A NOVEL PHYSICAL THERAPY METHOD OF TREATING MYOFASCIAL PAIN DUE TO MUSCLE SPASM AND SHORTENING

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ABSTRACT

AIM: Evaluation of the effect of a novel physical therapy method - post-isometric relaxation taping (PIR-taping) - compared with the effect of a conventional postisometric relaxation (PIR) in the treatment of outpatients with myofascial pain as a result of muscle spasm and shortening of static muscles, resulting in muscle imbalance.

PATIENTS AND METHODS: The study recruited 320 outpatients with myofascial pain due to muscle spasm and shortening, resulting in muscle imbalance in one of 8 kinetic segments. We treated randomly 8 groups of 20 patients by PIR and 8 matched groups by PIR-taping. The treatment consisted of one procedure daily (PIR or PIR-taping) with duration of 10 minutes for 10 working days. The pain was assessed by a visual analogue scale before and after each procedure.

RESULTS: The pain decreased significantly after the treatment course in each group (p < 0.05), but no difference was found between any pair of groups (p > 0.05). The pain before the next PIR procedure tended to increase in comparison with the pain after a previous one, unlike the pain in PIR-taping treatment which tended to decrease. Pain intensity after PIR procedure decreased significantly compared with the pain after a previous one (p < 0.05), while in PIR-taping – after two previous procedures (p < 0.05). Treatment with PIR increased pain significantly during the weekends (p < 0.05), while in treatment with PIR-taping the pain decreased insignificantly during the weekends (p > 0.05). The pain reduced significantly after PIR procedure (p < 0.05), as well as after PIR-taping procedure (p < 0.05). The pain after PIR procedure was significantly lower than that after PIR-taping procedure (p < 0.05), although the pain before PIR procedure was statistically equal with the one before PIR-taping procedure (p > 0.05).

CONCLUSION: Despite the better short-term effect of PIR versus PIR-taping, there was no difference between the final results of both methods, due to the continuous (24-hour) effect of PIR-taping.

Key words: treatment, pain, muscle, imbalance, spasm, shortening

INTRODUCTION

Physiological muscle imbalance could be cause or consequence of many activities of daily life in healthy individuals: low physical activity, vicious statics (improper postures/positions) and vicious dynamics (improper daily living activities).1 Without frequent relaxation of the corresponding static muscles with shortening and spasm, it worsens and could turn into pathological muscle imbalance2, which in turn could be the cause or consequence of many diseases such as: a) musculoskeletal disorders (scoliosis, sprains, strains, distortions, dislocations, fractures, myositis, tendinitis, tendomyositis, insertionitis, epicondylitis, periostitis, periarthritis, osteochondrosis, osteoarthri-
tis, dischondrosis, discarthrosis, disc protrusion/hernia, spondylosis, arthritis, spondylarthrosis, myofascial syndrome, radicular syndrome, pseudo-radicular syndrome, algo-dystrophic syndrome etc.); b) diseases of the central or peripheral nervous system (neuritis, neuralgias, plexitis, radiculitis, radiculalgia, stroke, multiple sclerosis, Parkinson’s disease, myelitis, polio, cerebral palsy, etc.); and c) other disorders (traumas, surgical disorders, respiratory, cardiovascular, digestive disorders, etc.). Without frequent relaxation of the corresponding static muscles with shortening and spasm, the pathological muscle imbalance could cause vicious cycle, leading to frequent exacerbations, chronic diseases and invalidation.
The most effective treatment of muscle imbalance is post-isometric relaxation (PIR) of static muscles with shortening and spasm.\textsuperscript{1,2} PIR has an analgesic effect comparable to that induced by no-vocaine infiltrations.\textsuperscript{2} Stretching is another muscle relaxation method mainly used in healthy subjects and athletes. However, none of the high quality randomized and controlled clinical trials in this field showed any positive effects of stretching.\textsuperscript{3} The most significant disadvantage of all known muscle relaxation methods is their temporal effect. Shortly after each relaxation procedure the static muscles begin to shorten progressively. To maintain the effect, multiple daily procedures are required, interrupting the rest, recreation, activities of the daily living, work activities, sports etc.

Kinesio-taping is a relatively new method in which elastic adhesive waterproof tape is used in traumatic injuries, ensuring a relative hypo-mobility of injured segments, assisting the injured muscles, or supporting disturbed lymph drainage.\textsuperscript{3} Unfortunately, kinesio-taping is not suitable for muscle relaxation and even could accelerate the shortening of static muscles when they are taped. Moreover, there is insufficient evidence to corroborate the use of kinesio-taping.\textsuperscript{5}

The novel method we propose herein, calling it „postisometric relaxation taping“ (PIR-taping), combines the advantages and reduces the disadvantages of PIR and kinesio-taping for the purpose of treating nonstop (24-hour) myofascial pain due to muscle spasm and shortening of static muscles resulting in muscle imbalance. This method of treatment requires no interruption of the rest, recreation, daily living activities, work activities, sports etc. For this purpose, an elastic waterproof tape similar to that used in kinesio-taping, is used as an aid in PIR-taping. Unlike kinesio-taping, in which the tape is placed non-selectively on static and dynamic muscles, in PIR-taping it is applied selectively on flabby dynamic muscles, which are antagonists to the static muscles with shortening and spasm. Thus, PIR-taping corrects the muscle imbalance through continuous minimal shortening of the flabby and weak dynamic muscles (agonists and antagonists) and exerting continuous minimal stretching on the static muscles (agonists) which are spastic and shortened. For periodic reinforcement of the effect, additional PIR-taping procedures similar to those in PIR are performed. The main difference is that the minimal resistance against the voluntary contraction is exerted by the elastic tape (in PIR-taping) instead of the hand of the therapist (in PIR).

The aim of our randomized controlled trial was evaluation of the effect of a novel physical therapy method - post-isometric relaxation taping (PIR-taping) - by comparing it with the effect of conventional postisometric relaxation (PIR) in the treatment of outpatients with myofascial pain due to muscle spasm and shortening of static muscles resulting in muscle imbalance.

**PATIENTS AND METHODS**

The study was carried out in the outpatient department of the Clinic of Physical Medicine and Rehabilitation at the Alexandrovska University Hospital, Sofia. We recruited 320 outpatients over 18 years of age. The inclusion criteria were myofascial pain due to muscle spasm and shortening of static muscles, resulting in muscle imbalance in one of the following 8 kinetic segments: 1) hand; 2) forearm; 3) arm, 4) shoulder girdle; 5) foot; 6) leg; 7) thigh; 8) spine. The various clinical pictures, locations, irradiations and characteristics of the myofascial pain syndrome, specific to each of the many muscles involved in the movement of these kinetic chains, had been extensively described by many authors, but the most frequently cited are Janda\textsuperscript{1} and Lewit\textsuperscript{2}. The exclusion criteria were neurologic deficits, surgery during the previous year, structural abnormalities, osteoporosis, severe infections or decompensation (cardiovascular, pulmonary, hepatic, renal, etc.). Each of the resulting 8 groups of 40 patients was randomized (by a computer generator – “Block Stratified Randomization Windows Free Version 6.0”) into two equal parts, treated by PIR or PIR-taping as follows:

We treated by PIR 20 patients in 8 groups, with muscle imbalance between: 1) shortened flexors versus flabby extensors of the hand (age 48.20 ± 12.67); 2) shortened flexors and pronators versus flabby extensors and supinators of the forearm (age 50.75 ± 10.53); 3) shortened flexors, adductors and internal rotators versus flabby extensors, adductors and external rotators of the arm (age 50.50 ± 10.63); 4) shortened upper retainers versus flabby lower retainers of the shoulder girdle (age 48.55 ± 15.14); 5) shortened flexors and pronators versus flabby extensors and supinators of the forearm (age 50.75 ± 10.53); 6) shortened flexors versus flabby extensors of the leg (age 48.50 ± 13.26); 7) shortened flexors, adductors and internal rotators versus flabby extensors, adductors and external rotators of the thigh (age 49.00 ± 10.08); 8) shortened extensors versus flabby flexors of the spine (age 48.75 ± 12.27).

PIR-taping was used to treat 8 matched groups
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of 20 patients with muscle imbalance between: 9) shortened flexors versus flabby extensors of the hand (age 49.15 ± 12.31); 10) shortened flexors and pronators versus flabby extensors and supinators of the forearm (age 49.05 ± 16.95); 11) shortened flexors, adductors and internal rotators versus flabby extensors, abductors and external rotators of the arm (age 49.70 ± 11.02); 12) shortened upper retainers versus flabby lower retainers of the shoulder girdle (age 51.10 ± 10.99); 13) shortened flexors and pronators versus flabby extensors and supinators of the foot (age 50.30 ± 11.17); 14) shortened flexors versus flabby extensors of the leg (age 47.80 ± 11.85); 15) shortened flexors, adductors and internal rotators versus flabby extensors, abductors and external rotators of the thigh (age 49.70 ± 12.42); 16) shortened extensors and supinators of the foot (age 51.55 ± 14.58).

The treatment consisted of one procedure daily (PIR or PIR-taping) with duration of 10 minutes for 10 working days. The algorithm of PIR-taping was the following:

II. “Tension” – slow and minimal stretch of the spastic and shortened muscle.
III. “Taping” – an elastic waterproof tape (Temtex® Kinesiology Tape, www.towatekkora.com) was stuck on the flabby dynamic muscles which are antagonists of the shortened static muscles-agonists.
IV. “Repositioning” – after assuring a good adhesion of the tape, the position was returned to normal. The patient was instructed to keep the tape dry for at least 30 minutes.
V. “Re-taping” – step I to step IV were repeated 3 times for 12 days because the sticking durability of the tape was 4 days.
VI. “Boosting procedure” – once daily we performed a minimal isometric contraction of the spastic/shortened muscle against the minimal resistance of the elastic tape for 14 sec., after which a complete relaxation was required for 21 sec. This contraction-relaxation cycle was repeated 3-5 times for every muscle with shortening and spasm.

Before and after each procedure the pain was assessed on a visual analogue scale (VAS). For this purpose we used a ten-centimetre horizontal line, whose left end corresponded to lack of pain and the right end – to maximal pain. The patient made pencil marks on this line that corresponded to the intensity of pain. The pain was quantified in centimetres.

Statistical analysis

ANOVA with alpha = 0.05 was applied on the following three statistical models: I. One-way ANOVA on 16Gx2R (16 groups of patients by 2 results, before and after the treatment course); II. One-way ANOVA on 20Rx2T (20 results, before and after each of the 10 procedures, by 2 therapies, PIR and PIR-taping); III. Two-way ANOVA on 2Rx2T (2 results, before and after procedure, by 2 therapies (PIR and PIR-taping). All pairwise multiple comparison procedures (Bonferroni’s method) were used to isolate the cluster that differed from the others.

RESULTS

I. The results from the first statistical model (16Gx2T) suggested that the differences in the mean values among the 32 clusters were statistically significant (F = 61.7, p < 0.0001, Power = 1.0, alpha = 0.05) (Fig. 1). The Bonferroni’s method showed that in each of the 16 groups there was a significant pain reduction after the treatment course (p < 0.05), but there was no difference between each pair of groups (p > 0.05) (Fig. 1).

II. The results from the second statistical model (20Rx2T) indicated that the differences in the mean values among the 40 clusters were statistically significant (F = 190.8, p < 0.0001, Power = 1.0, alpha = 0.05) (Fig. 2). The Bonferroni’s method showed that:

II.1. A single PIR procedure had an immediate effect, while a single PIR-taping procedure had none. The pain reduced significantly after each PIR procedure as compared with that prior to it: after the 1st procedure vs. that before it (DM = 0.86; t = 6.22; P = 0.05), after the 2nd procedure vs. that before it (DM = 0.77; t = 5.58; P < 0.05), after the 3rd procedure vs. that before it (DM = 0.74; t = 5.36; P < 0.05), after the 4th procedure vs. that before it (DM = 0.74; t = 5.36; P < 0.05), after the 5th procedure vs. that before it (DM = 0.76; t = 5.52; P < 0.05), after the 6th procedure vs. that before it (DM = 0.88; t = 6.41; P < 0.05), after the 7th procedure vs. that before it (DM = 0.70; t = 5.10; P < 0.05), after the 8th procedure vs. that before it (DM = 0.58; t = 4.19; P < 0.05), after the 9th procedure vs. that before it (DM = 0.55; t = 3.97; P < 0.05) (Fig. 2). The reduction of pain was not significant after PIR-taping procedure as compared with that before it (P > 0.05) (Fig. 2).

II.2. The pain before the next PIR procedure...
showed a tendency to increase in comparison with the pain after the previous one, while in PIR-taping – a tendency to decrease (Fig. 2). Pain increased significantly before the 3rd as compared with that after the 2nd PIR procedure (DM = 0.73; t = 5.36; p < 0.05), as well as before the 6th in comparison with the pain after the 5th PIR procedure (DM = 2.01; t = 14.59; p<0.05). Between the other corresponding pairs of PIR procedures the pain increased, but not significantly (p > 0.05) (Fig. 2). The pain before the next PIR-taping procedure decreased insignificantly versus the pain after the previous one (p > 0.05) (Fig. 2).

II.3. PIR reduced the pain for a shorter period than PIR-taping:

II.3.1. In PIR treated patients pain decreased significantly comparing the following consecutive days: day 2 vs. day 1 (after the 2nd vs. after the 1st procedure) (DM = 0.52; t = 4.10; p < 0.05), day 4 vs. day 2 (after the 4th vs. after the 2nd procedure) (DM = 0.90; t = 7.07; p < 0.05), day 5 vs. day 3 (after the 5th vs. after the 3rd procedure) (DM = 0.91; t = 7.13; p < 0.05), day 8 vs. day 4 (after the 6th vs. after the 4th procedure) (DM = 0.92; t = 7.19; p < 0.05), day 9 vs. day 5 (after the 7th vs. after the 5th procedure) (DM = 0.90; t = 7.03; p < 0.05), day 10 vs. day 8 (after the 8th vs. after the 6th procedure) (DM = 0.89; t = 6.98; p < 0.05), day 11 vs. day 9 (after the 9th vs. after the 7th procedure) (DM = 0.82; t = 6.42;
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p < 0.05), and day 12 vs. day 10 (after the 10th vs. after the 8th procedure) (DM = 0.86; t = 6.76; p < 0.05) (Fig. 2).

II.4. In the treatment with PIR the pain increased significantly during the weekends – from day 5 to day 8 (after the 5th PIR procedure vs. after the 6th PIR procedure) (DM = -1.13; t = -8.18; p < 0.05), so on day 8 (after the 6th PIR procedure) and on day 3 (after the 3rd PIR procedure) the pain was statistically equal (DM = 0.03; t = 0.18; p > 0.05) (Fig. 2). In treatment with PIR-taping the pain decreased insignificantly during the weekends (p > 0.05) (Fig. 2).

II.5. At the end of the two-week therapeutic course (after the last procedure) there was no difference in pain level in patients treated by PIR vs. those treated by PIR-taping (DM = 0.05; t = 0.42; p > 0.05) (Fig. 2).

III. The results from the third statistical model (2Rx2T) showed full statistical interaction between the four clusters:

III.1. The differences in the mean values for pain between the different levels of PIR/PIR-taping were significant after allowing for the effect of differences before and after the procedure (F = 10.9, p < 0.001, Power = 0.902, alpha = 0.05). The Bonferroni’s method showed that the mean values of pain in patients treated with PIR (mean 2.73 ± SEM, 0.0148) was lower than in patients treated with PIR-taping (2.86 ± SEM, 0.0148) (DM = -0.138, t = -3.30, p < 0.05).

III.2. The differences in the mean values of pain between the different levels before and after the procedure were significant after allowing for the effects of differences in PIR/PIR-taping (F = 124.8, p < 0.001, Power = 1.0, alpha = 0.05). The Bonferroni’s method indicated that pain after the procedure (2.56 ± SEM, 0.0148) was significantly lower than before procedure (3.03 ± SEM, 0.0148) (DM = -0.468, t = -11.2, p < 0.05).

III.3. The effect of different levels of pain before/after procedure depended significantly on those in PIR/PIR-taping procedure (F = 33.0, p < 0.0001, Power = 1.0, alpha = 0.05). The Bonferroni’s method showed that pain intensity decreased significantly after the PIR procedure.

Figure 2. Means and standard errors of pain assessed by VAS before and after each of the 10 procedures of the 2-week treatment course with PIR and PIR-taping.

VAS – visual analogue scale; PIR – postisometric relaxation; PIR-T – postisometric relaxation taping
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(\(DM = -0.708, t = -11.96, p < 0.05\)), as well as after
the PIR-taping procedure (\(DM = -0.227, t = -3.84, p < 0.05\)). The pain after PIR procedure was sig-
ificantly lower than that after PIR-taping proce-
dure (\(DM = -0.379, t = -6.40, p < 0.05\)), although
the pain before PIR procedure was statistically
equal with the one before PIR-taping procedure
(\(DM = 0.102, t = 1.72, p > 0.05\)) (Fig. 3).

DISCUSSION

The first and the second statistical models revealed
that PIR and PIR-taping were equally effective
after a two-week treatment course. Therefore, the
choice to use PIR or PIR-taping doesn’t depend on
their effectiveness, but rather on their advantages.
The most important advantage of PIR-taping is the
continuous maintaining of the effect. PIR-taping
could be preferred when performing of procedures is
problematic. An additional advantage is a better op-
portunity of self treatment of PIR-taping procedures
than PIR procedure because it uses the resistance
of the elastic tape instead of manual counteraction.
Moreover, PIR-taping is more applicable in children,
because they cannot produce adequate voluntary
contractions. PIR-taping could be a method of
choice when performing of PIR-taping (necessary for
PIR) is problematic, i.e. in unconscious, immobi-
lized, bedridden, emaciated, mentally ill patients,
etc. PIR-taping could substitute procedures which
cannot be performed during holidays.

The second and the third statistical models
showed that the immediate effect of PIR procedure
is significant. The second statistical model revealed
that the immediate effect of PIR-taping procedure
was insignificant, while the third statistical model
proved that it was statistically significant. This
could be explained by the higher number of val-
ues in each cluster in the third versus the second
statistical model. Therefore, every procedure with
PIR or PIR-taping has a positive immediate ef-
fect, but it is relatively more pronounced in PIR
versus PIR-taping. This was proved by the third
statistical model. The most probable reason for the
difference of the immediate effect between PIR and
PIR-taping was the different type and degree of
the resistance against the muscle contraction during
the corresponding procedure. In PIR the resistance
was realised by hand, while in PIR-taping – by
elastic tape. The degree of resistance was relatively
higher in manual resistance compared with the
elasticity of the tape.

The second statistical model revealed that after
a single PIR procedure and during days without
PIR procedures, the pain tended to increase. This
constant trend for recurrence of the condition con-
firmed the concept of Janda\(^1\) and Lewit\(^2\) for the
natural deterioration of muscle imbalance. On the
other hand, the second statistical model established
that after a single PIR-taping procedure and dur-
ing days without PIR-taping procedures, the pain
tended to decrease. This positive tendency could
be due to the continuous (24-hour) stretching effect
of the tape. In addition, this nonstop effect could
explain why the results were statistically equal at
the end of the two-week treatment course, despite
the better and faster immediate effect of PIR versus
PIR-taping.

In PIR-taping the stretching on static muscles
with shortening and spasm is minimal but continuous
(for 24 hours). It does not interfere with the daily
living activities as the elasticity of the tape allows
free muscle contractions and joint movements. The
nonstop stretching of the elastic tape prevents the
tendency towards shortening and spasm of the static
muscles not only at rest but also during muscle
contractions. Upon contraction some of the muscle
fibres are contracted while others are dormant. Part
of the dormant muscle fibres are stretched by the
contracting muscle fibres, leading to stretch of these
„resting” fibres, i.e. the number of the elongated
fibres is increasing. After muscle contraction, part
of the muscle fibres are elongated, others are not.
Moreover, some of the muscle fibres are elon-
gated by the stretching effect of the tape before

Figure 3. Means and standard errors of pain assessed by
VAS before and after procedure with PIR or PIR-taping.

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contraction. This overcomes the stretch reflex and initiates relaxation, inhibiting the elongated fibres from contraction. At the next contraction some fibres are contracted, some are relaxed and those that are pre-stretched are further elongated. These pre-inhibited fibres tend to further elongate due to „resetting“ of their initial length as a result of the corresponding habituation of the muscle spindles. In addition, the elastic tape facilitates the contraction of the flabby dynamic muscles, which in parallel with the relaxation of the static muscles with shortening and spasm produces combined remedial effect on the muscle imbalance. The analgesic effect of PIR-taping could be due to the effect of muscle relaxation, the respective increased range of motion of the joints, improvement of the local blood supply, accelerated elimination of metabolic products inducing pain (i.e. substance-P), as well as enhanced production of endorphins and other endogenous analgesic substances.

The results from the current trial support the results from previous studies on the pain relieving effect of PIR in myofascial pain due to muscle spasm and shortening of static muscles resulting in muscle imbalance. The new method PIR-taping is used for the first time in this study.

CONCLUSIONS

The new method PIR-taping we used in this study has comparable effects to those induced by PIR, but combines the advantages of PIR and kinesio-taping in treatment of outpatients with myofascial pain due to muscle spasm and shortening of static muscles resulting in muscle imbalance. The major advantage of PIR-taping is the continuous (24-hour) effect. PIR-taping does not obstruct the daily living activities and there is no need to interrupt the rest. On the contrary, it facilitates them by its constant pain relieving effect. An additional advantage is a better opportunity for self treatment with PIR-taping because it uses the resistance of the elastic tape instead of manual counteraction. Moreover, PIR-taping is more applicable in children because they cannot produce adequate voluntary contractions. PIR-taping could be a method of choice when voluntary contraction (necessary for PIR) is problematic, i.e. in unconscious, immobilized, bedridden, emaciated, mentally ill patients, etc. PIR-taping could substitute procedures which cannot be performed during holidays.

REFERENCES

Новый физиальный метод лечения миофасциальной боли в результате мышечного спазма и укорочения статичных мышц

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Резюме

Цель: Оценить эффект применения нового физиального метода („постизометрический релаксирующий тейпинг“ /ПИР-тейпинг/), сопоставляя его с эффектом применения конвенциональной постизометрической релаксации /ПИР/ для лечения амбулаторных пациентов с миофасциальной болью в результате мышечного спазма и укорочения статичных мышц, приводящих к мышечному дисбалансу.

Пациенты и методы: Рекрутировано 320 амбулаторных пациентов с миофасциальной болью в результате мышечного спазма и укорочения статичных мышц, приводящих к мышечному дисбалансу в одном из 8 кинетических сегментов. Рандомизировано 8 групп по 20 больным с ПИР и 8 сходных групп с ПИР-тейпинг. Лечение состояло из одной процедуры в день /ПИР или ПИР-тейпинг/ продолжительностью 10 мин, в течение 10 рабочих дней. Боль оценивалась с помощью визуально-аналоговой шкалы до и после каждой процедуры.

Результаты: Боль значительно уменьшилась после лечебного курса в каждой группе /р < 0.05/; разница между одной парой групп не установлена /р < 0.05/. Боль до последующей ПИР процедуры показывает тенденцию к увеличению по сравнению после предыдущей /р < 0.05/, в то время как при ПИР-тейпинге после двух предыдущих процедур /р < 0.05/. При лечении с помощью ПИР процедуры боль увеличивается значительно во время выходных /р < 0.05/, в то время при лечении с помощью ПИР-тейпинга боль уменьшается незначительно во время выходных /р < 0.05/. Боль уменьшается значительно после ПИР процедуры /р < 0.05/ и после ПИР-тейпинг процедур /р < 0.05/. Боль после ПИР процедуры значительно меньше по сравнению с болью после ПИР-тейпинг процедур /р < 0.05/, несмотря на то, что боль до ПИР процедуры статистически одинакова с болью до ПИР-тейпинг процедур /р < 0.05/.

Заключение: Несмотря на лучший кратковременный эффект ПИР процедуры по сравнению с ПИР-тейпинг процедурой, разница в окончательных результатах между обоими методами не наблюдается, что объясняется непрерывным 24-часовым эффектом ПИР-тейпинг процедуры.