INFLUENCE OF DIFFERENT SNOWBOARD MATERIAL ON MUSCLE ACTIVITY AROUND THE ANKLE JOINT

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This study investigates the influence of different snowboard materials, freestyle versus slalom, on muscle activity around the ankle joint, when using the up-unweighting technique. With a portable recorder EMG signals from the m. gastrocnemius (GAS) and m. tibialis anterior (TA) were recorded. As expected, highest activity levels were found for the m.GAS in frontside positions and for the m.TA in backside positions. In general, freestyle demands more muscle activity than slalom, probably because of the use of soft boots. Due to the traverse position of the feet on a snowboard, the muscle activation in the front and the rear leg was compared in freestyle and slalom. Only for the m.GAS, different activity patterns were found between the front and the rear leg which could indicate that both legs fulfil a different function in the up-unweighting technique.

KEY WORDS: EMG, snowboarding, m. gastrocnemius, m. tibialis anterior

INTRODUCTION: During the last three decades snowboarding developed from an exotic sport attraction to an Olympic event in 1998. Despite its Olympic recognition there is still a total lack of scientific data on snowboarding technique. The few studies that were published until now mainly concerned the injury risk attended with snowboarding (Kocher, Dupré & Feagin, 1998). As there is evidence that the awareness of movement patterns in skiing may help to reduce the incidence of injury (Hintermeister, Lange, O'Connor, Dillman, & Steadman, 1997) a better understanding of the muscle activity in snowboarding can 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, in the same way as in skiing (Müller, 1994). It may also have applications in equipment design. Due to the rapid evolution in snowboard materials two general styles of snowboarding have been developed: slalom and freestyle. In slalom, hard boots are used on small, stiff boards. These elements allow the boarder to make carved turns at high speed on the slopes. In freestyle, soft boots are placed on large, flexible boards. These materials allow the boarder to make turns and figures, not only on the slopes as in slalom, but also in the air. The snowboarding technique is very different from skiing partly due to the difference in materials, but mainly as a consequence of the traverse position on the board, compared to the forward oriented position in skiing. Firstly, this traverse standing on the board results in a backside position, with the boarder leaning on his heels, or in a frontside position, when the boarder leans on the toes, while making turns. Secondly, a front leg and a rear leg must be distinguished, both fulfilling different functions in sliding and turning. The most popular turning technique in both styles is called "up-unweighting". An extension movement in the knees, ankles and hips is used to release the board from pressure. By this, it becomes possible to turn the board over from toe edge to heel edge or the other way round.
It was the aim of this study to investigate whether the use of different boards and boots results in different muscle activity patterns in m.gastrocnemius (GAS) and m. tibialis anterior (TA) when 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. All subjects could have used the same boards but the adaptation on these new materials could have influenced the results in a negative way. Because of this reason, each subject was allowed to do the tests with his own snowboard equipment. All boards were checked to see if they fulfilled to the properties of boards that are commonly used in the two different styles.
The m. gastrocnemius and m. tibialis anterior were selected to control if the use of different boards and boots had any reflection on muscle activity around the ankle joint. 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 (= up-unweighting itself) 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: To compare freestyle to slalom, differences in muscle activity between frontside and backside position, when performing the up-unweighting technique, should be noticed. The sliding phases were selected to show (Figure 1) these differences because of their longer duration. As well in the frontside as in the backside sliding phase, the snowboarder finds himself in a stable position. Muscle activity is used to keep the body in the correct position. To make carved turns, it is essential that the snowboarder can lean with his bodyweight towards the centre of the turn while sliding. This is confirmed by the data in Figure 1, indicating the higher activity levels of the m. gastrocnemius of both legs in frontside positions, where the snowboarder leans on his toes. On the other hand, the m. tibialis anterior shows a higher activity in backside positions when the snowboarder leans on his heels. This is confirmed for both legs and both snowboard styles. The differences in muscle activity between frontside and backside position are mostly small in slalom, but are large in freestyle.

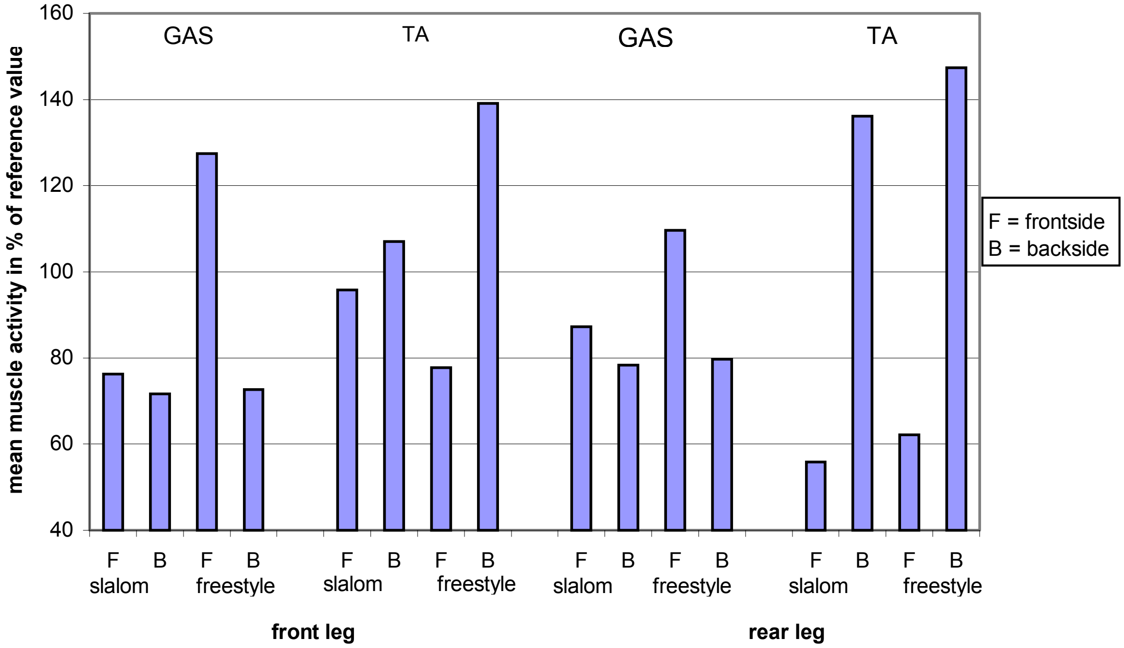
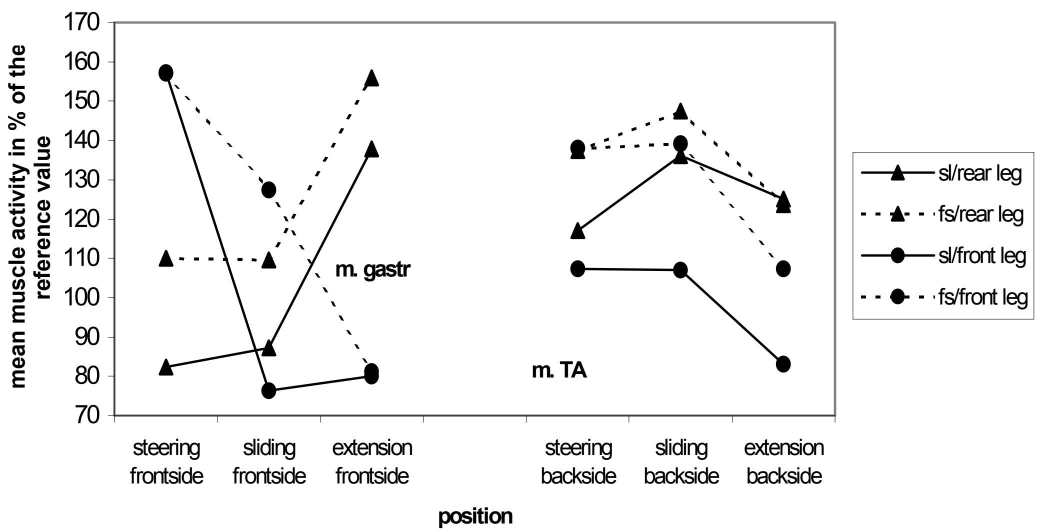


Figure 1 - Mean muscle activity of the m.GAS and m.TA while sliding in frontside and backside position.

To compare muscle activity around the ankle between slalom and freestyle, the data of the m. gastrocnemius were further analysed in frontside positions at the one hand and the activity of the m. tibialis anterior was analysed in backside positions on the other hand (Figure 2).

Figure 2 - Mean muscle activity of m.GAS and m.TA in different phases of the turn.



When analysing the data in Figure 2, in the first place, changes in activity from one phase to another are noticed. When comparing the front leg to the rear leg different activity patterns may suggest a different function. Secondly the intensity of muscle activation can be compared between slalom and freestyle. In the third place, the analysis of muscle activity from the steering phase to the extension phase can give additional information on turning technique in different snowboard styles.

When muscle activity of the m.TA is considered, it is remarkable that the same activity patterns occur in both legs and both styles. Only, the intensity is higher in freestyle towards slalom, and this in both legs (Figure 2). These results suggest that both legs fulfil the same function when the m.TA is considered. Freestyle demands more muscle activity than slalom, probably due to the deformation of the soft boots. This demands an active stabilisation of the ankle joint. Different activity patterns were found in both legs for the m. GAS. These results can be related with a major technical problem in snowboarding that is called "slipping". To avoid slipping, it is possible that both legs fulfil a different function (Figure 2), notwithstanding the material that is used. In the front leg m.GAS seems to play an active role in the steering phase of the frontside turn. Hereby m.GAS is mainly active in order to push the board into the desired track without slipping. While sliding in frontside position, it is expected that pressure is spread equally over both legs. An increase of the activity of m.GAS of the rear leg in the extension phase in frontside position, may refer to the role of this muscle in the up-unweighting movement. In the rear leg, freestyle demands more muscle activity than slalom in all frontside phases. In the front leg, only the sliding phase in frontside position demands more activity in freestyle than in slalom. Again, the active stabilisation of the ankle joint when using soft boots can be responsible for these differences.

CONCLUSION: As there is evidence that the awareness of movement patterns in skiing may help to reduce the incidence of injury (Hintermeister, Lange, O'Connor, Dillman, & Steadman, 1997) 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 (Müller, 1994). It may also have applications in equipment design.

As expected, the m. GAS showed highest activity levels when leaning on the toes, the m. TA showed highest activity levels when leaning on the heels. Furthermore, it can be concluded that freestyle demands more muscle activity than slalom which seems logical when the snowboarding technique is considered. When leaning towards the centre of the turn, soft boots will deform. To maintain balance, an active stabilisation of the ankle joint is required. When muscle activity is analysed in function of time, difference between the front and the rear leg appear for the m. GAS. The front leg is important in the steering phase, to push the board in the track without slipping. While sliding, both legs deliver approximately equal activity. The rear leg is important in the extension phase to release the board from pressure. In theory, it is assumed that in this phase, the front leg fulfils the role of rotation point and base of support. In backside positions, both legs seem to fulfil the same function, resulting in similar activity patterns of the m. TA. The decrease in muscle activity in the extension phase shows that the m.TA of both legs does not fulfil the same function as the m.GAS in this phase of the turn. The m.TA is most probably important to avoid slipping by pulling up the toes.

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