio-tibial. Durant ces mouvements, le ligament ilio-tibial exerçait une pression sur la tumeur qui y était sensible. Il est probable que ce mécanisme déclenchait un réflexe inhibiteur donnant comme résultat l'atrophie du quadriceps.

ZUSAMMENFASSUNG

Nach Verletzung des Kniegelenkes wird oft eine durch nociceptiven Reflex bedingte motorische Hemmung und eine dadurch verursachte Muskelatrophie festgestellt. Die gleiche Erscheinung wurde in einem Fall eines subperiostalen cartilaginösen Tumors beobachtet, der proximal des lateralen Femurepicondylus lokalisiert war. Der Tumor war empfindlich auf Berührung; Schmerzen wurden auch bei Bewegung

des Kniegelenkes innerhalb des Bereiches von 30°–60° Beugung empfunden. Der Quadricepsmuskel war hochgradig atrophisch. Druck auf den Tumor wärend aktiver Quadricepskontraktion verursachte den augenblicklichen Verlust der Muskelkraft. Die Elektromyographie zeigte in gleicher Weise, dass die willkürliche Aktivität im Vastus medialis und lateralis nach einer kurzen Latenzzeit durch Druck auf den Tumor gehemmt wurde. Nach Entfernung des Tumors verschwanden die Schmerzen und die Quadricepsfunktion besserte sich rasch. Die wärend der Bewegung des Kniegelenkes auftretenden Schmerzen werden durch den Sitz des Tumors in Bezug auf das Lig. ilio-tibiale erklärt. Innerhalb des erwähnten schmerzhaften Bereiches übte das Lig. ilio-tibiale einen Druck auf den empfindlichen Tumor aus. Es ist wahrscheinlich, dass dieser Mechanismus einen Hemmungsreflex hervorrief, der die Atrophie des Quadriceps zur Folge hatte.

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