Chapter 3

Diagonal Trunk Muscle Exercises In Peripartum Pelvic Pain

a randomized clinical trial

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Abstract

Background and Purpose. Muscle exercises in low back and pelvic pain are dualistic. Enlarging muscle force theoretically benefits the patient, but the exercises to achieve this goal could exacerbate symptoms by excessive loading of the spinal and pelvic joints. The purpose of this study is to investigate the value of graded exercises of the diagonal trunk muscle systems.

Subjects. The subjects were 44 women with persistent pelvic pain after pregnancy (mean age = 31.7 years SD = 3.2, mean period postpartum = 4.1 months, SD = 2.2).

Methods. Patients were randomized to be treated with 1) exercises to strengthen the diagonal trunk muscle systems, 2) or training of the longitudinal trunk muscle systems, 3) or were instructed to refrain from exercises. Effect was assessed by measuring pain, fatigue, perceived general health, and mobility of pelvic joints on X-rays.

Results. After 8 weeks treatment no important differences were found between the results of the three treatment groups.

Conclusion and Discussion. In treating patients with persistent pelvic pain, training of the diagonal trunk muscle systems, without individual coaching, has no additional value above instructions and a pelvic belt without exercises. It seems that the exacerbation of symptoms due to loading of the spinal and pelvic joints overrules the potential profit gained by enlarged muscle force.

Introduction

Pain in the lumbar spine and pelvic region frequently complicates pregnancy and delivery; the reported cumulative nine-month incidence during pregnancy ranges from 48-56%.[1-4] In retrospective studies among young and middle-aged women with chronic low back pain, 10-28% state that their first episode of back pain occurred during pregnancy.[5,6]

Many hypotheses on the pathogenesis of peripartum pelvic pain (PPPP) focus on decreased stability of the pelvic girdle. In these hypotheses it is assumed that stability is provided on the one hand by the coarse texture of the sacro-iliac (SI) cartilage surfaces, the complementary ridges and grooves and the undulated shape ("form closure"),[7-9] and on the other by compressive forces of muscles, ligaments and the thoracolumbar fascia ("force closure").[7-13] Muscles which generate a force perpendicular to the SI joints and/or increase tension on the sacroiliac ligaments and/or thoracolumbar fascia could contribute to force closure.[8-13] The external and internal abdominal oblique muscles (anterior diagonal trunk muscle system), the latissimus dorsi, the transversospinal parts of the erector spinae (especially the multifidus) and the gluteus maximus (posterior diagonal trunk muscle system) seem to be appropriate for this task.[8-13]

From this perspective it seems obvious that training of the diagonal muscle systems will benefit persons with PPPP, partly by increase of muscle force and endurance, partly by better awareness and recruitment.[8,9-13] In daily practice we experienced that many patients recover after this therapy. It remained unclear, however, whether success was due to increased stability by increased force of the diagonal trunk muscles, or to spontaneous recovery, placebo effects or applied co-interventions. It was not totally excluded that recovery was delayed by those exercises because enlarging muscle force theoretically benefits the patient, but the exercises to achieve this goal could exacerbate symptoms by excessive loading of the spinal and pelvic joints.[14] The purpose of this study is to investigate whether the results of treatment of peripartum pelvic pain with graded exercises of the diagonal trunk muscle systems are better than results without these exercises.

Methods

Study population

Participants were selected from 1248 patients who, (during a period of 2.5 years), contacted the outpatient clinic of the Institute of Rehabilitation Medicine of the University Hospital Rotterdam. They received by post a brochure with information about PPPP and a questionnaire about their medical history; 891 were returned. Eighty four patients seemed to fulfil the selection criteria and were invited to visit the outpatient clinic and to participate in the trial. A physical examination was performed, routine blood and urine tests were made, and X-rays of the lumbar spine and pelvis according

to Chamberlain were made.[15] In the second selection phase 40 patients were excluded for various reasons; 11 of them because they were treated with exercises during the waiting period between the registration and the first examination.

Inclusion criteria were:
1. The presence of pelvic pain. Pelvic pain was defined as pain experienced between the plane through the four superior iliac spines and the horizontal plane through the inferior border of the pubic symphysis.
2. Pain was influenced by position and locomotion.
3. To exclude isolated symphysial osteoarthropathy and isolated lumbar problems the pain had to be localized posteriorly as well as anteriorly of the pelvis.
4. Pain started during pregnancy or within three weeks after delivery.
5. The patient was not pregnant and the last delivery was 6 weeks to 6 months previously.
6. No history of fracture, neoplasm, inflammatory disease or previous surgery of the lumbar spine or pelvis.
7. The patient was never treated with exercises to treat PPPP.

Exclusion criteria were:
1. The complaints were not persistent. If improvement in symptoms took place in the 4 weeks preceding intervention. The judgment was based on the global impression of the patient, and on the impression of the examiner based on the patient's medical history and the forms filled in by the patient during the preceding weeks.
2. Signals of non-cooperation, obvious psychopathology, insufficient knowledge of the Dutch language to fill in forms, and visual or auditive handicaps that prevented patients from receiving instructions by videotape. Non-cooperation was judged by the examiner and based on the way forms were filled in and returned during the weeks preceding the first examination. Psychopathology was based on medical history concerning medical consumption because of psychological problems and on the global impression of the examiner.
3. Signs indicating radiculopathy (asymmetric Achilles tendon reflex, hypesthesia in a radicular pattern, (passive) Straight Leg Raising restricted by pain in the lower leg).
4. Abnormalities on routine blood and urine tests.
Approval for the study was obtained from the Ethics Committee of the University Hospital Rotterdam.

During a 2.5 year period 44 women were included in the study. No significant differences between the three groups were found for prognostic indicators, co-interventions during the study and baseline values of outcome measures (Table 1).

Table 1. Prognostic indicators, co-interventions during the study and baseline values of outcome measures. Mean values ± SD. No significant differences between groups (ANOVA one-sided). Intervention consisted of instructions given by videotape and a pelvic belt, in combination with training of the diagonal trunk muscle systems (study group), training of the longitudinal trunk muscle systems (control group 1) and without exercises (control group 2).

	study group (n =16)	control group 1 (n = 14)	control group 2 (n = 14)
Prognostic indicators			
Age (years)	30.7 ± 3.7	32.3 ± 3.3	32.1 ± 2.2
Parity	2.0 ± 0.9	1.9 ± 1.1	1.8 ± 0.7
Duration of complaints (months)	8.5 ± 1.9	9.3 ± 2.3	9.1 ± 2.4
Period postpartum (months)	3.9 ± 1.7	4.0 ± 1.8	4.3 ± 1.3
Participants working (%)	6.3	15.4	15.4
Co-interventions during study			
use of a pelvic belt (hours per day)	12.4 ± 7.1	12.5 ± 6.9	11.9 ± 5.8
use of pain medication (doses per day)	0.59 ± 0.88	0.57 ± 1.12	0.64 ± 1.27
Baseline values of outcome measures			
Pain in the morning*	36.6 ± 23.7	35.4 ± 17.5	37.5 ± 24.8
Pain in the evening*	57.6 ± 10.8	71.8 ± 23.0	60.3 ± 19.6
Tiredness in the morning*	46.5 ± 24.4	33.9 ± 19.9	37.9 ± 24.2
Tiredness in the evening*	77.0 ± 11.9	84.4 ± 10.1	77.2 ± 13.8
NHP energy	51.4 ± 39.5	53.9 ± 30.5	54.2 ± 38.6
NHP pain	62.4 ± 22.7	58.9 ± 26.3	47.3 ± 21.5
NHP emotional reactions	15.5 ± 17.8	21.0 ± 19.0	15.4 ± 15.4
NHP sleep	15.7 ± 24.6	14.3 ± 22.6	6.3 ± 10.2
NHP social isolation	19.1 ± 19.2	14.2 ± 16.2	15.6 ± 24.3
NHP physical mobility	40.9 ± 21.6	30.9 ± 16.3	36.4 ± 15.5
PPPP test left (% positive)	81.3	50.0	64.3
PPPP test right (% positive)	93.8	64.3	71.4
X-ray**	3.0 ± 2.0	2.5 ± 1.1	3.5 ± 2.0

* score on a visual analogue scale (0 - 100)
** movement of the symphysis pubis in millimeters
NHP Nottingham Health Profile
PPPP test Posterior Pelvic Pain Provocation test

Interventions

In order to be able to answer our main question it was required that the interventions between the three groups were as equal as possible except for the studied issue. Instruction from physiotherapists of our team would entail the disadvantage that patients would have to travel several times to the university hospital. The journey would be fatiguing, especially for those living far away; this could reduce patient compliance. Moreover, the large variation in travelling time (15 minutes to 3 hours) might have reduced the comparability between the patients. Instruction from a physiotherapist in their own neighborhood was not deemed appropriate because variation in both travel distance and personal viewpoints of the physiotherapist might introduce bias. We decided to instruct the patients by videotape. In that way the variation between groups was reduced to the essence.

Every patient received a 30-minute videotape on which explanations were given about the possible cause of PPPP, prognosis and therapeutic possibilities. Furthermore, apart from detailed ergonomic advice, information was given on how to behave if activities cause pain, and how to use a pelvic belt. The last part of the videotapes differed; three possibilities existed (see Appendix). Tape I gave instructions on how to train the diagonal trunk muscle systems. Tape II demonstrated light exercises of the longitudinal trunk muscle systems as placebo exercises. Tape III asked patients to try to gradually increase the activities of daily living and to refrain from exercises. The persons explaining the exercises on the videotapes and the locations were identical.

The chosen exercises were largely based on the work of Kendall et al.[16] The frequencies were based on the principles of sports training.[17] In conformity with these principles, training to gain muscle force and endurance was performed by heavy exercises three times a week. These exercises were partly isometric and partly dynamic. Two series were performed with a rest of 5 minutes in between. The patient had to try to gradually increase the amount of repetitions per series, guided by pain and fatigue. Training to improve muscular awareness and recruitment was performed by light exercises three times a day.

To control and facilitate compliance the patients had to fill in weekly visual analogue scales (VAS) for pain and fatigue and send them to an administrative assistant by means of an addressed pre-paid envelope.

A designated form enquired about frequency of training, the use of medication and/or a pelvic belt, whether general health was disturbed and if they were working. Patients were also given the opportunity to ask questions; these questions were blinded by the administrative assistant and submitted to the principal investigator (JM). The administrative assistant contacted the patient by telephone if no forms were received, if the forms were not filled in appropriately, and to answer any questions. To check correctness of the exercise technique the patients were asked to demonstrate their way of training during the evaluation after 8 weeks intervention.

Assignment

After inclusion and informed consent patients were given a videotape in a sealed envelope. At home, they played the tape in order to first learn to which group they were allocated. Prior to the start of the trial, an investigator (HB) who was not involved in the trial prepared numbered sealed envelopes with a copy of one of three different videotapes in random order. All envelopes and videotapes had the same appearance and were not marked.

Outcome assessment

The outcome was assessed after conclusion of the 8 weeks protocolised intervention. To prevent the influence of fluctuations of complaints associated with the menstrual cycle, the day of the week and the hour of the day, the second examination in the hospital was

planned exactly 8 weeks after the first one on the same day and at the same hour. Because no specific effect measures for PPPP exist, it was decided to use scales for general health: pain, fatigue and Nottingham Health Profile (NHP). Moreover we used the posterior pelvic pain provocation test (PPPP test),[18] and the X-ray examination according to Chamberlain.[15] Chamberlain described how mobility of the pelvic joints could be assessed by measuring the step between the pubic bones when the patient was weightbearing alternating on the left and right leg. Berezin used the Chamberlain method to compare the mobility of the pelvic joints of women with and without pelvic girdle pain in the puerperium.[19] The measured shift between the pubic bones was 5.9 ± 3.3 mm in women with complaints and 1.9 ± 2.2 mm in those without ($p = 0.0000$). Because validity of the PPPP test and X-ray examination as instruments to measure effect was unsure, these measurements were classified as secondary.

Primary outcome measures

Global impression of improvement was scored by the patient on a three-point Likert scale (1 = worse, 2 = unchanged, 3 = improved).

The mean severity of pain and fatigue were scored on a 100 mm horizontal VAS by asking how was your pain (or, fatigue) this week in the morning (or in the evening); 0 = 'no pain (or not tired) at all' to 100 = 'very severe pain (or extremely tired)'.[20] Because of the large variation in pain and fatigue between morning and evening, both were scored. The patients were encouraged to fill in the forms each week on the same day and at the same hour (preferably in the weekend in the evening).

The six main outcome scales of the NHP were used to measure various aspects of perceived health: energy, pain, emotional reactions, sleep, social isolation and physical mobility.[21]

Secondary outcome measures

Gluteal pain provoked by the PPPP test left and right was scored on a two-point scale (gluteal pain yes or no).

X-ray examination was performed to assess mobility of the pubic symphysis during alternating weightbearing on the right and left leg.

Sample size: Sample size calculations were based on a clinical success rate in the study group of at least 20% higher than in the control groups (outcome measure: global impression of improvement). The target sample was estimated at approximately 30 patients per group (alpha = 0.05, beta = 0.20). When about half the sample size had been enrolled an interim analysis was planned to investigate if it was necessary to include 30 patients per group before conclusions could be made. When 44 patients were enrolled, this analysis took place and the study was terminated.

Blinding

It is impossible to blind patients for the kind of intervention and completion of self-

assessment scales. Before randomization, the patients were told by the principle investigator that the approach in persistent PPPP was the combination of a pelvic belt and ergonomic advice and that the study was initiated to answer the question whether addition of exercises is beneficial or harmful, or has no influence. In order not to influence the patient, all the assessment forms had to be filled in at home.

The assessment of the score of the PPPP test after 8 weeks intervention was blinded. Before the examination the patient was asked not to inform the assessor about treatment and results until the examination was finished. Interpretation of the X-rays by the investigator was blinded for the kind of intervention and the results.

Statistical analysis

SPSS statistical software was used for data analysis. Prognostic similarity between intervention groups was assessed at baseline for prognostic indicators and for baseline values of outcome measures. All outcome measurements were analyzed as intention to treat. Changes from baseline were calculated for each patient by subtracting the results at baseline from those after 8 weeks. Differences between baseline and at conclusion of the study were analyzed using the ANOVA one-sided test. Categorical data were compared with the Kruskal-Wallis test. $P < 0.05$ was considered significant.

Results

Patients in the two exercise groups were encouraged to increase the number of repetitions. If the patient was unable to perform the exercises she could decrease the amount, or stop. Four patients in the study group (25%) stopped the exercises due to increase of pain; two in the sixth week, one in the seventh and one in the eighth week. In the first control group one patient (7.1%) stopped due to increased pain in the eighth week. No case was lost at conclusion of the study. Four patients (two in the study group and two in the first control group) refused the second examination because of exacerbated symptoms after the first examination; for these patients the results were based only on the primary outcome measures. The two patients in the study group who refused the second examination classified their result as "worse" and stopped the exercises before the end of the study.

All patients considered the videotape comprehensive and almost all found the information sufficient. All patients of the two exercise groups demonstrated that the way they had trained was the correct way. No patient in the second control group had performed any structured training.

After 8 weeks intervention 28 of the 44 patients (63.6%) subjectively improved; 12 (27.3%) were unchanged and 4 (9.1%) felt worse ($p = 0.000$). Of the five patients who stopped the exercises one was subjectively improved, one was unchanged (the patient of the first control group) and three felt worse. Significant improvement was scored for pain in the morning ($p = 0.01$), fatigue in the evening ($p = 0.000$), NHP pain ($p = 0.01$) and NHP physical mobility ($p < 0.05$).

Comparison at the end of 8 weeks intervention between the study group and both control groups revealed no significant differences for the primary outcome measures (Table 2). The statement that global improvement of the study group was not 20% better than control group 1 could be made with a confidence of 95%, and with a confidence of more than 99% in control group 2. With respect to change of the PPPP test at the right side the study group scored better than control group 2 ($p < 0.05$). The interpretation of this finding is hindered by the difference in baseline values of the groups for this test.

Table 2. Effects of 8 weeks treatment of Peripartum Pelvic Pain: mean change from baseline and statistical significance of differences between groups. Positive values indicate improvement.

Measurement scale	Study group (n=16)	Control group 1 (n =14)	Control group 2 (n = 14)
Global improvement			
better	10 (62.5%)	10 (71.4%)	8 (57.1%)
unchanged	3 (18.8%)	4 (28.6%)	5 (35.7%)
worse	3 (18.8%)	0 (0.0%)	1 (7.1%)
pain in the morning	3.6 ± 23.6	8.9 ± 15.7	11.4 ± 17.8
pain in the evening	2.0 ± 23.1	8.6 ± 14.2	6.9 ± 18.4
tiredness in the morning	6.4 ± 33.9	7.2 ± 17.9	1.4 ± 27.1
tiredness in the evening	16.8 ± 31.5	8.9 ± 15.3	5.7 ± 24.3
NHP energy	8.0 ± 36.3	4.3 ± 32.1	6.4 ± 40.1
NHP pain	12.8 ± 31.8	13.7 ± 22.3	4.9 ± 26.2
NHP emotional reactions	- 0.9 ± 14.5	3.4 ± 12.1	-0.7 ± 13.5
NHP sleep	3.0 ± 16.1	3.8 ± 22.7	3.6 ± 12.0
NHP social isolation	2.9 ± 23.9	-0.04 ± 12.4	6.0 ± 24.1
NHP physical mobility	6.2 ± 25.6	5.2 ± 12.7	6.5 ± 17.5
PPPP test left	(n=14)	(n=12)	(n=12)
better	5 (35.7%)	4 (33.3%)	2 (14.3%)
unchanged	9 (64.3%)	6 (50.0%)	10 (71.4%)
worse	0 (0.0%)	2 (16.7%)	2 (14.3%)
PPPP test right*	(n=14)	(n=12)	(n=12)
better	7 (50.0%)	3 (25.0%)	0 (0.0%)
unchanged	5 (35.7%)	7 (58.3%)	10 (71.4%)
worse	2 (14.3%)	2 (16.7%)	4 (28.6%)
movement of the pubic symphysis on X-rays (decrease in millimeters)	(n=8) 0.0 ± 1.3	(n=10) - 0.2 ± 0.79	(n=11) 0.7 ± 0.79

* differences significant ($p < 0.05$).

CHAPTER 3

Discussion

In this study, patients with persistent pelvic pain after delivery were treated by an eight-week instruction by videotape. The results might have been influenced by the way the instructions were given. Patient instruction by videotape has been used for many years for many indications; for example since 1985 the American College of Obstetricians and Gynecologists has used videotapes to instruct pregnant and postpartum women how to perform exercises.[22] Instruction given by a physiother apist would enable more individualized training. Östgaard et al. demonstrated the surplus value of individual based instructions above group classes.[23] It might be expected that the mean improvement would have been larger with individual instructions, however, answering the question of our study would have been more difficult.

The results of the present study show that during the program 63.6% of the patients improved. No evidence was provided that training of the diagonal muscle systems of the trunk in patients with PPPP was beneficial. There were minimal differences between the results of the study group and both control groups. After 8 weeks intervention, a significant difference was shown in only one item: the PPPP test at the right side improved more in the study group. The cause of that difference might be the result of a "regression to the mean".

A surprisingly large percentage of the study group had to cease training because of pain and fatigue (25%). Many patients in this group complained of increasing pain during the exercises; the majority attributed the pain to the exercises aimed to strengthen the hip extensors: raising the leg in prone position.

We conclude that training of the diagonal trunk muscle systems, without individual coaching, is not more effective than low graded training of the longitudinal trunk muscle systems or no exercises at all. Training of the hip extensors in our patients may have increased pain to such an extent that any benefit derived from stability of the pelvis was overruled. Vleeming et al. reported that tension of the gluteus maximus muscle and the hamstrings increases the tension of the ligaments and decreases the mobility of the SI joints.[7,10-13] A decrease in the movements of the SI joints may be beneficial, but probably extra load on the ligaments is not. Callaghan reviews the dualistic character of exercises in back pain extensively.[14]

A literature search was made in MEDLINE for the period 1966–1998, in the Cochrane Controlled Trials Register, and in the proceedings of the three interdisciplinary congresses on low back pain.[24-27] Two randomized clinical trials and three non-randomized intervention studies on PPPP were found.[23,28-31] In the first randomized trial the preventive value of a back school education and training program during pregnancy was investigated.[23] The program could reduce short-term sick leave due to PPPP provided that the instructions were individual based. Nilsson et al. compared the effect of exercises given by a physiotherapist with home training and stretching, and with a program without exercises; no differences were found.[28] Noren et al. studied the

individual based education and training program in pregnant patients with PPPP;[31] days lost to sick leave was significantly reduced in the intervention group compared to a non-treated group of women from another antenatal clinic. In a prospective non-randomized trial the value of exercise classes to prevent and to treat PPPP was investigated by Dumas et al;[29] no significant effect on back pain during pregnancy and after delivery was found. Mantle et al. studied the effect of ergonomic advice on the development and course of back pain during pregnancy; the treated group scored better than the control group.[30] The results of the present study and the literature search agree with the hypothesis that giving information about the disease in combination with ergonomic advice is beneficial, but until now, the studied exercises have no additional value to treat PPPP during pregnancy or during the first 6 months after delivery.

It is recommended to study the effect of training the diagonal trunk muscle systems without hip extensors, eventually in combination with exercises to strengthen the transverse abdominal muscle as recommended for lumbar segmental instability,[32,33] and by others as stabilizer for the pelvic girdle.[9,34]

Conclusion

The results of instruction without exercises were the same as with exercises. Without exercises the change on somatic fixation is reduced and there is no risk of increase of pain if exercises are too heavy or performed in a wrong way.

We conclude:

1. In treating patients with persistent pelvic pain 6 weeks to 6 months after delivery, training of the diagonal trunk muscle systems, without individual coaching, has no additive value above instructions and a pelvic belt without exercises.
2. Reassurance of the patient and awaiting spontaneous resolution in combination with instructions and a pelvic belt are, with the present knowledge, first choice.

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Appendix

Exercises tape I (study population)

Tape I gave instructions for heavy exercises, to be performed three times a week (Monday, Wednesday and Friday) and light exercises to be performed three times a day. The instruction for heavy exercises were:

Lie back with knees at 90 degrees and feet flat on the surface. Make diagonal sit-ups by raising the left shoulder as far as possible in the direction of the right knee. Keep your right shoulder in contact with the surface. Hold this position for seven seconds, then lay down and relax for three seconds and repeat the exercise. When this series is completed perform a similar series raising the right shoulder. It was advised to perform five repetitions per series during the first setting.

In prone position with the arms lying beside the head; raise your left arm and shoulder from the surface and raise the extended right leg. Hold this position for seven seconds, than lay down and relax for three seconds and repeat the exercise. When this series is completed perform a similar series with the right arm and left leg. After a rest of 5 minutes the complete program was repeated. If performing these exercises provoked no pain and/or fatigue the patient was advised to increase the number of repetitions during the next setting to six, and so on. If the patient was unable to increase the repetitions because of pain, fatigue or weakness she could stay at that level, but was encouraged to increase the number of repetitions later on if possible. If the patient was unable to perform the exercises she could decrease the amount, or stop.

The instructions for light exercises on videotape I were the same as the heavy exercises, except that the tensed position was held for only three seconds and no second series was done after a rest period. The number of repetitions was the same as for the heavy exercises. Three times a week, when the heavy exercises were done, the light exercises were omitted.

Exercises tape II (control group 1)

Tape II demonstrated exercises to tense the longitudinal trunk muscle systems.

In supine position with knees at 90 degrees and feet flat on the surface; make a sit-up by raising both shoulders as far as possible in the direction of the knees. Hold this position for three seconds, then lay down and relax for three seconds and repeat the exercise. If this series is completed, lift the pelvis from the surface without tilting the pelvis. Hold this position for three seconds, then lay down and relax for three seconds and repeat the exercise. During the first setting, five repetitions were advised, six during the next and so on. If the patient was not able to increase the repetitions because of pain and/or weakness she had to stay at that level during the remainder of the 8 weeks.

Tape III (control group 2)

Tape III asked patients to try to gradually increase the activities of daily living and not to do exercises.