DYNAMIC TESTING OF MOTORIAL STEREOTYPES IN HIP EXTENSION

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INTRODUCTION

Hyperextension of the hip joint is one sequence of movement during human locomotion.

Studies on low back muscles suggest that the lumbar extensor muscles are important factors in low back pain. Muscle innervation sequences and repetitions of movement patterns are also involved in low back pain.

In this study the hip extension is discussed in relation to the elaboration of locomotor stereotypes and vertebral dysfunction.

PURPOSE

The purpose of the present study is the evaluation of the dynamic locomotor stereotype in hip extension with the aid of electromyography. Onset times and recruitment patterns of the examined agonistic and antagonistic muscles were used to identify the characteristic dynamic locomotion stereotype during hip extension lying in prone position. Possible simultaneous coactivation or inhibition reflex activities should be recorded.

METHODS

15 healthy male sport students were examined, aged 23 to 27 **(x=25,3),** body length **179,6cm** +/- 5.92 and body weight 73.43 kg +/- 8.08.

Shortenings of postural muscles were tested by modified Frisch (1991) muscle function analysis.

For controlling the limb extension a functional measurement system with standardized hip extension movement was developed. The subjects were lying in prone position and were instructed to extend their straight leg.

The movement was **uniaxially** conducted by the measurement system. The beginning of leg lifting was recorded using a switch at the distal end of the tibia. A second switch underneath the "anterior superior illiac spine" recorded the elevation of the pelvis which was determined as the end of the movement. Range of motion of the hip joint was recorded by an electronic goniometer fixed distal and proximal from the trochanter major. The position of the distal tibia trigger was adapted to the individual limb length. The limb extension velocity was controlled by metronom frequency (116 bpm; 4 beats in elevation).

Eight agonistic and antagonistic muscles were examined in case that any influence of coactivation in hip extension occured;

agonistic muscles:	**antagonistic** muscles:
semitendinous	rectus **femoris**
glutaeus **maximus**	tensor fasciae latae
ipsi-, contralateral lumbar erector spinae	ipsi-, contralateral rectus **abdominis**

We used a 16 channel EMG-system **(BIOVISION_** Frankfurt) with bipolar **AgCl** surface electrodes. A **1000** Hz sampling rate per channel was selected. The electrodes were applicated refering to the ISEK standard (1980). Electrode cables were protected against traction and movement artefacts. In prone position the ventral electrodes were protected from artefactual influences by eroding the corresponding spot of the padding.

All EMG-patterns were optically controlled for artefacts. Muscle onset time (quality) and integrated full wave rectified EMG (JEMG; quantity) was checked in the pre- and post-innervatiqn phase which was determined by lifting of the ankle.

Based on the trigger signals, muscle onset patterns have been exposed. The angle curves showed the movement pattern in degree of limb extension.

DATA ANALYSIS

The data of five repetitions per subject was transformed from absolute values into percentual data. The sampled data was time normalized refering to the beginning of activation of the first innervated muscle (=0%) and the pelvis elevation (=100%). The normalized onset times of all examined muscles and the IEMG in pre- and post-interval were analysed by MANOVA (a = 1%).

The reliability of the functional measurement was verified by the correlations of 5 repetitions of JEMG patterns and onset times per subject .

Following the pattern of Ratov 1972 for defined movements (highest IEMG = 100%) the main muscles (>30%) in hip extension were selected.

RESULTS

The table 1 shows the results of the onset times, the JEMG in pre-, post-interval and the hip angles at the onset times.

muscle	onset times in % (SD)	IEMG preinterval (SD), µV*s	JEMG postinterval (SD)µV*s	hip angles at the onset times
contralat.rectus abd.	0.86 (1.51)	5.77 (3.77)	7.59 (3.63)	0.29
ipsilat.rectus abd.	0.91 (2.25)	4.89 (3.18)	6.73 (3.58)	0.33
rectus femoris	9.84 (19.79)	3.42 (1.71)	10.35 (4.61)	0.69
ipsilat. lb.erector sp.	13.91 (10.97)	26.78 (14.07)	94.33 (35.19)	0.82
semitendinous	17.61 (13.04)	22.28 (15.59)	83.56 (32.21)	1.92
contral.lb.erector sp	17.27 (12.86)	19.62 (19.41)	62.01 (24.63)	1.80
tensor f.latae	28.76 (18.32	11.41 (6.67)	62.36 (46.55)	2.78
gluteus maximus	41.84 (22.64)	6.12 (4.05)	40.69 (28.67)	5.31

The average extension maximum until pelvic lifting was 12,69 +/- 3.27.

The manual examination of the muscles revealed shortenings of postural muscles in 75 % of the subjects.

The reliability of the measurement system determined by the correlations in all intraindividual repetitions was acceptably (r > .85).

Because of their IEMG level (>30%) tensor fasciae latae and the four agonistic muscles are the main muscles in hip extension.

A MANOVA revealed significant differences between the onset times of synergistic muscles in hip extension ($F(7,91)=9.37$; $p< .01$).

The statistically significant differences between IEMG in pre- and post-intervall of tensor fasciae latae and the four agonistic muscles were scrutinized by MANOVA $F(1,98)=87.94$; $p< .001$.

Any reflex activities in antagonistic muscles could be exposed.

CONCLUSIONS

In hip extension the following sequence of muscle groups recruited in the pre-intervall, has been reported:.

1. The ipsilateral lumbar erector spinae.
2. The semitendinosus.
3. The contralateral lumbar erector spinae.
4. The innervation of tensor fasciae latae was nearly synchronous with the beginning of limb lifting.
5. The dynamic locomotor stereotype was completed by glutaeus maximus with activation evident after leg elevation.

The results of the presented study confirm former presentations of the stereotyped hip extension pattern (Janda 1984). Additionally the synergistic function of tensor fasciae latae could be shown.

In consideration to Ratov and the significant difference between IEMG of main muscles in pre- and post-interval it was concluded that ipsi-, contralateral rectus abdominis and rectus femoris are not representative for hyperextension.

The lack of reflex activities certified that the chosen velocity was reasonable.

In hip extension coactivation of tensor fasciae latae and its anatomical antagonists is present.

A theoretically possible interference of glutaeus medius activity through the electrodes over the tensor fasciae latae could be excluded by an additional measurement. This shows the importance of tensor fasciae latae in hip extension. This contribution results possibly from tractus iliotibialis tension during knee extension in co-contraction with glutaeus maximus.

In future studies the examination of movement pattern with patients with clinical symptoms like low back pain will be conducted.

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