

EFFECTS OF LPG SYSTEMS® TECHNIQUE ON MOTOR PERFORMANCE IN HIGH LEVEL FOOTBALL PLAYERS

ENGLISH VERSION

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INTRODUCTION

The practice of modern competitive football induces a fairly high physical workload (cumulated competition and training). The recovery of the different muscular functions needs to be optimised and, in particular, muscular power as well as the ability to produce intense efforts that appear to be essential performance factors (Tumilty, 1993; Bangsbo, 1994). Muscular fatigue (Bosco et al, 1986 ; Komi et al, 1992) and the stiffness induced upon intensive exercise (Kyröläinen et al, 1998, Horita et al, 1999) play a significant role in the reduction of musculoskeletal efficiency and the ability to produce intense efforts. This stiffness seems to generate neuromuscular dysfunctions (Saxton et al, 1995) and, in addition, the muscular fatigue induced by physical exercise over a long period of time, hypoxic conditions and the formation of free radicals tend to produce stiffness as the result of increased lysosome activity (Appell et al, 1992).

Optimising performance often involves increasing the training workload but also improving the training tolerance that is a key factor in sports-related successes. Football is no exception to this rule. Medical and paramedical assistance significantly helps facilitate recovery between matches and training sessions. Physiotherapy techniques are extensively used although their objectives have not been clearly defined (Cafarelli and Flint, 1992 ; Rodenburg



et al, 1994; Weber et al, 1994 ; Tiidus and Shoemaker, 1995; Gullick et al, 1995 ; Tiidus, 1997). Recently, positive results were obtained regarding the fatigue and stiffness induced by intense physical exercise (Portero et al, 1996 and 1999) with a new technique designed by LPG Systems® generating movement of cutaneous and subcutaneous tissues.

This technique was included in the paramedical follow-up study of a team composed of professional football trainees. The purpose of this study was to determine with simple functional tests the effects this technique would have on strength and muscular power as well as the production of intense efforts and muscular fatigue.

MATERIAL AND METHODS

Population

Two groups including twelve (12) professional football trainees each

volunteered in the study. Players were distributed randomly in both groups. The objective of those players as they complete their training is to improve their performance and become active professionals. The population under study is presented in Table 1.

The first group (control group) received a conventional treatment (physiotherapy, stretching etc.) and the second one was treated with the LPG® technique in addition to conventional training every Monday, Tuesday, Wednesday and Thursday. Treatment was suspended on Friday and Saturday, the weekly match day.

The players trained from 12 to 15 hours every week during the study. One football match was played every week.

Material

→ The isokinetic dynamometer was of the Cybex Norm type : This dynamometer helped measure the force torques developed by the musculo-

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	Age	Weight	Stature
Control group	19.25 ± 0.4	72.6 ± 5.5	178.3 ± 5.5
LPG® treated group	20.25 ± 0.6	73.4 ± 4.7	176.9 ± 2.3

Table 1 : Characteristics of the population under study.

skeletal system and the readings were expressed in Newton x meter (N.m)

➔ **The Bosco treadmill (Power-timer)** includes a contact treadmill, photoelectric cells and a reaction time measuring element. This system allows calculating the mechanical parameters involved in jumping and, of particular interest in this study, the vertical jumping height.

➔ **The equipment used in the study was an LPG Systems® S6 model** : This model was designed to specifically mobilise muscular tissues and fascia. Tissues are exercised regularly or sequentially between motorised rollers operating in a variable volume chamber. A tissue 'wave' is thus folded and unfolded according to the therapeutic objectives of the study. The data are continuously displayed on a liquid crystal monitor operated with the main S6 module and parameters can be modified in real time.

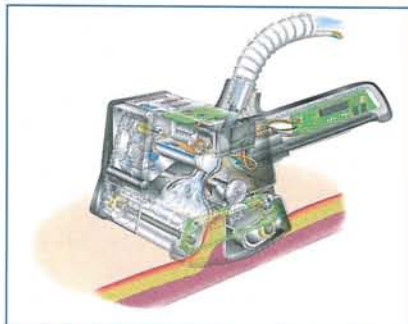


Figure 1 : LPG Systems® Model S6 main module

Protocol

The study lasted 3 weeks. Measurements were made before and after those 3 weeks. The LPG Systems® treatment was given 4 days a week.

➔ **LPG Systems® treatment** : A physiotherapist trained in the technique beforehand applied the treatment to the lower limbs for twenty (20) minutes.

The treatment was given before training sessions for scheduling reasons. Since training took place on Mondays, Tuesdays, Wednesdays and Thursdays, the players were not treated the day before weekly matches.

The S6 model was used continuously with power intensity 4.

➔ **Measured parameters** : The measurement chronology in this experimental protocol was 10 minutes warm-up on a stationary bicycle – isokinetic tests – 10 minutes rest – relaxation tests on the Bosco treadmill.

➤ **Maximum quadriceps strength** (3 extension–flexion movements of the knee at 60°.s⁻¹ angular speed) and maximum quadriceps power (5 extension–flexion movements of the knee at 180°.s⁻¹ angular speed). The speeds were selected for their functional representation. Slow angular speeds (e.g. 60°.s⁻¹) and fast angular speeds (e.g. 180°.s⁻¹) respectively are the reflection of strength and muscular power (Ivy et al, 1981). The best results were taken into account during those dynamometric tests.

➤ **Muscular fatigue** evaluated during an isokinetic test including a maximum of 25 extension–flexion movements of the knee at 180°.s⁻¹ angular speed. A fatigue index was determined from the values measured and their progressive reduction. This index was expressed as a percentage of the initial value measured at the beginning of the test.

➤ **The vertical jump test** was divided into two tests including a counter-movement jump and a squat jump respectively. Measurements were made with a Bosco treadmill according to the method described by Komi and Bosco (1978). The subjects were allowed three tries for each test. The best results were taken into account in the study.

A 5-minute rest period was allowed between each series of tests throughout the protocol and increased to 10 minutes after the isokinetic fatigue test.

➔ **Statistics** : Individual group results were compared with a Student's t test in paired series and inter-group results were compared with a single Student's t test. The significant threshold was set to P = 0.05.

RESULTS

Results are given as averages (± SEM) for 12 subjects in each group.

➔ **Muscular strength and power** : The force torques are expressed in N.m and representative either of muscular strength at 60°.s⁻¹ or muscular power at 180°.s⁻¹.

➤ **Maximum torque at 60°.s⁻¹ in N.m** (Fig. 2) : The torque values in the LPG Systems® treated group increased from 159.1 ± 17.9 to 167.7 ± 20.1 i.e. a significant 5.44% strength increase (P = 0.03).

In the control group, the torque values increased from 159.8 ± 31.3 to 164.9 ± 28 i.e. a non-significant 3.16% strength increase.

➤ **Maximum torque at 180°.s⁻¹ in N.m** (Fig. 3) : The torque values in the LPG Systems® treated group increased from 123.2 ± 15.1 to 132.8 ± 16.4 i.e. a significant 7.76% power increase (P = 0.001).

In the control group, the torque values increased from 119.8 ± 24.1 to 126.9 ± 12.6 i.e. a non-significant 5.96% power increase.

➔ **Fatigue** : The calculated fatigue indices evidenced no significant difference either between groups or from a time standpoint.

- LPG® treated group (before versus after measurements) : 68.4 ± 10.8 versus 63.2 ± 3.5

- Control group (before versus after measurements) : 63.8 ± 5.4 versus 65.9 ± 5.3.

➔ **Vertical jump test (in centimetres measured on Bosco treadmill)**

➤ **Squat jump** : There was a significant increase before and after measurements in both groups but this significance was higher in the LPG® treated group (40.9 ± 5.1 versus 43.0 ± 3.2 – P = 0.008) than the control group (40.5 ± 4.9 versus 41.5 ± 4.3 – P = 0.05).

➤ **Counter-movement jump** (Fig. 4) : An indicative increase (P = 0.09) was noted for performance in the LPG® treated group (43.8 ± 5.7 versus 45.5 ± 3.7) whereas there was no significant variation in the control group (43.9 ± 5.5 versus 43.7 ± 5.3).

➤ **Squat jump / Counter-movement jump difference** :

- LPG® treated group before and after measurements : 2.9 cm versus 2.5 cm

- Control group before and after measurements : 3.4 cm versus 2.2 cm.

A decrease in difference is noted in both cases but it is low and non-significant in the LPG® treated group, therefore enhancing its performance whereas performance

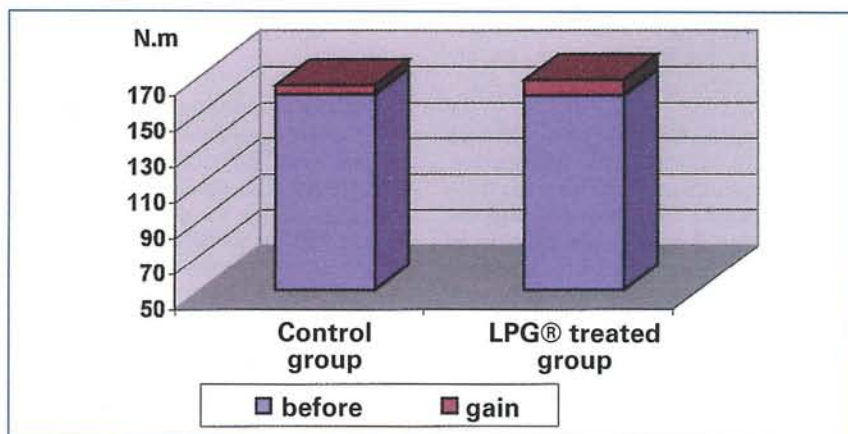


Figure 2 : Evolution of quadriceps force torques at 60°·s⁻¹ angular speed

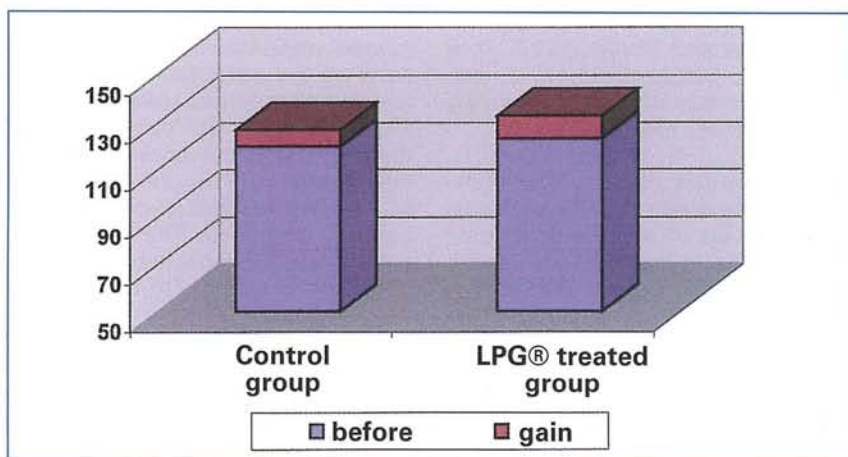


Figure 3 : Evolution of quadriceps force torques at 180°·s⁻¹ angular speed

remains unchanged in the control group.

DISCUSSION

The intensive practice of a competitive sport like football induces a fairly high workload for the body as a whole. The multiplication of competitive events associated with training makes it difficult for the players to recover between training sessions, between training sessions and matches and after matches. Facilitating recovery means improving training tolerance and, consequently, optimising the players' response in those background and technical phases. Medical and paramedical assistance was considerably developed within professional structures to meet those requirements. Every

available therapy is used while physiotherapy and re-adaptation to training, in particular, are used to counter the effects of fatigue and limit, if possible, stiffness and the dysfunctions it is causing. Numerous techniques are applied although their effectiveness and the mechanisms involved have not been clearly demonstrated. A number of studies attempted to evaluate the effects of the techniques applied to facilitate recovery from fatigue and stiffness that are the main factors contributing to the reduction in musculoskeletal efficiency. The results of those studies were at best inconsistent and contradictory, particularly as regards manual massage (Lightfoot et al, 1997; Gulick et al, 1996).

Functional overload in high level football players as well as other

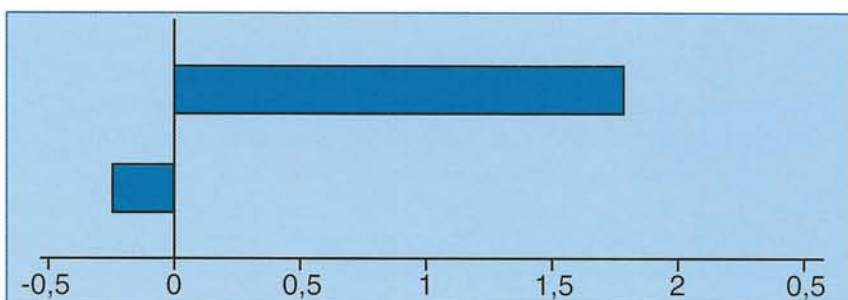


Figure 4 : Performance gained during counter-movement jumps

sportsmen induces a muscular fatigue and stiffness that reduce the ability to produce intense efforts (Bosco et al, 1986; Komi et al, 1992; Kyröläinen et al, 1998, Horita et al, 1999). Yet, this ability is essential in football players (Tumilty, 1993).

Overall, the results evidenced an improvement of the musculoskeletal functions in the LPG® treated group.

Motor control is analysed with isokinetic and vertical jump tests that help evaluate both muscular power (squat jump) and the ability to stock and spend elastic energy (counter-movement jump). As regards the initial values of isokinetic and relaxation tests, the isokinetic torques reported match the values published in previous studies (Rochcongar et al, 1998). Those authors measured torques averaging 124 N.m in 17-year old football players and 145 N.m in 24-year old football players versus 119.8 and 132.8 N.m in our study. As regards squat jump, the values in our study (40.9 to 43 cm) are lower than those (generally higher than 55 cm) published in the literature (Tumilty, 1993; Wisløff et al, 1998). These differences may be related to age or the measuring protocol used since no details were given regarding methodology in the studies involved. However, when our values are compared with those obtained during counter-movement jumps, they are found to be much lower than the values quoted above. It would thus appear that the ability to produce intense efforts was limited in the population included in our study. This was confirmed with the analysis of the difference between both types of jump that is comprised between 2.2 and 3.4 cm in our study whereas Bosco and Komi (1992) are suggesting a 6 cm average (although this was for the national Italian football team). The difference in the ability to produce intense efforts must therefore be considered as an intrinsic difference (age, motor skills, playing level etc.)

As regards the effects of LPG® treatment on those motor parameters, we noted that the isokinetic performance of the LPG® treated group was significantly improved as regards both strength (+5.44%) and power (+7.76%) whereas the increase of those criteria was not significant in the control group.

Thus, it may seem probable that this strength and power increase is partly related to a learning curve in between before and after measurements but more likely to the LPG® treatment effects.

CONCLUSION

The same findings apply for the vertical jump test and performance was significantly improved in the LPG[®] treated group. Motor performance improvement (strength, power, intense efforts) is consequently a highly significant point in professional football trainees because it was obtained during a difficult part of the season when their workload was quite heavy. In the light of the Kyröläinen et al, (1998) and Komi et al (1992) studies, one might think that the LPG[®] treatment may have had positive effects on some of the muscular fatigue and stiffness factors to explain those results, all the more since the effects of this technique on motor performance improvement, recovery from fatigue, in particular, and stiffness were demonstrated (Portero et al, 1996 and 1999). Insofar as cumulated fatigue and stiffness is a major factor interfering with the ability to stock and spend some elastic energy during stretching-contraction cycles, we can assume that the LPG[®] technique simultaneously facilitated fatigue recovery and limited stiffness. This dual effect was also perceived and expressed as easier movement during matches by the players whereas they were describing a tone reduc-

tion immediately after treatment while the technique was being applied.

The muscular fatigue tests did not show any significant difference within individual groups or between groups. This is explained by the fact that if metabolic fatigue is considered from a purely acidosis viewpoint, massage is efficient immediately after effort production (Portero et al, 1996) and, even without treatment, metabolic recovery and the return to a normal pH level takes approximately ten minutes (Allsop et al, 1990). However, since muscular fatigue is very much a multi-factor phenomenon (Enoka and Stuart, 1992), it is likely that the application of the LPG[®] technique could also have an effect on other mechanisms.

The integration of the LPG[®] technique in the medical and paramedical follow-up of professional football trainees helped improve some motor functions that are highly significant for players' performance, and this despite the fact that the study was initiated at a time in the season when sportsmen are using their full potential. Training tolerance improvement probably played a significant role too.

This study demonstrated the efficiency of LPG[®] treatment associated to conventional paramedical follow-up for high-level football players. Power and the ability to produce intense efforts, both significant performance criteria in this sport, were improved despite the physiological overload the players were being subjected to and the fact that the time in the season was not favourable to recovery. The limits of this study are the limitations inherent to high-level sport e.g. limited availability of the players on the one hand, preventing multiplying experiments or using heavier experimental equipment and field conditions on the other hand, where evidencing phenomena specifically related to fatigue, stiffness or other disorders is difficult contrarily to studies undertaken in the laboratory. Multiplying tests is a delicate problem in this case. The therapeutic strategy could probably be refined as treatment is adapted to training and the application of other techniques. Yet, despite the limitations inherent to high-level sport, this study demonstrated advantages to be directly gained from this technique as regards football players' recovery and performance.



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