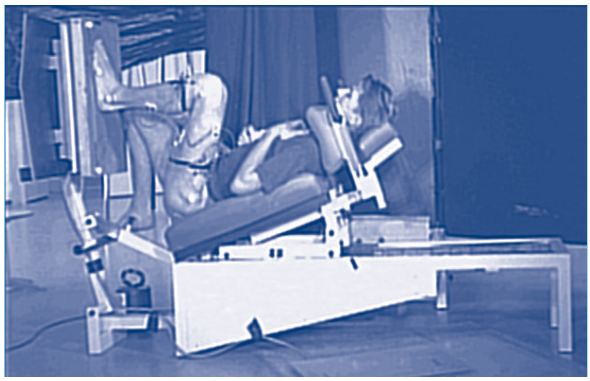
MONITORED REHAB SYSTEMS

Muscle co-ordination and knee-load in the Functional Squat System (Monitored Rehab Systems)



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Muscle Co-ordination And Knee-load In The Functional Squat System

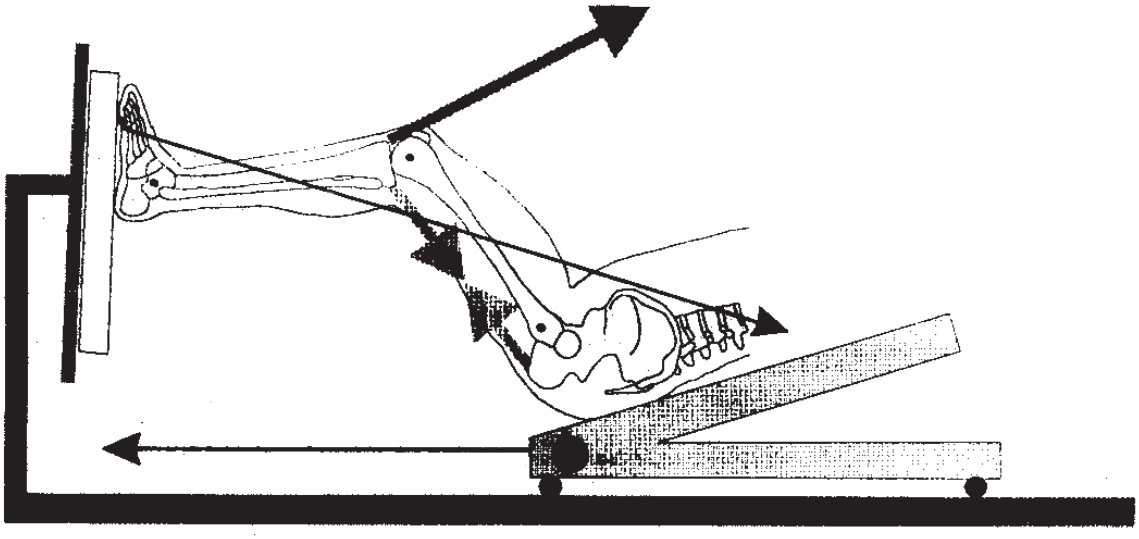
Introduction

Training the function of thigh musculature is important part of the rehabilitation program after knee injury. Training of quadriceps and hamstrings musculature can be done using monoarticular resistance in non weight bearing positions, prior to functional (i.e. multi-articular, weight bearing) training, c.q. jumping or hopping. Alternatively, a "leg press" system can be used to train the combined extension pattern of the lower extremity joints, in a weight bearing analogue. Recently a functional squat system was introduced by MONITORED REHAB SYSTEMS that mimics the movement co-ordination pattern of a squat jump, under the control of an external load. This study was designed how the pivoting mechanism of the sledge was affecting knee load and the activation level of the thigh muscles. Also the effect of different foot positions were studied.

Method

Subjects: Four young (av. 25 y.o.a.) healthy male subjects took part in the investigation

Instrumentation: A MR Functional Squat System (FSS) was equipped with a Kistler force plate mounted vertically, on the foot-plate of the FSS. Also the surfacc EMG signals of M. Rectus Femoris, M. Vastus Medialis, M. Semitendinosus and M. Biceps Femoris were recorded. For movement analysis, markers were placed on the trochanter major, epicondylus lateralis, caput fibulae, malleolus lateralis, os metatarsale V. A VICON system was used to sample the actual position of this markers. See the next figure for an overview, including the forces that are considered in this study.



Conditions: Repetitive squat exercises were performed with one leg in a standardized pace. After some acquaintance to the exercise, 3 consecutive cycles were recorded. Squats were performed against an external load of 25% body weight. The tests were performed with and without the pivoting sledge mechanism. Also the use of three different foot positions were tested: high, midway and low on the footplate.

Data-processing: All EMG-signals were processed by rectifying and filtering (@ 2 Hz), resulting in the Smoothed Rectified EMG (SRE) or Linear Envelope. The signal was normalized with respect to maximal isometric contraction. Net joint moment was calculated from forceplate-data and marker position data. All data (extension phase of the squat) was averaged across cycles and across subjects, and expressed as a function of knee angle.

Fig. 1 : Knee Moment

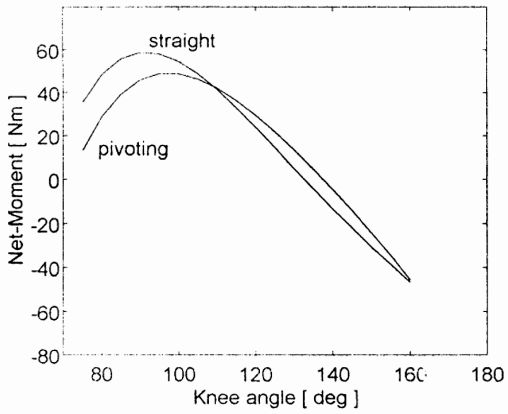


Fig. 2 : Quadriceps

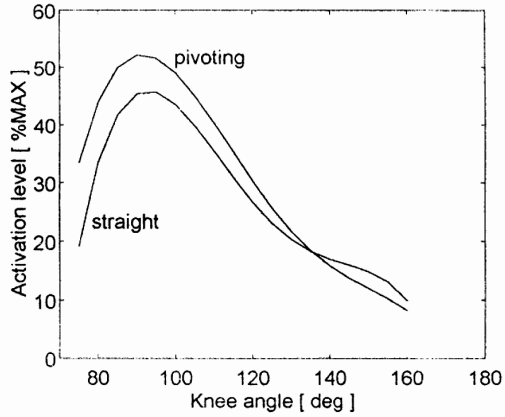


Fig. 3 : Hamstrings

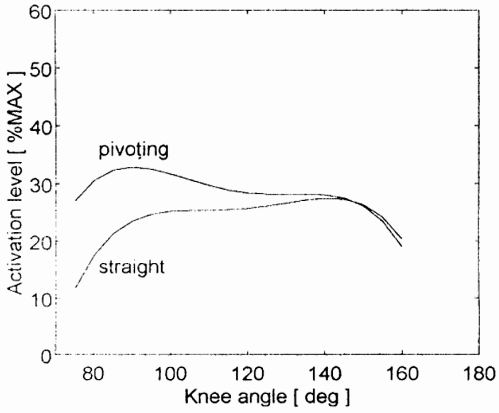
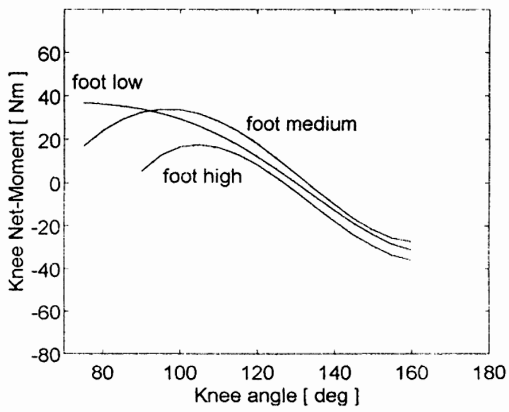


Fig. 4 : Foot position



Results and Discussion

The use of the pivoting sledge on the net kneemoment (figure 1) shows that a lower knee moment is achieved in the first part of the extension movement, i.e. at a flexed knee. The EMG mesaurements reveal that the lower net knee joint moment of pivoting does NOT results in a lower activation level of the quadriceps (figure 3). A higher activation level of hamstrings muscles is seen instead, which not only increases hip extension moment, hut also increases co-contraction around the knee (figure 3). The mechanism of lowering the net joint moment by increased co-contraction is also known frorn other studies of functional activities. For the training effect it means that use of the pivoting mechanism will be more effective in the activation of the thigh musculature. Also the load on the ACL is lower through lower net joint moments, and increased hamstrings co-contraction. Finally the muscle co-ordination that is trained advantages ACL protection ("active stabilisation") in real life situations. lt is shown in literature that hamstrings co-contraction is highly correlated with functional scores in ACL deficient patients.

The same effect is seen when a high foot position is used. The use of a high foot position lowers the net joint moment (figure 4), which is attributable to an increase of harnstrings co-contraction.

Conclusions

- The FSS enables a normal leg extension squat pattern for training the thigh musculature.
- The pivoting mechanism as well as high foot positions inerease hamstrings co-contraction during extension on the FSS
- The FSS excercises stimulate muscle co-ordination pattern for active stabilisation of the knee.

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