EFFECTS OF THE DIFFERENT POSITION OF THE FEET IN SLALOM AND FREESTYLE SNOWBOARDING ON MUSCLE ACTIVITY OF KNEE EXTENSORS

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It was the purpose of this study to investigate the effect of the different position of the feet in slalom compared to freestyle snowboarding, on muscle activity of the m.rectus femoris and the m.vastus medialis when using the up-unweighting technique. Three male snowboard instructors participated in the investigation. They were experts in both snowboard styles. With a portable recorder EMG signals from the m.vastus medialis and m. rectus femoris were recorded. The knee extensors were more active in backside positions compared to frontside positions. The m. rectus femoris seems to fulfil a role in the stabilisation of the knee joint in backside positions. The m.vastus medialis seems to be important in the up-unweighting movement itself by performing a knee extension in backside position.

KEY WORDS: EMG, snowboarding, m. vastus medialis, m. rectus femoris

INTRODUCTION: Since the 1998 Winter Olympics, snowboarding has become a full-grown sport. Unfortunately, very little scientific investigations were carried out on this issue in the past (Müller, 1994; Hintermeister, Lange, O'Connor, Dillman & Steadman, 1997). As there is evidence that the awareness of movement patterns in skiing may help to reduce the incidence of injury (Kocher, Dupré & Feagin, 1998) a better understanding of the muscle activity in snowboarding can also be very useful in this context. In addition information about muscle activation in different conditions is essential for the development of programs for skill acquisition, appropriate movement progression and conditioning for snowboarders. The growing popularity of snowboarding and commercial interests resulted in the development of different snowboard materials and construction principles. Nowadays two different styles can be distinguished: slalom and freestyle. In slalom, hard boots are used in combination with hard bindings to optimise the contact between boots and board. Slalom boards are stiff and small to enable full control of the board at high velocities. Because of the narrow width, the feet are pointing towards the nose of the board. In freestyle, soft boots and bindings are placed in a transverse position towards the longitudinal axe of the board. The large boards are flexible and allow the boarder to make spectacular jumps and figures in the air or on the slope. Although skiing helped snowboarding in the production progress of the boards, skiing and snowboarding techniques are totally different as a consequence of the traverse position on the board in snowboarding. This traverse standing has two important consequences. Firstly, there is a backside and frontside position while making turns. Secondly, a front and a rear leg must be distinguished, both fulfilling different function while snowboarding. To maintain balance, a snowboarder has to lean with his bodyweight towards the centre of the turn. As a result, the projection of the centre of gravity will be at the toe side of the board in frontside position and at the heel side of the board in backside position. This may result in different muscle activity patterns. The muscles at the backside of the body are expected to be more active in frontside position, while in backside position the muscles at the frontside of the body are expected to be active. It was the aim of this study to investigate whether the different materials and the specific position of the feet in each style result in different muscle activity patterns in the m.vastus medialis and the m.rectus femoris, when sliding or making turns using the up-unweighting technique.

METHODS: The subjects were three well-trained male snowboard instructors. All of them were experienced in freestyle as well as in slalom. Their descriptive characteristics were (mean ± SD) age = 25 ± 3yr, height = 1,78m ± 0.05m, mass = 73 ± 4kg. The raw EMG was recorded with a portable eight-channel recorder and with pre-amplifier bipolar surface electrodes. A

potentiometer detected changes in the knee angle during snowboarding. It was attached on the first EMG channel. By this, the signals of the potentiometer were automatically synchronised with the data from the EMG recorder. The investigation took place on an indoor ski slope with real snow. In consequence, the gradient of the slope, snow conditions and temperature remained constant during the whole investigation. The m. rectus femoris and m. vastus medialis were selected to see if the different position of the feet on the boards had any reflection on muscle activity of these knee extensors. The potentiometer was attached at the knee of the leg of which muscle activity was recorded. The subject executed two runs with the same snowboard equipment. In each run, four turns were executed, two frontside and two backside turns. According to the data of the potentiometer, the up-unweighting technique was analysed and chronologically divided into six phases: the first phase is called the “sliding phase in frontside position”. In this phase, the snowboarder leans on the toe edge of the board. His knees and ankles are bent, the axes through his pelvis and shoulders are in a perpendicular position towards the longitudinal axe of the board. After sliding, an extension movement is carried out in the knees and ankles to release the board from pressure. This phase is called “the extension phase in frontside position”. Immediately after the extension the board is turned over from toe side to heel side. The snowboarder bends his knees again, leans on the heel side of the board and tries to steer it in the desired direction. This phase is called the “steering phase in backside position”. Those three phases together are called the “backside turn”. Phase four, five and six are similar to phase one, two and three respectively but are performed in the frontside turn, were the board is turned over from heel side to toe side. The mean IEMG was calculated for the three phases of each turn. As all subjects carried out four frontside and four backside turns, four analogue sets of data were recorded for each subject. If one of those four values deviated from the three others, it was rejected. By this, sufficient and reliable trials could be averaged. To compare muscle activity between freestyle and slalom or between frontside and backside turns, mean muscle activity of all phases in all turns was averaged for both styles. For each individual and each specific muscle the EMG activity was expressed as a percentage of the average total activity.

RESULTS AND DISCUSSION:

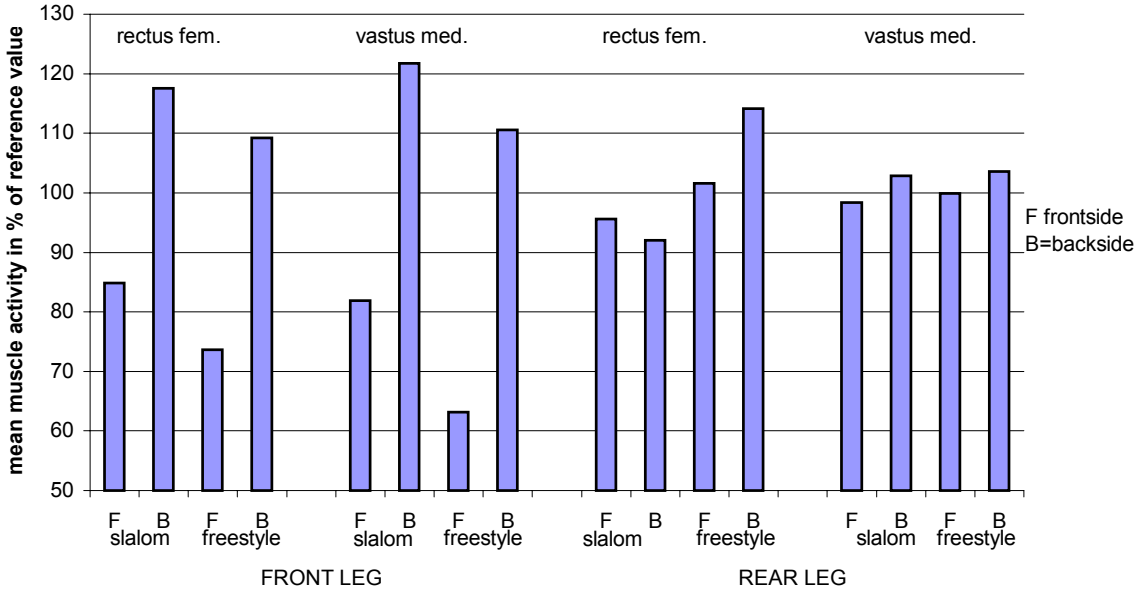

Figure 1 - Mean muscle activity of the m. rectus femoris and m. vastus medialis while sliding in frontside and backside position for slalom and freestyle.

The sliding phase was selected to compare muscle activity in frontside and backside position (Figure 1). In this phase, the boarder finds himself in a stable position of rather long duration. It

was hypothesized that muscles at the front side of the body are more active in backside positions compared to frontside positions. This is clearly confirmed when the activity of the m. rectus femoris and m. vastus medialis of the front leg is considered (Figure 1). It is remarkable that differences between muscle activity in front and backside position are small in the rear leg. To compare muscle activity in slalom and freestyle and in the front and the rear leg, data of the m. vastus medialis and the m. rectus femoris were analysed. In the **front leg**, activity patterns are similar in both styles (Figure 2). In general, slalom seems to demand more muscle activity than freestyle for both muscles, but most differences are rather small. Peak values for both muscles are shown in the extension phase in backside position.

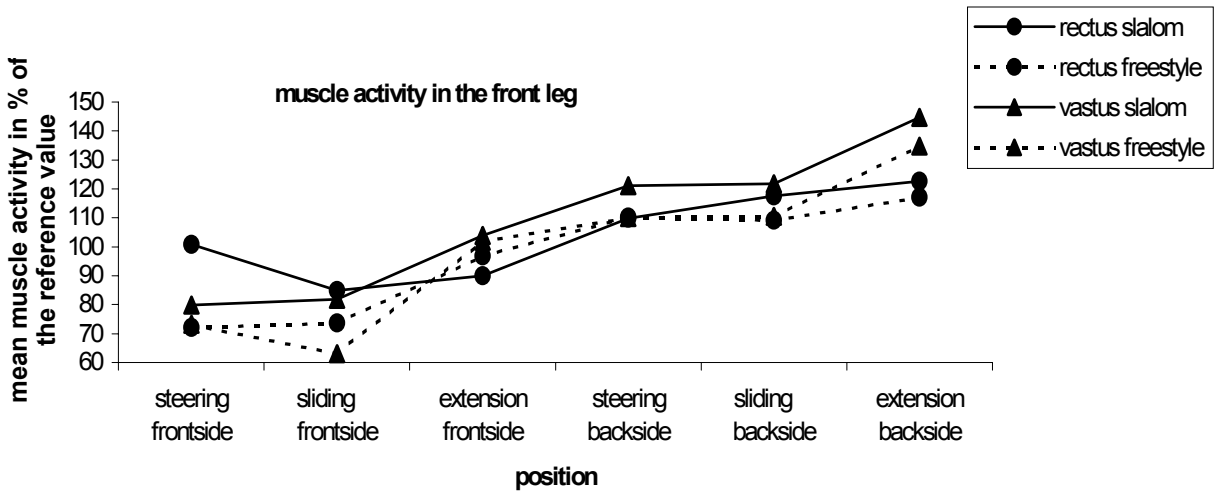

Figure 2 - Mean muscle activity of the m. rectus femoris and m. vastus medialis of the front leg in different phases of the turn.

These results can probably be explained by the fact that the extension movement in the knee in backside position is not supported by an extension in the ankle joint. In the extension phase in backside position, activity levels of the m. vastus medialis are higher compared to activity levels of the m. rectus femoris (Figure 2). Perhaps, the m. rectus femoris, as bi-articular muscle, is used to stabilise the angle in the knee and hip joint, while the m. vastus medialis is responsible for the up-unweighting movement itself.

When muscle activity in the **rear leg** is considered, similar activity patterns were found for slalom and freestyle (Figure 3). In frontside positions, little differences in muscle intensity occur between both styles. In backside positions, the m. rectus femoris and m. vastus medialis of the rear leg show higher activity levels in freestyle than in slalom (Figure 3). Perhaps, this is due to the different position of the feet on the board. With a traverse position towards the longitudinal axe in freestyle, while the feet are pointing towards the nose of the board in slalom. This different position of the body has important consequences. In slalom, the body is kept above the board, resulting in a projection of the centre of gravity of the snowboarder close to the heel edge in backside positions. In freestyle, this projection will be at larger distance from the edge, resulting in higher activity levels in freestyle, for the knee extensors in backside positions, compared to slalom.

When activity patterns between the two investigated knee extensors is compared, it is remarkable that, once again, activity of the m. vastus medialis of the rear leg increases faster from steering to extension phase in backside position than activity of the m. rectus femoris, especially in freestyle (Figure 3). The conclusions for the rear leg are similar to those of the front leg: it seems that the m. vastus medialis is used to realise the extension, while the m. rectus femoris takes care of stabilisation.

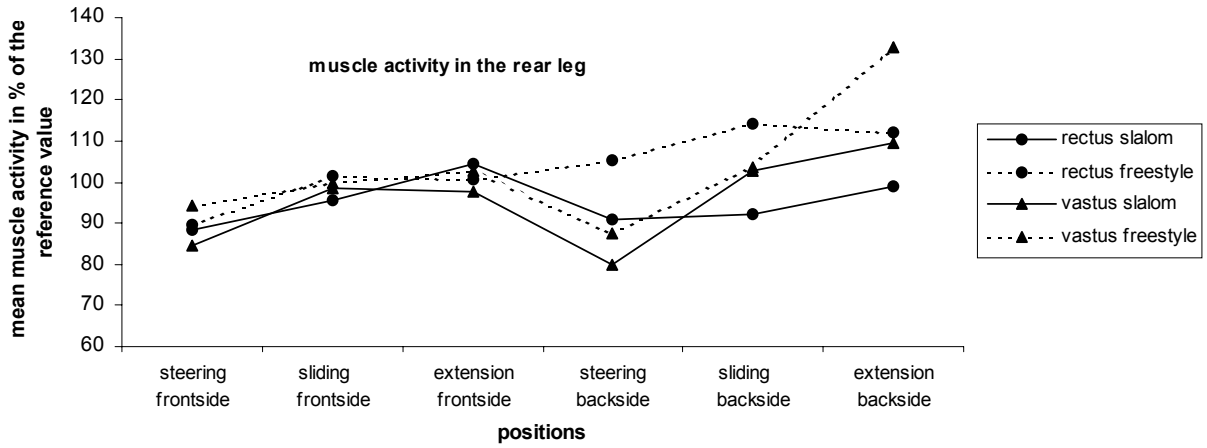

Figure 3 - Mean muscle activity of the m. rectus femoris and the m. vastus medialis of the rear leg in different phases of the turn.

CONCLUSION: Leaning with the bodyweight towards the centre of the turn results in a higher muscle activity from the knee extensors in backside positions compared to frontside positions. In freestyle snowboarding, the rear leg is placed in a more traverse position compared to slalom. Hereby the projection of the centre of gravity will be at further distance from the base of support in freestyle than in slalom. This could be the reason why the largest differences in activity of the knee extensors between slalom and freestyle were found in the rear leg. In this context freestyle snowboarding demands more muscle activity than slalom.
In snowboarding, sliding is a stable position. It seems as if the m. rectus femoris is an actor in the control of a correct body position. Following to the sliding phase, an extension in the knees and ankles is carried out to release the board from pressure, which makes it possible to turn the board. The m. vastus medialis plays an active role in this movement.

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