Dynamometric and Electromyographic Evaluation of the Quadriceps and Hamstring Muscles after the Knee Trauma and Treatment.

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Introduction:

Thigh muscles atrophy and weakness after the knee trauma, has been observed for a long time [10], but still there are a lot of questions about their role in the knee stability, and the influence of their efficiency on the outcome of the treatment and rehabilitation. There are two kinds of atrophy, first concerning type I – slow twitching fibres disuse atrophy- due to immobilisation for instance in a long leg cast and second, concerning type II fast twitching fibres caused by impulses from the irritated proprioceptors [10,15,12] in the cruciate ligaments and synovia. Depending on the trauma and treatment one of them dominates[ 13]. The aim of this study is to evaluate strength and mass deficit of quadriceps and hamstring muscles depending on the type of knee injury and treatment, especially comparing ACL deficient operated and non-operated, immobilised and non-immobilised patients with soft tissue injuries and fractures. This could throw some light on the widely discussed adaptation mechanisms in unstable knees, and correlation between the muscles strength, thigh circumference and EMG activity.

Methods:

158 patients treated in the Department of Traumatology and Orthopaedics Postgraduate Medical Center in Warsaw after the knee trauma were evaluated. Isometric dynamometry at an 65 degrees knee angle during 20 seconds was performed and the result was average moment for the 90% of the maximal strength [Nm]. Injured leg was compared to non-injured. Thigh circumference 5, 10, and 20 cm. above the patella was measured. In 40 patients surface electromyography of Vastus Medialis was performed simultaneously with dynamometric evaluation (Oxford Intruments-Medelec).Amplitude, duration, and area of the EMG signal was analyzed. Patients were divided into groups according to their injury and treatment.

Group 1 – 43 patients with isolated ACL injury treated non-operatively, without functional instability.
Group 2 – 29 patients after ACL reconstruction due to knee instability, using Leeds-Keio prosthesis.
Group 3 - 29 patients after subtotal arthroscopic meniscectomy.
Group 4- 13 patients with patellar fractures operated with wire fixation, immobilised in a long leg cast for six weeks, then rehabilitated.
Group 5- 31 patients with proximal articular tibial fractures treated operatively using different methods, immobilised and non-immobilised after the operation.
Group 6 –13 patients with distal femoral articular fractures treated operatively using different methods, immobilised and non-immobilised after the operation.

The data was analyzed using STATISTICA program.

Results:

Quadriceps average strength deficit was: Group 1- 18,48 %, Group 2- 11,87 %, Group 3- 3.3 %, Group 4- 19,58 %, Group 5- 23,28 %, Group 6- 10,15 %.
Hamstring average strength deficit was: Group 1- 7,19 %, Group 2- 10,3 %,
Group 3- 5,95 %, Group 4- 17,98%, Group 5- 10,0 %, Group 6- 14,97 %. (see graph 1).
Thigh circumference average deficit was: Group 1- 2,1 %, Group 2- 1,89 %, Group 3- 1,81 %,Group 4- 4,39 %, Groups 5,6-circumference not measured because of the callus presence.
No significant correlation (p > 0.05) between quadriceps and hamstring strength deficits and thigh circumference deficit was found.

No significant correlation (p > 0.05) between the EMG parameters change: amplitude, duration, area, and quadriceps strength deficit was found.

There is a significant correlation (p < 0.05) between average moments for the 50% and 90% of the maximal strength, which means that muscle contraction strength does not decrease over the time of the test.

**Discussion:**

Similar thigh circumference deficits were obtained by other authors [6,3,1], and they also found this measurement unreliable in determining muscle wasting.

More precise Cross Sectional Area (CSA) measurements in MRI showed quadriceps atrophy [7,3] less intensive atrophy of hamstring [16], or even its hypertrophy [7], still without correlation between CSA and muscle strength deficits.

Quadriceps strength deficit with relative strengthening of hamstring is seen to be a mechanism preventing anterior tibial displacement produced by quadriceps contraction in ACL deficient knee [11,2]. Spontaneous adaptation of muscles might be an answer to the question why according to the Noyes “rule of thirds” some ACL deficient patients demonstrate functional instability of the knee while others are asymptomatic[9]. In this study ACL deficient patients without knee instability (Group 1) have quadriceps atrophy with relative preserving of hamstring more intensive than patients from Group 2 which had to be operated because of the knee disability.

Patients with the knee fractures Groups: 4,5,6 have more significant strength deficits than those with soft tissues injury- Groups: 1,2,3 where the neural reflex atrophy dominates. Group 4 might be an example of dominating disuse atrophy [4,14].
Conclusions:

1. Both quadriceps and hamstring are weakened after the knee trauma.
2. Quadriceps strength deficit is higher and hamstring lower in the ACL deficient non-operated group comparing to the ACL reconstructed group.
3. Patients whose limbs were immobilised (Group 4) had more quadriceps and hamstring strength deficit than non-immobilised (Groups 1, 2, 3).
4. Thigh circumference measure does not provide information about muscle strength.

References
