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Effect of a French Class II (18-21 mmHg) elasticated compression device on how marathon runners' muscles adapt to exertion and their ability to recover.

Effect of French class II compression socks (18-21 mmHg) on muscular adaptation and recovery of the marathoners.

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Summary

Objective: *To assess versus case control the effect of wearing a class II elastic socks (18-21 mmHg) on muscular adaptation and recovery of the marathoners.*

Methods: *This non interventional case control study was conducted during the "Marathon de Paris". Compression socks (18-21 mmHg) were proposed to marathoner who accepted to wear it during the race (Compression Sock Group, CSG) and compared to a case control group who did not wear it (Case Control Group, CCG). Marathoners had a Doppler examination before and after the race and described their feeling at the end of the race and during the 4 following days on self questionnaire (Visual Analogie scale from 0 to 100).*

Results: *86 subjects, 43 in each group were strictly comparable. They were 43 ±8 years old and 69.4% were men. They hâve no venous insufficiency and the diameter of their internal gastroenemius vein was 5.3 ± 1.5 mm. At the end of the race, compared to CCG group, CSG group described lower muscular pain, 33 ± 25 vs 49 ± 28, p< 0.01, lower muscular leg tiredness, 44 ± 21 vs 57 ± 25, p < 0.01, and lower leg swelling, 9 ± 18 vs 18 ± 22.*
The diameter of the internal gastroenemius vein was also lower 5.1 ± 1.4 mm vs 5.7 ± 1.5 mm, p < 0.05.
Data follow up showed that if pain decrease was then comparable, recovery of muscular leg tiredness was significantly improved in the ESG group (p < 0.01).

Conclusion: *Wearing compression socks may contribute to increase muscular adaptation and recovery.*

Keywords: *elastic compression, marathoners, muscular recovery*.

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Introduction

Marathon runners are prone to three types of muscle pain: muscle pain during and immediately after the race, delayed onset aches, and cramp. These types of pain come on at different times and are associated with different etiologies [i].

Pain experienced during exercise or immediately after exertion is caused by a number of factors, with the production of lactic acid the most often cited, although this is far from the only factor involved. Aches tend to come on between 12 and 48 hours after exertion and generally last 5 to 7 days, with intense and prolonged exertion tending to exacerbate the situation. After a marathon, for example, most of those taking part find they cannot walk normally for the first few days.

These aches are caused by muscular damage at cell level provoking inflammatory responses, which explains their delayed onset.

Contrary to popular opinion, they are not associated with the production of lactic acid - unlike those symptoms mentioned previously - since this is eliminated within an hour, whereas aches take a day or so to come on.

Lastly, cramps are sudden, painful contractions caused by hyperexcitation of motor neurons resulting from fluid and electrolyte disorders. These mainly involve calcium and potassium and are largely triggered by water and mineral losses associated with intense sweating over prolonged periods.

An elasticated compression device worn during exertion can help reduce the muscle pain experienced during exertion and improve recovery by facilitating the return of venous blood, reducing stasis of the toxins produced by muscular exercise, and providing an analgesic effect.

A number of athletes have reported these effects, and various studies have been conducted with a view to providing objective evidence of them, although these have often involved quite small cohorts and experimental situations far removed from people's typical experience of sport.

In order to further document the effects of wearing an elasticated compression device during prolonged muscular exertion, we are pleased to report the results of a non-interventional case/control study involving participants in the 2011 Paris marathon.

Methodology

The aim of the study was to assess, compared with a control group, the effect of wearing elasticated compression stockings (18-21 mmHg) during exertion on how the muscles of marathon runners adapt to exertion and their ability to recover.

On the day of the Paris marathon, the runners were offered elasticated compression stockings (18-21 mmHg, from Bauerfeind). Those choosing to wear them (Compression Stocking Group, CSG) were compared with a control group who did not (CG).

The elasticated compression device was only worn during the marathon in order to highlight the specific impact of wearing an elasticated compression device during exertion on recovery over the next four days.

The marathon runners underwent a Doppler examination before and after the race, with the diameter of the gastrocnemius vein being measured. They described the intensity of the pain, cramp, muscle swelling, and the muscle and general fatigue they experienced at the end of the race and during the next four days, based on visual analog scales from 0 to 100.

Descriptive analyses were performed based on the mean and standard deviation for the quantitative variables, cohorts, and percentages for the quantitative variables.

Mean values were compared using ANOVA tests and percentages compared using chi-squared tests or non-parametric equivalents where conditions required this.

Variance analyses were used to study how parameters changed during a four-day follow-up period. Analyses were based on two factors, namely time and treatment/interaction, with daily mean values being compared across the groups via Student's *t* tests.

Version 9.2 of the SAS software was used for all analyses.

The level of significance was fixed at $p < 0.05$.

Effect of a French Class II (18-21 mmHg) elasticated compression device on how marathon runners' muscles adapt to exertion and their ability to recover.

	Control group (CG)	Compression stocking group (CSG)	Chi-squared or Fisher's exact or ANOVA
Age	43.1 ± 8.7 years	42.9 ± 8.0 years	p: NS (0.9282)
Male / Female	71.4% / 28.6%	67.4% / 32.6%	p: NS (0.6900)
BMI	23.0 ± 1.7	24.2 ± 6.5	p: NS (0.2756)
Functional signs of venous insufficiency	0.0%	0.0%	p: NS
Physical signs of venous insufficiency	0.0%	0.0%	p: NS
Diameter of the gastrocnemius vein	5.4 ± 1.3 mm	5.2 ± 1.6 mm	p: NS (0.6181)
Participation before marathon	100.0%	97.3%	p: NS (1.0000)
Experience of running marathons	9.0 ± 13 years median: 4.0 years	4.8 ± 5.9 years median: 3.0 years	p: NS (0.0819)
Time taken to run this year's marathon	261.5 ± 36.9 min (4.4 h)	272.8 ± 36.1 min (4.5 h)	p: NS (0.1707)
Marathon completed	88.9%	96.6%	p: NS (0.3703)

TABLE 1: Comparison of socio-demographic characteristics and marathon-running history between case-study group and control group.

Results

The 86 patients, 43 in each group, were strictly comparable.
They were aged 43 ± 8 years, with males accounting for 69.4% of the total, and had similar experience of running marathons.
None showed functional or physical signs of venous insufficiency and the diameter of their gastrocnemius vein was 5.3 ± 1.5 mm.
Table 1 shows the various data for each group and the results of comparing the two.

Study of how muscle adapts to exertion

Around 90% completed the marathon in 4.4 hours, with no real difference between the groups. By contrast, once the race was over, the group wearing elasticated compression stockings reported less muscle pain than the control group 33 ±25 vs 49 ± 28 ($p < 0.01$), less muscle fatigue 44 ± 21 vs 57 ± 25 ($p < 0.01$), and fewer feelings of swelling 9 ± 18 vs 18 ± 22 ($p < 0.05$) (Figure 1). No difference emerged in terms of cramp or general fatigue. The diameter of the gastrocnemius vein was also smaller 5.1 ± 1.4 mm vs 5.7 ± 1.5 mm ($p < 0.05$).

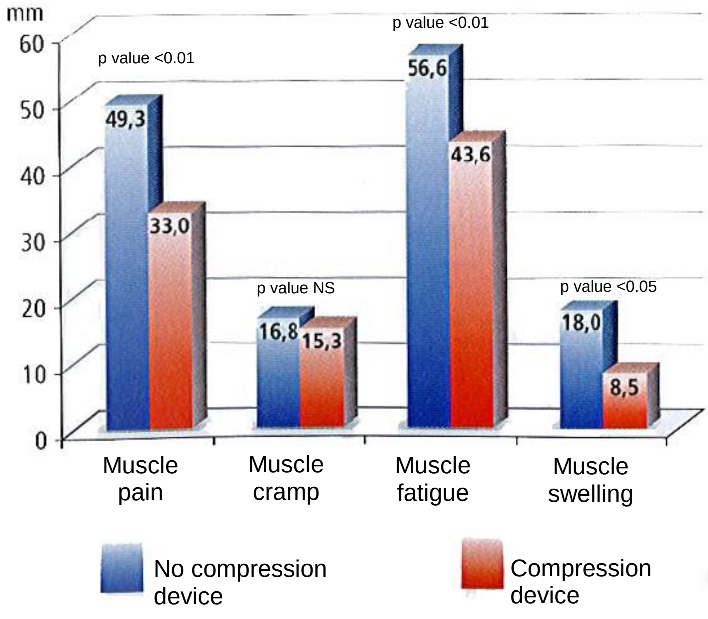

FIGURE 1: Discomfort experienced following exertion.

Study of muscle recovery following exertion

The four-day follow-up period showed how the various criteria changed during the recovery period.

After four days, muscle pain, muscle fatigue, feelings of swelling, cramp, and general fatigue were found to have almost disappeared in the two groups.

There were significant improvements in terms of speed of recovery from muscle fatigue **(Figure 2)**.

The same was true of feelings of muscle swelling, although the difference involved failed to reach the level of significance in statistical terms **(Figure 3)**. Although levels of pain were initially lower after exertion, they increased again the next day, before following a similar pattern to that experienced by the control group.

As for general fatigue and cramp, which were comparable at the end of the marathon, these decreased by almost identical amounts across the two groups.

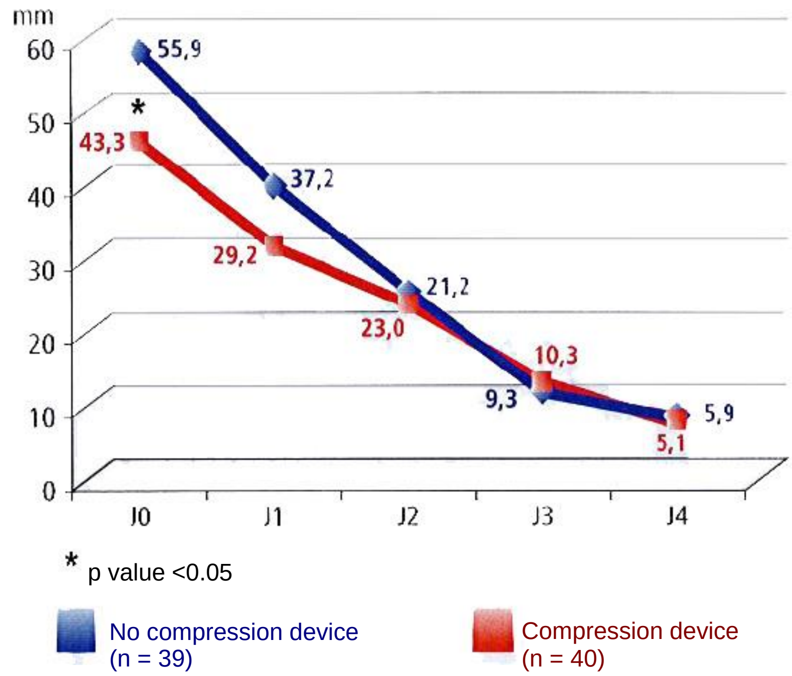

FIGURE 2: Pattern of muscle fatigue during the recovery phase (VAS from 0 to 100).

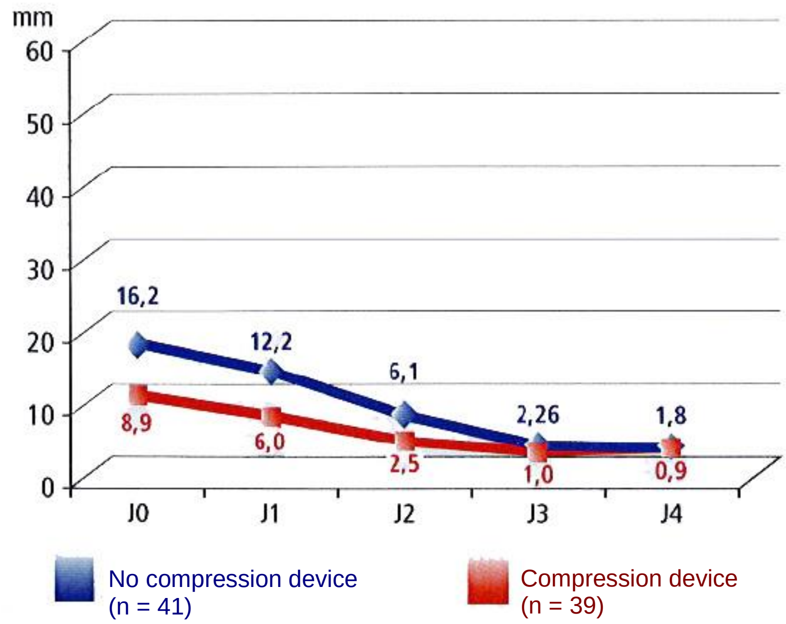

FIGURE 3: Pattern of feelings of swelling during the recovery phase (VAS from 0 to 100).

Discussion

In terms of methodology, the choice of a case/control study rather than a therapeutic trial is open to debate.

The choice was determined by a number of considerations, primarily that a clinical trial - without the option of a placebo - would have been nothing more than a randomized, open trial and therefore of limited value.

Under such conditions, the only real advantage would have been randomization, but this would have meant defining strict inclusion criteria to ensure randomization involved a sufficiently homogeneous population and produced comparable groups of at least 50 people per group in terms of the cohort size.

These conditions would not really have matched the profile of our unscreened marathon runners, so we preferred to conduct a case/control study instead to reflect this population and we put together comparable groups, a prerequisite for assessing the effect of elasticated compression devices on how the muscles of the marathon runners adapted and their ability to recover.

We would have adopted a different approach had blinding been possible.

Subject to this limitation, the results obtained both at the end of the study period and during the four-day follow-up period help illustrate the benefits of wearing an elasticated compression device during long periods of exertion and, by implication, for those involved in endurance sports.

Following their exertion, the marathon runners wearing elasticated compression devices reported less muscle pain, less fatigue, and fewer feelings of swelling, as well as a smaller diameter of the gastrocnemius vein than the control group.

These various aspects contribute to the benefit expected from improving venous return during exertion, whereby a drainage effect combats stasis of the metabolites produced by muscular work, and particularly lactic acid in the interstitial space.

This reduction in pain and muscle fatigue can help reduce the risk of having to cut short the period of exertion required and enables the athlete to deliver a final, winning push.

This hypothesis is also backed up by the work of Kemmler W. et al [2], who showed that wearing a compression device during exertion improves runners' performance in both aerobic and anaerobic terms.

The same is true of the work of Ali A. et al [3] based on people running 10 km races, who adapted better to exertion and suffered less when wearing elasticated compression devices, and the work of Chatard J.C. et al [4], where cyclists had lower concentrations of lactate and less muscle pain after exertion.

There is no doubt that the lack of effect on cramp has something to do with this being caused by electrolyte disorders associated with loss of water and minerals, where compression is already known to be irrelevant.

The effect on recovery following exertion where those concerned stop wearing their elasticated compression devices is also appreciable, and could be seen as underlining the effects experienced by those wearing elasticated compression devices throughout the recovery period.

The work of Kraemer W.J. et al [5] and Jakeman J.R. et al [6] showed that applying a compression device immediately after exertion helps reduce the intensity of aches and feelings of swelling, as well as improving recovery in terms of muscle strength.

By contrast, there is something surprising about those in the group wearing elasticated compression devices feeling pain return the day after exertion, even though this group experienced significantly less pain at the end of the marathon.

This can be explained by the fact that these kinds of pain are not the same: the pain experienced immediately after exertion is mainly caused by the presence of lactic acid, whereas the achy pain experienced later is associated with inflammatory responses secondary to muscle damage [1].

It is worth noting, however, that their pain is less intense than that experienced by the patients who did not wear elasticated compression devices, even if the difference involved does not reach the level of significance.

It would appear reasonable, therefore, to suppose that wearing elasticated compression devices during exertion improves recovery, although it is certainly necessary to continue wearing them throughout the recovery phase in order to maximize the effect in terms of recovery.

Improving the speed and quality of recovery in this way can really make a difference for those who participate in sport and physical activity at a recreational level. However, the benefits may be even greater for those semi-professional or professional athletes obliged to take part in high-level sport on a regular basis with little time between events.

There needs to be a study of the synergy effect during exertion and the recovery phase, with an emphasis on top-level athletes.

It would also be interesting to assess whether the benefits associated with wearing an elasticated compression device can be demonstrated for all types of sport, or whether the added value varies with the type of sport and the muscle metabolism it involves.

Conclusion

Wearing a French Class II (18-21 mmHg) elasticated compression device helps muscle adapt to long periods of exertion and, by implication, to endurance sports.

Wearing an elasticated compression device during exertion also has a positive effect on recovery and could provide synergy by consolidating the effect on recovery of wearing an elasticated compression device following exertion.

Acknowledgments and conflicts of interest

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