DIE WERKING VAN DIE QUADRICEPS-SPIER en 'n FUNKSIONALE BENADERING TOTSY HEROPLEIDING

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Disfunksie van die Quadriceps-spieer is een van die mees algemene verskynsels in trauma van die onderste ledenmaat. Enige besering in die omgewing van die kneegewrig sal 'n vermindering in die effektiewe werking van hierdie spiergroep veroorsaak en 'n erger grad van besering en/of chirurgie kan 'n totale inhibisie veroorsaak. Dit is veral in laasgenoemde geval dat die pasiënt na Fisioterapie verwys word vir 'Quadriceps drill'. Die sukses of mislukking van hierdie 'drill' hang af van 'n goeie begrip van die werking van die spiergroep. Anatomies word die quadriceps beskou as 'n knie extensor—d.w.s. m. vastus lateralis is die voet vry voet word die knie van die gebugde posisie tot die reguit posisie gebring. Dit is natuurlik die aksie van hierdie spier, maar waarom moet die spierbou so massief wees vir so 'n ligte werk? Ekstensie van die knie met 'n vry voet is nie die primêre funksie van die quadriceps nie.

Let ons eerste ons structure. Die quadriceps is 'n extremelye muskulatuur wat die volle van die front van die been dek. Morphologies kan dit binne vier disante komponente verdeel word:

(i) Rectus Femoris is wat fusiform in shape, arises from the anterior inferior iliac spine en inserts into die base van die patella. Dit forms die superfical central part van die quadriceps tendon. Rectus femoris is 'n twee-joint muscle what it acts on both the hip and the knee joints.

(ii) Vastus lateralis is die grootste component van quadriceps. Dit arises from die intertrochanteric line, the anterior and inferior borders of die greater trochanter and the upper half of die lateral lip van die linea aspera. Dit inserts principally into die lateral border van die patella en into die quadriceps femoris tendon.

(iii) Vastus medialis arises from die lower part van die intertrochanteric line, spiral line, medial lip van die linea aspera en upper part of die medial supracondylar line etc. Dit fibres pass downward and forward and are chiefly attached to die medial border van die patella en die quadriceps tendon. Die lowest fibres are almost horizontal en form die bulge van die medial side van die knee dat is distinctive in a well-developed muscle. Die fibres van vastus medialis run thus in two distinct directions and one would expect the function van die two parts to differ.

(iv) Vastus intermedius arises from die anterior en lateral surfaces van die upper two thirds van die shaft van die femur. In its upper part it is frequently fixed met die upper fibres van vastus medialis. Dit insertion forms die deep part van die quadriceps tendon and dit is also attached to die lateral border van die patella. (11)

During the last ten years a fair amount van work been doen in die action van die individual parts van the quadriceps. In a mechanical study using amputation specimens, Lieb en Perry (17) established that—

(a) Vastus intermedius is the most efficient extensor. With various combinations the total force combination was very close to that van vastus intermedius alone. Vastus medialis alone could not extend the knee.

(b) Full knee extension en terminal rotation were attained only when die primary extensor was vastus lateralis. Die horizontal fibres van vastus medialis failed to produce extension. Full extension was obtained when die extension load was on any of die other long heads.

(c) When a weight was applied to the horizontal fibres van vastus medialis sufficient to keep die patella centred in die femoral groove, die force required voor die vastus lateralis to extend die knee fully, was decreased by 13%.

(d) As die knee became progressively straighter, a greater force was required.

They came to the conclusion that:

(i) The only selective function attributable to the horizontal fibres van vastus medialis is patellar alignment.

(ii) The extensor lag accompanying knee lesions is a function van the loss in mechanical advantage van die quadriceps during die last 15° van extension, a 60 per cent increase in force being necessary to complete extension.

(iii) Die clinical prominence van vastus medialis is related to die marked obliquity van die distal fibres, die lowness van it insertion and die thinness van die fascial covering of this part van die muscle.

(iv) Early atrophy van the vastus medialis en lack van terminal extension after injury are indicative van general quadriceps weakness.

These findings are borne out by other investigators performing electromyographic studies on both normal en recently injured knee joints. (4, 15, 18, 24) One is able to infer from available studies van no individual component van die quadriceps performs consistently in any specific part van the range. Die muscle components act as a whole with considerabe variation. There is consensus van opinion dat die action van die horizontal fibres van vastus medialis during die terminal phase van extension, is to retain patella in its groove op die patellar surface van die femur, helping to counteract die natural tendency to lateral displacement. (11, 26)

All these studies been performed met die quadriceps acting as a knee extensor met die foot free. Insofar as die establish die necessity to re-educate die muscle as a whole en not to concentrate on one component alone viz vastus medialis, they can assist in the planning van a rehabilitation program. However, in order to obtain die optimum performance in die minimum time, one must consider the function van die quadriceps in the living body.

Die quadriceps is a postural muscle which fact is die reason for its bulk. It's function is to counteract gravity in a multitude van different postures. Its function is not so much to maintain a standing posture as to perform die powerful movements required voor the changes van posture such as sitting to standing, crouching to standing, etc. (3) In die erect position die line van gravity falls slightly in front van die knee joint so dat quadriceps action is slight, if not entirely absent. According to Basmajian (3) during walking on the level, die quadriceps contracts as extension van the knee is being completed, early extension being principally passive (dis chief is used in the construction van the free knee joint in an above-knee prosthesis), and dit continues to act during die early part van the supporting phase while die line van gravity is behind die knee joint. A strong quadriceps is thus not a requirement voor walking on the level. Patients met a paralysed quadriceps use die hand to lock die knee at die heel strike, en otherwise manage very well.

Thus, as soon as die line van gravity falls behind die knee en if there is any degree van flexion, die quadriceps will be
**pain is our scene...**

**analgen ointment**

**Formulation:** Two pain-killing ingredients, diethylamine salicylate and nopoxamine, in a special ointment base to speed subcutaneous penetration.

**Indications:** Rheumatic pains in joints and muscles, low backache, fibrositis, sprains and bruises, muscular cramps and stiffness, neuralgic pains.

**Action:** Soothing, deep-penetrating, rapid pain relief with local anaesthetic effect.

**Application:** Massage gently into the skin around the affected area until completely absorbed. Apply as often as required.


Formula:
- Diethylamine Salicylate 10 g
- Nopoxamine 1 g
- Excipient q.s.ad. 100 g
thrown into action. In walking up and down an incline the muscle works more strongly than on a level surface. Walking up and down steps is impossible without an adequately functioning quadriceps on the supporting leg—the higher the step the greater the muscle activity. The major action of this muscle is, therefore, to straighten the knee while the quadriceps act to help keep the body balanced, to allow the knee to bend (by means of a lengthening reaction), again with a fixed foot. In this fashion it performs its postural function and it is in order to support the weight of the body that the quadriceps is so massive in structure.

The re-education of quadriceps function poses several problems:—

1. After injury or surgery there is a reflex inhibition which is thought to be a result of pain. In the studies performed on knee injuries, most investigators come to the conclusion that the inhibition is central and that pain and not soft tissue stretching is the major factor concerned. (8, 9, 13, 22, 23, 27, 28, 30)

2. With most patients who have undergone knee surgery, flexion of the knee is not allowed for approximately 10 days to avoid the possibility of a haemarthrosis. In fact the knee joint is generally splinted in full extension.

3. Immediate weight-bearing is not usually permitted.

4. The last being most important from the point of view of re-education—the principle function of the quadriceps is not to lift the leg up straight and this combined with the previously mentioned factors, impede re-education. It must be understood that re-education or therapy does not comprise the motor act alone. Normal motor activity is always a response to stimuli and therapy should therefore consist of the application of stimuli to activate the motor response in such a way as to stimulate normal motor functions.

According to Prof. Rood (29) motor development takes place in four steps:—

(i) In a non-weight-bearing reciprocal pattern moving the small lever e.g. the foot in a mass flexion pattern. This is seen in the supine infant kicking.

(ii) In a weight-bearing co-contraction pattern e.g. in the stabilizing action seen in stance patterns i.e. all muscle groups around a joint are active.

(iii) In a weight-bearing pattern moving the larger lever e.g. in the action of bringing the body over the foot the calf muscles are thrown into strong contraction.

(iv) In a co-ordinate pattern e.g. at the heel strike phase of walking there is dorsiflexion of the foot with knee extension and hip flexion.

These patterns of movement are presented in order of complexity and are found to occur in this order during the developmental process. If functions such as stabilizing are lost as a result of reflex inhibition they must be restored before progressing to the more complex skills.

Rood also classifies muscles into two major functional groups viz. mobilizing and stabilizing. Most muscles in the body comprise both these elements, but it is possible to consider some muscles to be predominantly mobilizers and others to be predominantly stabilizers. This classification is not only functional, but histological and neurological as well. Histologically, mobilizing muscles have a high concentration of white muscle fibres, stabilizers having more red. Mobilizing muscles are usually fusiform in shape, they cross two or more joints and are attached to the flexor and adductor groups. They tend to perform light work with the distal part of the limb free. Rectus femoris falls into this category. Stabilizers are commonly bipennate or irregular in shape, they cross one joint and are found to be extensors and abductors. Their action is to move the body over the fixed limb in a heavy work. The other components of quadriceps are stabilizers. The muscle spindles of single joint extensors are richly supplied with secondary afferents whose activity facilitates a co-contraction. (21) The nerve supply is thus also functionally arranged.

It is not only the peripheral innervation which is functionally orientated, but the central nervous system as well. Buchwald (7) states that “Central mechanisms upon which postural maintenance is primarily dependent would seem to reside in those pathways terminating most densely around the axial and extensor interneurons and motoneurons i.e. the vestibulo-spinal and bulospinal tracts . . . Central control of limb movements and actions of fine co-ordination would seem to descend through those pathways terminating most heavily around the interneurons and motoneurons innervating the distal and flexor musculature i.e. pyramidal and rubrospinal tracts,” p. 150.

It would seem then that in order to obtain the optimum results from any muscle group, irrespective of the specific movement technique employed, one must take into account its physiological function as well as its anatomical action.

To return to the quadriceps—this is a bi-functional muscle. The rectus femoris part is a mobilizer working principally with the light lever i.e. straight leg raising, while the other three components are stabilizers whose principal function is to move the body weight. Now, we have the patient with a reflex inhibition of the quadriceps, a splinted straight knee and he is not allowed to weight-bear. Before he is able to lift his leg (a co-ordinate pattern or skilled function) the patient must regain the stabilizing function of the quadriceps. If one attempts re-education without considering the functional level of the patient, the re-education is extremely unsuccessful, is certainly greatly hindered. One must thus as far as possible simulate weight-bearing conditions without putting any strain on the joint. This is not as difficult as it sounds.

Stretch of the interosseus muscles of the foot has a facilitating effect on the postural muscles of the lower limb. Joint compression is facilitatory to extensor muscles. If a quick, alternate rotation of the hip in a very small range, is applied together with other superimposed facilitatory methods, a co-contraction of the muscle groups of the lower limb is elicited and the quadriceps contracts as a stabilizer. Stretch by gravity can be superimposed by placing the patient in the prone position. Once the quadriceps is able to function as a stabilizer, one can progress to using it in a co-ordinate pattern i.e. straight leg raising.

Effective re-education of quadriceps function is most difficult in the immediate post-operative stage. Once movement of the knee and weight-bearing are allowed, the problems are fewer. Normal function need not be simulated. The limb can be subjected to the natural facilitatory effects of changes in the centre of gravity, weight-bearing, walking, etc. as an essential part of the re-education program.

The action of the quadriceps is extremely complex and many aspects must be taken into consideration by the therapist so that he can provide the most favourable conditions for rehabilitation. From experience it has been found that the application of a functional, developmental approach to rehabilitation can dynamically influence the musculo-skeletal system.

REFERENCES

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