

Analysis of the Muscular Activity of Anticipation of the Deltoid in a Fall Reception Movement: Pilot Study

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Abstract

Anticipation is one of the mechanisms to limit the risk of injury upon receipt of a fall by reducing impact forces. In this anticipation, the Deltoid muscle in particular plays an important role, but its activity has not been studied in this context. The purpose of this study is to investigate the anticipatory activity of the three Deltoid heads in a falling recovery movement, the hypotheses tested are that there is a correlation between the Deltoid anticipatory activity and the impact forces, and that bilateral differences between the studied parameters exist. 4 subjects performed a forward fall simulation, from which the impact forces and muscle activity of the Deltoid heads were measured with electromyography. This study shows that the anticipation activity of the anterior Deltoid is positively correlated to the impact forces, this correlation is not found on the anticipation of the other two heads, on the other hand there is an increased impact force associated with an early impact time on the left side, in accordance with the international literature. The results suggest that Deltoid plays a major role in falls anticipation and reception, and features an asymmetric motor pattern with a first contact of the non-dominant limb to improve the damping

phase. **Introduction** In France, more than 15% of people over the age of 65 have fallen at least once in the past 6 months, and 25% are considered to be at risk of falling [1–3], and in an ever-growing population, the number of falls and its socio-economic impact is only increasing, notably linked to the numerous injuries associated with these falls, from simple contusion to major fractures of the pelvis, spine and skull .The importance of impact forces results in more than a third of falls with impact of the hands in a bone or joint injury of the upper limb, localized mostly at the distal end of the radius by direct shock, but also injuries of the shoulder by transmission of the impact force through the arm. The purpose of this study is to analyze the electromyographic activity (EMG) of the three heads of the Deltoid when anticipating a forward fall.

Materials and methods Study population

The study was carried out on a population of healthy subjects selected from students in training institutes forming a unique group of asymptomatic subjects. The inclusion criteria for this study were: being between 18 and 30 years old, having a height between 150 and 180 cm and a weight between 50 and 70 kg, not having had a fracture or surgery on the upper limbs in the previous 2 years, not having a medical condition which could cause a disorder of neuro-motor coordination or balance, and not practicing sport leading to fall reception (martial arts etc...). The EMG data collected are processed with a moving average over 100 values after centering and rectification of the signal, then normalized from the value of MVIC for each muscle and each subject. For the statistical analysis the EMG values at impact time

Extended Abstract

as well as the average values on the pre-impact phase are used.

Results

A significant correlation was found between the activity of the anterior Deltoid and the impact forces, with a correlation coefficient of 44.38% (p -value = 0.004). For the middle and posterior Deltoids the correlation tests performed, showed on Table 2 did not show significant results, the overall trend appeared to show no correlation, with respective coefficients of 11.81% and 14.59%. An increase in the activity of the anterior Deltoid was also found on the left side compared to the right side (+ 16.36%) but without statistical significance. These results indicate an increase in the activity of the left anterior deltoid and the right posterior Deltoid.

Discussion

The positive correlation found between the activity of the anterior Deltoid and the impact forces seems at first glance to contradict the findings of Lattimer et al. in 2016 [2], according to which the anticipatory muscular activity of the different muscles participating in the reception of a fall is negatively correlated with impact forces. Several hypotheses can explain this difference. To these hypotheses the current study seems to add that the subjects select a first contact systematically on their non-dominant member, thus leaving a delay after the contact of the hand to absorb the impact force, and so increasing the damping phase on this side. These results lead to the following hypothesis : this faster contact on the non-dominant side allows to move to the damping phase earlier than the dominant side, and therefore to have a longer time to recover from the fall may be necessary considering that the non-

dominant side is weaker than the other, allowing greater reception efficiency. The counterpart of this early contact of the non-dominant hand is, however, an increase in the maximum impact constraints at this time at the hand level. The objective of these asymmetrical reception strategies would therefore be to avoid contact with the trunk or head during the fall by promoting damping on the weaker side, but not to reduce the maximum stresses applied to the arm during contact with the ground.

For muscle activity, the bilateral differences are not statistically significant, except for the posterior Deltoid which has a greater value on impact on the right side compared to the left side (p -value of 0.02831), we also find an increase in the activity of the left anterior Deltoid.

Conclusion

This study made it possible to determine that there is a positive correlation between the anticipation activity of the anterior beam and the impact forces when receiving a fall, which seems to depend on the differences in force between the subjects. On the other hand, the activity of the middle and posterior Deltoids does not seem to be correlated with the impact forces, but their activity is associated with stabilization of the shoulder joint.