THE SKIER'S MUSCULO –TENDINOUS STIFFNESS: A COMPARAISON AMONG TWO DIFFERENT ATHLETIC GROUPS

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INTRODUCTION

The elastic characteristics of the muscle-tendinous unity constitute an important maker in the field of the performance control. The elastic characteristics of the muscle could be referred to as a "global type" elasticity or to a specific elasticity of the Serial Elastic Component (SEC).
In fact, in a stretch-shortening cycle (SSC), the mechanism of storage and restitution of elastic energy from the SEC would be emphasised from a muscle-tendinous unity (MTU) with optimal extensibility and stiffness. In this way it's possible to store up an acceptable elastic energy quota and in the same time be able to return it in mechanic work during the movement concentric phase.
The SEC elastic ideal characteristics would seem to be toward extensibility part of the elastic continuum (Belli and Bosco, 1992). On the contrary a better stiffness of the MTU would be significatively correlated to the concentric and isometric performance (Wilson and coll., 1994). Nevertheless these requisite could be strongly influenced from the specificity of the advised performance.
The purpose of this study was to determine the SEC elastic characteristics in two different groups of athletes: the alpine and cross-country skiers, whose sportive performance was characterised by very different neuro-muscular pattern activity.

METHODS

Two different groups of athletes have been considered: the first group was composed from 10 alpine skiers of national level (GS), whose age, weight and height were respectively 19±3 (average ± standard deviation) years, 73,3±9.4 kg and 179.4±5.0 cm, the second group was composed from 10 cross-country skiers (GC) also of national level, whose age, weight and height were respectively 19±5 years, 65.2±7.3 kg and 177.0±5.8 cm.. The muscle-tendinous stiffness of crural triceps and femoral quadriceps were calculated by means of a new test, this allow the calculation for the times of contact and flight recorded during a jump test effected on an electronic mat using the following formula (Dalleau and coll., 1998):

$$K_N = \frac{\pi\left(T_v + T_c\right)}{T_c^{\,2}\left(\frac{T_v + T_c}{\pi} - \frac{T_c}{4}\right)} \qquad [N \cdot m^{-1} \cdot kg^{-1}]$$

Were T_V was the flight time and T_C was the contact time recorded on the electronic mat.

Additionally have been effected: i) a sprint test on 30, 50 and 100 m. distance ii) two types of Rate of Maximal Isometric Force test during which have been recorded the muscular electric activity. iii) a Squatting Jump, a Counter Movement Squatting Jump and two types of Rebound Jump 10" tests

RESULTS

The skiers of the Cross Country Group presented a greater stiffness of the crural triceps in comparison to the skiers of Alpine group (497.1 $\pm$72.8 N · m^{-1} · kg^{-1} versus 383.8 $\pm$ 76.1, $p<0.001$). On the contrary the two groups didn't present stiffness differences concerning the femoral quadriceps (65.1 $\pm$ 11.1 N · m^{-1} · kg^{-1} versus 66.2 $\pm$ 11.5). In addition to the two groups considered there was no significant relationship among the listed tests and the muscle-tendinous stiffness.

DISCUSSION

These results could be explained from the difference of muscular activity required from the speciality practised from the two groups of athletes. In fact the GC group greater crural triceps stiffness could be explained from most important activation of eccentric type of this muscular groups during the specific activity. This data would be in accord with the results reported from Pousson and coll. (1990) that show as an intense eccentric work could increase the SEC stiffness. Additionally the absence of significant relationship among the listed tests and the muscle-tendinous stiffness could be caused by the fact that the muscle-tendinous stiffness could be very dependent to the specificity of the advised movements.

In a second time we have judged interesting to compare the results obtained in this first study with those obtained in a similar study effected on Sprinters and Middle Runners in Athletics (Bisciotti and coll. 1999)

The subjects considered in this study were 10 Sprinters and 10 Middle Runners of national level

The sprinters have a better quadriceps stiffness in comparison to the Middle Runners (81.17 $\pm$21.88 N · m^{-1} · kg^{-1} versus 55.51 $\pm$ 12.62 N · m^{-1} · kg^{-1}).

On the contrary the two groups didn't present statistical significance differences concerning the triceps stiffness (460.55 $\pm$53.02 versus 462.88 $\pm$ 113.43 N · m^{-1} · kg^{-1}).

The situation would seem opposite respect to that of the skiers but comparing the Sprinters whit the Alpine Skiers and the Middle Runners whit the Cross Country Skiers we could note some interesting particularity concerning their neuromuscular outline

Effectively the Sprinters presents a greater triceps stiffness in comparison to the Alpine Skiers (460.55 $\pm$53.02 versus 383.8 $\pm$ 76.1 N · m^{-1} · kg^{-1}, $p<0.05$) while there was no difference concerning the quadriceps stiffness (81.17 $\pm$21.88 versus 66.2 $\pm$ 11.5 N · m^{-1} · kg^{-1}).

This datum would confirm the triceps muscle of calf insufficient activation, chiefly of eccentric type, of the Alpine Skiers.

On the contrary the Cross Country Skiers presented a greater triceps stiffness in comparison to the Middle Runners (497.1 $\pm$72.8 N · m^{-1} · kg^{-1} versus 462.88 $\pm$ 113.43 N · m^{-1} · kg^{-1}) while there was no difference concerning the quadriceps stiffness (65.1 $\pm$ 11.1 N · m^{-1} · kg^{-1} versus 55.51.$\pm$12.62 N · m^{-1} · kg^{-1}).

This datum we could allow to advance the hypothesis of a better eccentric activation in the triceps muscle of calf for the Cross Country Skiers in comparison to the Middle Runners.

These data underline like neuromuscular characteristics are very specific and they depend strongly from the sporting practised discipline.

To conclude we want to remember then if is clearly possible to adopt training methods deriving from other sporting disciplines, is extremely necessary that these last has adapted to the neuromuscular characteristics of the advised sport and athlete.

Thank you for your attention

REFERENCES

Belli A., Bosco C. (1992) Influence of stretch-shortening cycle on mechanical behaviour of triceps surae during hopping. *Acta Physiol Scand.* 144: 401-408.

Bisciotti GN., Scanavino A. Trevisson P., Necchi P., Kratter G., Gaudino C., Sagnol JM. L'influenza delle caratteristiche elastiche dell'unità muscolo tendinea sulla risposta neuromuscolare e la capacità di equilibrio dell'atleta. Medicina dello Sport. In press

Dalleau G., Belli M., Bourdin M., Lacour J. R., (1998) The spring – mass model and the energy cost of treadmill running. *Journal of Applied Biomechanics* In press

Pousson M., Van Hoecke J., Goubel F (1990) Effect of eccentric training on the characteristics of the muscle series elastic component. *J Biomech*. 23: 343-348.

Wilson G.J., Murphy A.J., Pryor J.F. (1994) Musculotendinous stiffness: its relationship to eccentric, isometric, and concentric performance. *J. Appl. Physiol*. 76 (6): 2714-2719.