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The Effects of Press Tack Needle Treatment on Muscle Soreness after Triathlon Race - Sham-controlled Study-

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Abstract

[Purpose] To examine the effect of press tack needle (PTN) treatment on muscle soreness after triathlon race in a sham (S)-controlled study.

[Methods] Subjects were 149 healthy triathletes randomly divided into 2 groups, PTN group and S group. PTN and S were placed on the L 3 to S 2 dermatome area (BL 23, BL 24, BL 25, BL 26 and BL 32) only during the race. The visual analog scale (VAS) was used to measure muscle soreness at 6 points (anterior thigh, posterior thigh, anterior lower legs, posterior lower legs, lower back and hip). Measurements were obtained before the race (PRE), after the race (POST 1), and on the day after the race (POST 2) to evaluate the effect of PTN treatment.

[Results] All of the VAS values were increased on POST 1 compared to that on PRE ($p<0.01$) for both groups. In the PTN group, the VAS values were decreased on POST 2 compared to those on POST 1 except for the buttock area ($p<0.01$, $p<0.05$), and muscles recovered to the pre-race condition. In the S group, the VAS value of the posterior thigh was decreased on POST 2 compared to that on POST 1 and the VAS values of anterior thigh, posterior thigh, and posterior lower legs were still increased on POST 2 compared to that on PRE ($p<0.05$).

[Conclusion] It was suggested that occurrence of delayed onset muscle soreness is suppressed by the use of press tack needles during the race.

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Key words: *triathlon, press tack needle, sham, muscle soreness*

Ⅰ. Introduction

When an athlete estimates one's own condition at the clinical site, subjective symptoms, such as fatigue or muscle soreness are frequently complained of. Muscle soreness can be classified as acute muscle soreness, which occurs right after exercise, and delayed onset muscle soreness (hereinafter referred to as DOMS), which occurs from a few hours to 24 hours after exercise, and reaches a peak in 24 to 72 hours. There are various views[1)] about the developmental mechanism of muscle soreness. The predominant theory is that the former is derived from the accumulation of algogenic substances, such as lactic acid or hydrogen ions, resulting from lack of local circulation, and the latter is derived from inflammation, which follows the injury of muscle fibers or surrounding connective tissue caused by extraordinary movement. Although it has been reported that acupunc-

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ture treatment prevents or relieves the occurrence of muscle soreness[2], the influence on competitive performance has not been established yet. Careful study is required regarding the characteristics of racing, quantity of stimulation associated with needling, and needling location in order to optimize athletic conditioning through the use of acupuncture treatment.

Opportunities for acupuncturists to take on the role of athletic trainer (hereinafter referred to as AT) have been increasing in recent years. There are also study results which indicate that acupuncturists form the largest number of qualified ATs working with competitive sport teams[3]. Local acupuncturist and massage therapist associations take a main role in providing AT activities for athletes by opening up acupuncture and massage corners in nationwide sporting events, such as in national athletic meets, and other such events as part of their volunteer activities[4].

There are great expectations for acupuncturists to partake in AT in the future, especially for those who have acquired medical knowledge and AT techniques because the role of AT covers various fields, such as injury prevention, first aid treatment, rapid recovery from exhaustion, and conditioning for performance enhancement.

In order to study the possibilities of conditioning by acupuncture stimulus, triathlon athletes, whose sport is considered a severe endurance sport, were used as subjects. The athletes raced with press tack needles indwelled, and the effects on muscle soreness occurring right after the race and the day after the race were studied by using a comparison group.

Ⅱ. Methods

1. Subjects and Informed Consent

This study was conducted during the triathlon race (swimming 1.5 km, bicycling 40 km, running 10 km, total of 51.5 km) held in the Nishi Lake area of Yamanashi-ken on August 11, 2001, August 10, 2002, and August 16, 2003. At the initial stage of this study, the race director notified the participating athletes that this study was going to be conducted and asked for their cooperation as subjects when recruiting participants. The total number of participants in the race was 163, consisting of males and females. The contents and methods of this study, and any adverse events that could happen were sufficiently explained orally and in writing, and in order to conduct this study the consent for cooperation in this study was granted via signatures of all of the athletes.

2. Intervention

(1) Press tack needle and sham

The pyonex needle manufactured by Seirin Co., Ltd. (needle length 0.6 mm) was used as the press tack needle (hereinafter referred to as PTN). A sham (hereinafter referred to as S), which has the same shape but without a needle tip, that causes contact pressure stimulation without invading the body, was made by the manufacturer for this purpose. Furthermore, the packaging was also made to look exactly the same as the PTN, so that the sham could not be distinguished in any way by appearance from the PTN (Fig. 1).

(2) Method of allocation

The coordinator assigned the subjects to 2 groups, the PTN group and the S group, according to a random number table, and one or the other of these was handed to the subject without revealing the content when the

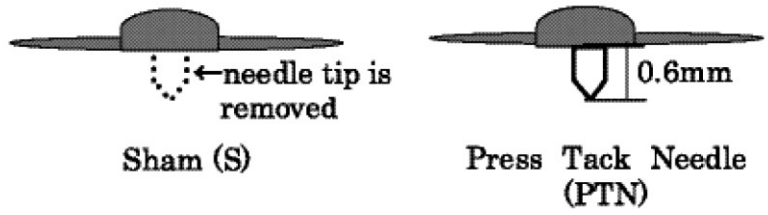


Fig. 1 The Sham (S) and the Press Tack Needle (PTN)
The sham has the same shape as the press tack needle, except for the fact that the sham has had the needle removed.

subject registered for the race.

(3) Treatment

Three full-time instructors from our school affiliated acupuncture clinic performed treatment. The practitioners did not contact the coordinators in advance, and were not involved in the allocation at all. The practitioners treated without confirming the existence or non-existence of the PTNs or S needles, which were brought in by the subjects.

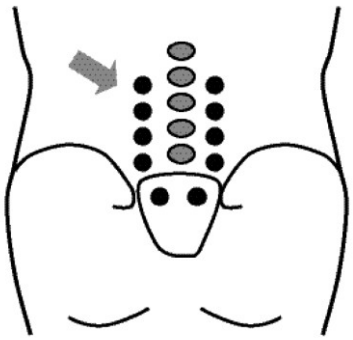


Fig. 2 Stimulus Sites
There were 5 stimulus sites on the left and right sides, for a total of 10 points, which were located 2 cm lateral to a point between the spinous processes of L 2 through S 1, and sites corresponding to the 2 nd posterior sacral foramina. The points include: BL 23, BL 24, BL 25, BL 26, and BL 32.

(4) Stimulus sites

The stimulus sites were a total of 10 points that were located on the left and right side, 2 cm lateral to a point between the spinous processes of L 2 through S 1, and the 2 nd posterior sacral foramina which correlates with the posterior branch of the spinal nerves that are the same level as the nerves innervating the muscles of the lower extremities. These were BL 23, BL 24, BL 25, BL 26, and BL 32 (Fig. 2). In addition, the treatment was performed just before the start of the race, and the PTNs or Ss were removed immediately after crossing the finish line with the objective of indwelling the patches only during the race in order to quantify the amount of stimulus.

3. Survey Items

The subject's age, athletic career, height, weight, and medical history were surveyed by questionnaire before the race. Furthermore, 6 sites were surveyed in respect to lower extremity muscle soreness resulting from over-straining during triathlon racing: (1) anterior thigh (quadriceps femoris), (2) posterior thigh (hamstring muscles), (3) anterior crus (anterior tibialis), (4) posterior crus (gastrocnemius, soleus), (5) lower back (erector spinalis, lumbar quadratus, etc.), and (6) buttocks (glute-

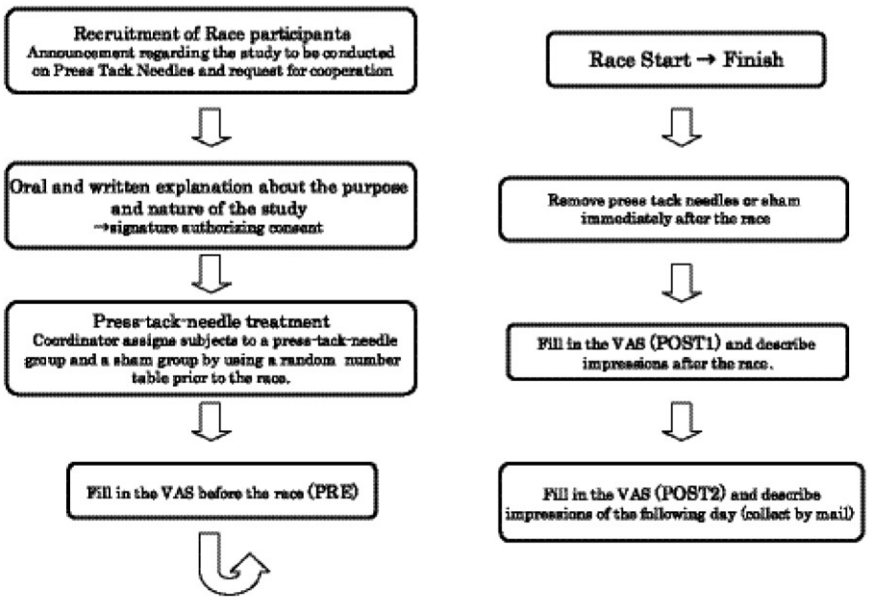


Fig. 3 Study Flow Chart
This illustrates the flow of the entire study.

us maximus, gluteus medius, etc.). It was decided to conduct the survey 3 times: (1) before the race (hereinafter referred to as PRE), (2) immediately after the race (POST 1), corresponding with the onset of acute muscle soreness, and (3) the day following the race (POST 2), corresponding with the onset of DOMS. The visual analogue scale (hereinafter referred to as VAS) was used for the assessment of muscle soreness. In the VAS, the left end of the 100 mm black line was established as "No pain" in respect to muscle soreness, and the right end was established as "Unbearable pain". It was decided that the degree of perception should be checked on the line[5]. Processing of the VAS values involved measuring the length from the left end to the marked point in mm units, expressed numerically. Accordingly, the VAS value becomes larger as "muscle soreness become more severe". In addition, the VAS was directly input by the subject with the assistance of a race volunteer. The subject answered with his/her own supposition whether the attached item was a PTN or as S, and described his/her impressions at POST 1 and at POST 2 in a free format. The flow of the entire study is shown in Fig. 3.

4. Statistical Analysis

Stat View 4.5 (product of Abacus Concepts) and SPSS 11.5 J (product of SPSS) were used in the statistical analysis.

A significance test was conducted using the t-test between the PTN group and the S group for age, height, weight, and athletic career. The kappa statistic was used regarding the reliability of S for PTN. Transition of the VAS values before the race, immediately after, and the day following were compared using the replicate determination analysis of variance and the multiple comparison (Bonferroni). In addition, the chi-square test was used for the impressions immediately after the race and the day following. The evaluation of the statistically significant difference was considered a significance level of less than 5%.

Table 1. Background of Subjects
No significant difference was recognized between these groups.

Item	PTN Group	S group
Number(name)	79	70
Age(yrs)	28.5± 10.7	27.3± 8.5
Height(cm)	169.6± 7.4	169.2± 8.5
Weight(kg)	61.7± 7.4	60.7± 9.0
Athletic career(yrs)	4.7± 3.9	4.9± 4.6

Ⅲ. Results

1. Background of the Subjects (Table 1)

There were 149 subjects who were eligible for this study out of 163 who participated in the race, excluding retired athletes and individuals whose responses to the survey were somewhat incomplete, making it impossible to work with statistically. The breakdown (mean ± standard deviation) of the PTN group was as follows: total 79 subjects, including 67 male and 12 female; age 28.5 ± 10.7 years; height 169.6 ± 7.4 cm; weight 61.7 ± 7.4 kg; and athletic career 4.7 ± 3.9 years. The S group consisted of a total of 70 subjects, including 14 females and 56 males, with an age of 27.3 ±8.5 years old, height of 169.2 ± 8.5 cm, weight of 60.7 ± 9.0 kg, or an athletic career of 4.9 ± 4.6 years. No significant difference was recognized between the 2 groups in respect to age, height, weight, and athletic career. Moreover, in the previous medical history, the number of subjects who experienced low back soreness was 13 in the PTN group (including 1 subject with a herniated lumbar disk) and 12 in the S group (including 1 subject with sciatica); and knee joint pain was 13 subjects in the PTN group and the S group, respectively; and ankle sprain was 2 subjects in the PTN group and 3 subjects in the S group.

2. Reliability of Sham as a Press Tack Needle (Table 2)

In the PTN group, 34 subjects answered that the attached needle was a PTN, and 45 subjects answered that the attached needle was an S. In the S group, 54 subjects answered that the attached needle was as S, 16 subjects answered that the attached needle was a PTN, and the kappa value was 0.20.

3. Changes in the VAS Value of Muscle Soreness (Table 3)

(1) PTN group

The change in the VAS values at PRE, POST 1, and POST 2 were measured, and it was found that the VAS value increased in the order of PRE to POST 1 with a significance ($p<0.001$). The VAS values for all parts of the body except for the buttock area decreased when comparing values at POST 1 with POST 2, demonstrating a significant difference ($p< 0.05$). In addition, no

Table 2. Reliability of the Sham for the Press Tack Needle
It is possible that the subject's judgment regarding the assignment showed a low incidence because the kappa value showed a low value of 0.20; in other words, it is believed that it is difficult for subjects to distinguish whether the attached items are PTNs or Ss.

Item		Assignment P	PTN	計
Subjects responses	S	54	45	99
	PTN	16	34	50
	Total	70	79	149

Probability of Identification (Po)=59.1%

Probability of Identification by Chance (Pe)=49.0% Kappa= 0.20

Table 3. VAS Values before the Race, Immediately after the Race, and the Day following the Race
The VAS values of POST1 increased compared with the VAS values of PRE in all parts of the body for both groups ($p<0.01$). The VAS values for POST2 decreased in the anterior thigh, posterior thigh, anterior lower extremity, posterior lower extremity and buttock area compared with the VAS values for POST1 in the PTN group ($p<0.01$), and the posterior thigh of the S group ($p<0.05$). In the PTN group, no difference was recognized in the VAS values for POST2 with the values of PRE for all parts of the body, but the VAS values for POST2 in the anterior thigh, posterior thigh, and posterior lower extremity demonstrated significantly higher values than the values of PRE in the S group ($p<0.05$).

Press Tack Needle (PTN) Group (n=79)

Region	PRE	POST1	POST2
Anterior Thigh	32.1± 24.2	48.4± 22.0**	36.0± 24.9##
Posterior Thigh	32.2± 23.6	47.0± 20.6**	30.9± 22.5##
Anterior Lower Leg	25.8± 18.9	40.4± 23.5**	30.5± 22.4##
Posterior Lower Leg	32.7± 23.1	49.0± 24.2**	35.1± 24.6##
Lower Back	37.8± 24.5	46.8± 24.1**	37.5± 24.2##
Buttocks	31.4± 22.6	40.3± 22.4**	32.8± 22.4

Sham (S) Group (n=70)

Region	PRE	POST1	POST2
Anterior Thigh	30.2± 23.0	41.9± 24.2**	38.1± 22.8*
Posterior Thigh	25.6± 19.7	41.6± 25.1**	33.0± 21.3*#
Anterior Lower Leg	25.5± 21.7	35.4± 23.3**	28.9± 20.6
Posterior Lower Leg	30.0± 23.0	43.3± 26.4**	36.7± 25.6*
Lower Back	30.3± 22.6	37.8± 23.0**	33.2± 21.8
Buttocks	28.0± 21.1	35.9± 23.0**	34.4± 21.0

**: The VAS value significantly increased compared to the value of PRE ($p< 0.01$)
* : The VAS value significantly increased compared to the value of PRE ($p< 0.05$)
##: The VAS value significantly decreased compared to the value of POST1 ($p< 0.01$)
: The VAS value significantly decreased compared to the value of POST1 ($p< 0.05$)

significant difference was recognized between POST 2 and PRE for any areas of the body.

(2) S group

In the S group, the VAS values increased for all parts of the body when comparing the values at PRE to POST 1, resulting in a significant difference ($p<0.01$). The VAS values of the posterior thigh decreased when comparing the values at POST 1 to POST 2 resulting in a significant difference ($p< 0.05$). The VAS values of POST 2 compared to PRE were higher in the anterior thigh, posterior thigh, and posterior lower extremity, resulting in a significant difference ($p<0.05$). In the buttock area, VAS values at POST 2 showed a high tendency compared to the values of PRE ($p=0.08$).

4. Impressions

(1) Impressions immediately after the race

Thirty subjects out of 79 in the PTN group and 22 subjects out of 70 in the S group described their impressions after the race. The impressions described were classified into the 5 categories : "No low back soreness, not as sore as usual", "Light fatigue", "Heavy fatigue", "Felt uneasy about needles", and "Have no idea" for comparison. In the PTN group, the impression of "No low back soreness, not as sore as usual" was described by 12 subjects; "Light fatigue" was described by 12 subjects; "Heavy fatigue" was described by 1 subject; "Felt uneasy about needles" was described by 1 subject and "Have no idea" was described by 5 subjects. On the

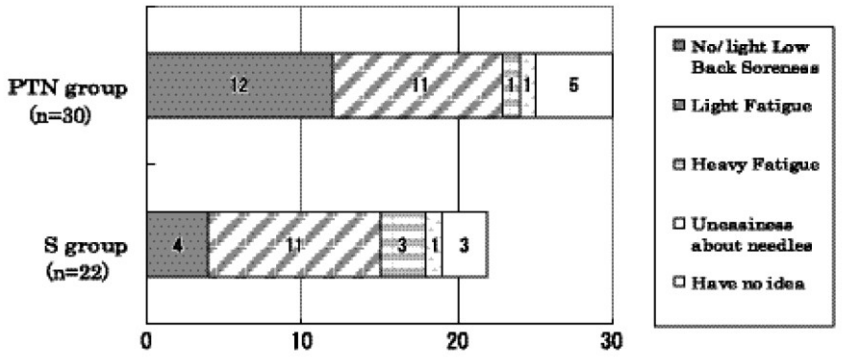
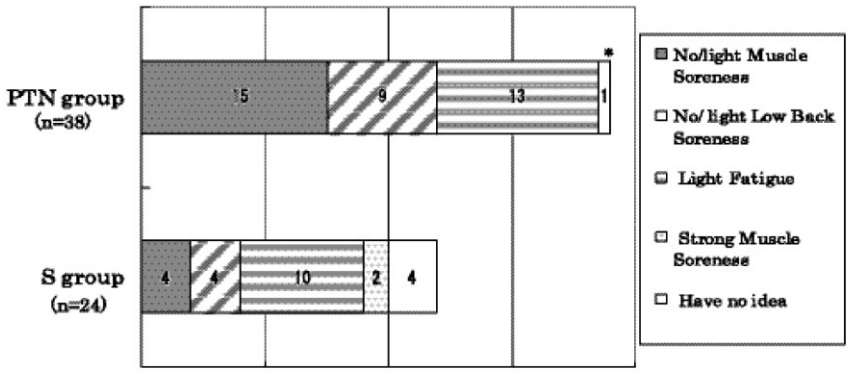


Fig. 4 Impressions Immediately Following the Race
There were not any differences recognized in either of the groups immediately after the race.



* :Press tack needle group demonstrated a significant difference compared to the sham group. ($p< 0.05$)

Fig. 5 Impressions on the Day Following the Race
At POST 2, impressions, such as "Low back soreness is not as sore as usual, or no soreness" and "Light fatigue" were described significantly more frequently in the PTN group than in the S group ($p<0.05$).

other hand, in the S group, "No low back soreness, not as sore as usual" was described by 4 subjects; "Light fatigue" was described by 11 subjects; "Heavy fatigue" was described by 3 subjects; "Felt uneasy about needles" was described by 1 subject; and "Have no idea was described by 3 subjects (Fig. 4).

(2) Impressions regarding the day following the race

Thirty eight subjects in the PTN group and 24 subjects in the S group described their impressions on the day following the race. The impressions described were classified into the 5 categories : "No muscle soreness, light muscle soreness", "Low back soreness that is less than usual, or no soreness", "Light fatigue", "Strong muscle soreness", and "Have no idea" for comparison. In the PTN group, "No muscle soreness, light pain" was described by 15 subjects; "Low back soreness that is less than usual, or no soreness" was described by 9 subjects; "Light fatigue" was described by 13 subjects, "Strong muscle soreness" was described by 0 subjects; and "Have no idea " was described by 1 subject.

On the other hand, in the S group, impressions were described as: "No muscle soreness, light soreness" by 4 subjects; "Low back soreness that is less than usual, or no soreness" by 4 subjects; "Light fatigue" by 10 subjects; "Strong muscle soreness" by 2 subjects; and "Have no idea" by 4 subjects. The PTN group and the S group demonstrated a significant difference ($p<0.05$) (Fig. 5).

Ⅳ. Discussion

1. Action Mechanism and Muscle Soreness Control Effects of the PTN

We studied the effects of PTN stimulation during exercise on muscle soreness after exercise. Previous studies suggest that there are various influences on exercise resulting from PTN stimulation. Ueno et al. reported that the PTN indwelled during exercise accelerates the synchronization of motor units accompanied with the muscle contraction[6-8], and the author et al. have confirmed that the metabolism of lactic acid in the blood in the initial period of exercise was accelerated[9] by PTN indwelling in the low back and buttock area when a maximal exercise stress test was conducted by cycle ergometer. In addition, Sugiyama et al. reported that the lowering of muscle strength was controlled when the isokinetic extension and flexion exercise of the knee joint was performed under the above described stimulation[10,11]. In a previous study on these PTNs, Kusumoto et al. reported that the recovery of muscle twitching of the gastrocnemius muscle, which had been reduced after tetanic contraction, could be accelerated by needling on the paravertebral muscle in the rat, and this mechanism was caused by the excitation of the sympathetic vascular expansion nerve by the somatic autonomic nervous reflex[12]. Stimulation with acupuncture in this report is performed on the muscle branch of the posterior branch of the spinal nerve. It is believed that stimulation with PTN, which performed on the cutaneous branch of the posterior branch of the spinal nerve, may induce the somatic autonomic nervous reflex based on the same mechanism as the stimulation on the motor branch. The VAS values at POST 1 increased in all the parts in both groups compared with PRE, and the effects of PTN for acute muscle soreness were not recognized. Although some participants reported that acute muscle soreness was sedated by PTN stimulation at POST 1, no difference with the S group was recognized. It is thought that a reason for this is that promotion of blood circulation in the lower extremities by PTN intervention could not exert a sufficient effect because of the notable production of chemical substances and their accumulation, which led to acute muscle soreness due to the intense exercise involved in the triathlon race. On the other hand, it is believed that the PTN stimulation contributed to the sedation of the DOMS occurrence because the VAS values of POST 2 decreased significantly compared with the values from POST 1 in all parts except the buttock area in the PTN group. There were many impressions of "less muscle soreness" or "less fatigue" than the day following the other races, and a significant difference compared with the S group was recognized. In respect to the effects on DOMS occurrence by needle stimulation, there are reports in which needle stimulation performed on active muscle before and after exercise results in lessened DOMS[13,14], and it is believed that these effects are derived from an increase in muscle blood flow through the axon reflex[15,16]. Although it is believed that sedation of the development of DOMS in the low back in this study includes the axon reflex because of the correspondence between the parts being stimulated and the parts experiencing soreness, the sedation of DOMS in other remote parts cannot be explained by the axon reflex alone. Analgesic action of needle stimulation also reveals the intervention of endogenous opioids[17]; however, the stimulation in this study was only performed during the race, and, moreover, it is difficult to suppose

that the influence on the DOMS occurring the next day would be that serious because the stimulus quantity was extremely small compared to the stimulus quantity used in so-called acupuncture analgesia. It is conjectured that the burden on the muscle fiber during racing is reduced by the intervention of the PTN, which accelerates synchronization of the motor unit, and as a result, the secondary inflammation occurring in the muscle and surrounding connective tissue is alleviated, and thus the development of DOMS is prevented. It is plausible that the occurrence of DOMS could interfere with training or a game, so in the future we would like to further study the region and timing of the stimulation, in order to establish a methodology which would more effectively prevent the occurrence of DOMS.

2. Adverse Events

In this study, 1 subject complained of uncomfortable feeling, and 1 subject experienced heavy fatigue. On the other hand, in the S group we heard from one person that s/he worried about the needle during the race and from three people who became strongly aware of exhaustion. Moreover, in the S group, there were two people who complained of feeling more fatigue and muscle soreness than usual. According to our experience, well-trained athletes are very sensitive to changes in their physical condition, and it is also frequently observed that they change their condition by a small amount of needle stimulation. Therefore, it seems that those who felt uncomfortable or who worried about the needles did so because of their original high sensitivity, and they over reacted in the race situation, a situation that induces a lot of nervous tension or psychological effects. In addition, the possibility of PTN stimulation reaching the level of an overdose for the subject cannot be denied, but it is thought that such an impression could have been given because of muscle fatigue, which was within the physiological range and psychological factors were overlapping due to the fact that the triathlon is a very strenuous competition and that fatigue and muscle soreness during the race or on the day following the race are usual. When conditioning the athlete in the field, the onset of adverse events should be prevented by carefully paying attention to the observation of physical and psychological aspects.

3. Applications in the Field

According to this study, it is thought that PTN should not just be used temporarily for improving physical ability in important races; rather it should also be used continuously during daily training. It is supposed that an athlete stays in good condition by suppressing muscle soreness after training, by preventing injury, and by reducing fatigue; and furthermore, it can be said that speeding up the recovery from fatigue is associated with improving the quality and quantity of training.

Ⅴ. Conclusion

The muscle soreness on the day following a race was controlled by the press tack needle stimulation on the low back and buttock area during the triathlon race. It is believed that continuous use of the press tack needle during a race or in daily training can contribute to effective training because it alleviates the burden on the low back and lower extremities, and improves the athlete's condition.

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