

Effect of pelvic adjustment on chronic low back pain and spino-pelvic parameters in middle-aged women

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골반교정이 중년 여성의 만성요통과 척추골반지표에 미치는 영향

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Abstract The purpose of this study was to investigate the effects of pelvic adjustment on low back pain and spino-pelvic parameters in middle-aged women. Thirty-eight middle-aged women with chronic low back pain were randomly assigned to the pelvic adjustment (n = 20) or untreated control (n = 18) group. Pelvic adjustment interventions were performed four times a week for 8 weeks in the former group. At baseline and after 8 weeks, the back pain and back function were evaluated using the visual analogue scale (VAS), Oswestry disability index (ODI), and back flexibility. Additionally, the spino-pelvic radiographic parameters and serum C-reactive protein (CRP) levels were assessed. After 8 weeks, the VAS, ODI, and back flexibility significantly improved in the pelvic adjustment group compared with the control group. It was found that the changes from baseline in the lumbar lordotic angle, sacral slope, pelvic crest unleveling, and femoral head height inequality were significantly greater in the pelvic adjustment group than in the control group. There were no significant changes in the pelvic incidence or serum CRP levels in either group. In conclusion, pelvic adjustment has beneficial effects on chronic low back pain and back function, suggesting that the effects of pelvic adjustment on back pain may at least in part result from changes in the spino-pelvic alignment.

요약 본 연구의 목적은 골반 교정이 중년 여성의 만성 요통과 척추 골반 지표들에 미치는 영향을 규명하는데 있다. 이를 위하여 만성 요통이 있는 중년 여성 38명을 실험군(20명)과 무치치 대조군(18명)에 무선 할당하여 실험군에게는 골반 교정을 주 4회, 8주 간 시술하였다. 시술 전과 8주 후에 요통은 시각적 상사 척도와 Oswestry 요통 장애 지수로 측정하였고, 그 외 요부 유연성, 염증인자인 혈중 C-reactive protein (CRP) 및 척추 골반 지표들을 평가하였다. 처치 8주 후 대조군에 비하여 골반 교정군에서 요통 강도, 요통 장애 지수 및 요부 유연성 모두가 유의하게 향상되었으며, 혈중 CRP의 유의한 변화는 없었다. 척추 골반 지표들을 분석한 결과 골반 교정군에서 대조군에 비해 요추전만각, 천골경사 및 골반균형지표는 유의하게 변화된 반면, 골반입사각의 변화가 뚜렷하지 않았다. 따라서 골반 교정은 요통 환자의 통증 감각과 기능 향상에 효과적인 것이며, 척추 골반 정렬의 변화의 결과일 것이다.

Keywords : Back Flexibility, Chronic Low Back Pain, Oswestry Disability Index, Pelvic Adjustment, Spino-Pelvic Parameters

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Received August 25, 2017

Revised (1st September 13, 2017, 2nd September 14, 2017)

Accepted September 15, 2017

Published September 30, 2017

1. Introduction

Prevalence of chronic low back pain (*i.e.*, pain lasting for more than 3 months) has recently increased ranging from 10 to 20%[1,2]. Since the causes of low back pain are often unknown and multifactorial, multidimensional and non-pharmacological treatments including complementary and alternative medicine (CAM) have been practiced to relieve low back pain[3-5]. The number of patients referred to CAM and use of CAM appears to be increasing and back pain is the most common diagnosis for use of CAM[6,7]. Chiropractic and spinal manipulation are the most frequently used CAM therapies for chronic low back pain and known to have favorable effects on chronic low back pain[3,5,8].

The etiology of low back pain is diverse and consequently several physiological mechanisms have been proposed to explain the effect of manipulative therapy on chronic low back pain[9,10]. Although there have been conflicting reports about associations between low back pain and postural factors including altered sagittal spino-pelvic alignment, pelvic unleveling, and leg-length inequality[11-15], these postural factors have been suggested as plausible mechanisms for low back pain[15-17].

Imbalanced posture is known to make a strain on muscles and connective tissues and affect the alignment of the lumbar spine[18]. Normal sagittal spine has an optimal lumbar lordosis over a correctly oriented pelvis[19]. Change in lumbar lordosis is related to changes in pelvic alignment, which is determined by sacral slope and pelvic incidence[19]. Increase or loss of lumbar lordosis and pelvic misalignment causes spinal imbalance resulting in low back pain[16,17].

Recently, it has been reported that sagittal spino-pelvic alignment measured by pelvic incidence, sacral slope, and lumbar lordosis was different between patients with chronic low back pain and asymptomatic adults[16]. In addition, leg-length inequality of 5 mm or more has been observed in 44% of pain-free

controls and in 75% of patients with low back pain suggesting that inequality in leg length might be related to low back pain[21,22]. Leg length discrepancy is known to be linked to pelvic torsion, which is measured by pelvic unleveling[23,24]. Altered pelvic torsion was observed in patients with low back pain[25].

Spinal manipulation has been suggested to be moderately effective for chronic low back pain[3,5]. However, it is not yet fully understood how manipulative therapy has beneficial effect on chronic low back pain[10]. We propose that mechanical stimuli of manipulative therapy could affect spino-pelvic balance which is related to low back pain. Recently, it has been reported that pelvic adjustment could decrease leg length discrepancy[26]. Therefore, we hypothesized that manipulation applied on the pelvis (*i.e.*, pelvic manipulation, abbreviated PM in this study) might have the effect on spino-pelvic alignment with concomitant improvements in back pain and back function in patients with chronic low back pain. To the best of our knowledge, there have been very few studies investigating the effect of pelvic adjustment on spino-pelvic alignment and pain in patients with low back pain. The effect of pelvic adjustment on spino-pelvic alignment in patients with chronic back pain has not been investigated although it has been reported that pelvic adjustment decreased back pain[27] and the extent of pelvic unleveling[28] in patients with chronic low back pain. These studies showed limitations such as no control group and no concomitant measurement of back pain[28] and spino-pelvic alignment[27].

Accordingly, in this study we investigated the effects of 8-week PM intervention on back pain, back function, and anterior and sagittal spino-pelvic alignments in middle-aged women with chronic low back pain and compared the effect of PM on chronic low back pain with that of no treatment.

2. Methods

2.1 Study design

Forty-six women with chronic low back pain were recruited from outpatients at the T oriental medical hospital in the Daegu city, South Korea and randomly assigned into PM and untreated control groups. PM group underwent an 8-week intervention program. Thirty-eight women completed the study. Eight subjects dropped out of the study due to personal reasons. Attrition rate was 87% in the PM and 78% in the control group, respectively.

At baseline and after 8 weeks, back pain and function were measured and radiographs of the lumbar and pelvis were obtained in both groups. Body weight and height were measured, and BMI was calculated to estimate obesity. Duration of back pain and diagnosed diseases from doctors were surveyed. Inflammation has been known to be associated with chronic back pain[9]. Therefore serum C-reactive protein (CRP) levels were measured to screen for inflammation at baseline and after 8 weeks.

Ethical approval for this study was obtained from Institutional Review Board of Korea National Institute for Bioethics Policy (IRB approval No. P01-201507-11-002). All subjects gave their written informed consent before participating study.

2.2 Subjects

Middle-aged women with low back pain lasting more than 3 months were recruited. Exclusion criteria included inflammatory disease, infectious disease, spine disorders such as degenerative disc disease, spondylolisthesis, spinal stenosis, or inflammatory spinal diseases, osteoporosis, cancer, and pregnancy.

2.3 Pelvic manipulation

Subjects in the PM group received the 15-minute session, four times a week for 8 weeks by one manipulative therapist at the T oriental medical hospital. Pelvic adjustments were performed utilizing a

drop table technique[29] with modifications to enhance the forces transmitted in the area to be adjusted. The drop table has sections that can be raised and then dropped down. When manual impact is made on the body region to be adjusted, at the same time the table drops back to its original position producing the inertia forces from the body dropping. The subject was instructed to lie in the supine position on the drop table. The therapist placed one hand on top of the other on the anterior superior iliac spine. A force was applied to the ipsilateral or contralateral anterior superior iliac spine. In addition, an impact was made on the anterior superior iliac spine in the side-bent position and on the posterior superior iliac spine area in the prone position.

2.4 Serum CRP

A blood sample was taken between 10 and 11 A.M. in the morning at baseline and after 8-week intervention. Serum samples were prepared by centrifuging the samples at 3000 rpm for 10 minutes and were stored at -70°C until analysis. Serum CRP levels were analyzed by the Green Cross Reference Laboratory in South Korea. Serum high-sensitivity CRP levels were assessed by latex-enhanced immunoturbidimetric assay (ADVIA 2400, Siemens, USA) using CRP-Latex (II) X2 kit (Denka-Seiken, Japan).

2.5 Back pain intensity, disability, and flexibility

Back pain intensity was evaluated with the visual analogue scale (VAS). Patients estimated their intensity of pain and marked a vertical dash on a 10-cm horizontal line with no markings, except "no pain" at the left and "very severe pain" at the right end of the line[30]. The distance from the "no pain" point was then measured (0-100 mm).

The Korean version of the Oswestry disability index (ODI) was used to assess pain-related physical disability in daily activities[31]. The ODI has been previously translated in Korean and found to be valid

and reliable[31,32]. The scores of all questionnaires were added up and expressed as a percentage.

Flexibility of lower back and hamstring was assessed with the sit and reach test using a measurement box (SAT116, Sina, Korea). The subject sat on the floor and placed sole of the feet against side of box with the legs fully extended. The subject then extended her arms forward as far as possible without bending knees and hold at the furthest point for two seconds[33].

2.6 Radiographic spino-pelvic parameters

All subjects had sagittal radiography of the lumbar and pelvis while standing and anterior pelvic radiography in supine position. On each sagittal radiograph three spino-pelvic parameters including sacral slope, pelvic incidence, and lumbar lordosis were measured as previously described[19,34,35].

The sacral slope was defined as the angle between the horizontal line and the sacral (S1) end-plate tangent[19,34]. The pelvic incidence was defined as the angle between the line perpendicular to the middle of the sacral plate and the line connecting this point to the center of the bicoxofemoral axis[19,34]. The lumbar lordosis was defined as the angle of intersection of the lines drawn across the lower border of the L2 vertebra and the upper border of the L5 vertebra[35].

The functional leg length inequality was assessed using the anterior radiograph by measuring the difference in heights of the femoral heads[20,22]. Pelvic unleveling was defined as the difference in heights of the iliac crest[36]. Horizontal lines were drawn at superior borders of left and right iliac crests. The vertical distance between two lines was measured.

2.7 Statistical analysis

All data were analyzed using IBM SPSS version 22 (IBM SPSS Inc., Chicago, IL). The significant level was set at 0.05 for all analyses. Calculation of sample size was based on the minimally clinically important change of 20 mm on the VAS scores for patients with

chronic low back pain reported in a previous study[37]. Our planned sample size of 19 for each group had 80% power to detect the minimally clinically important change of 20 mm on the VAS assuming a two-sided $\alpha = 0.05$, 1 standard deviation, and 20% drop-out rate.

All variables were tested for the normality of distribution using Shapiro-Wilk test. When data were not normally distributed, non-parametric statistics were used to test statistical significance. Accordingly, an independent t-test or Mann-Whitney test was performed to evaluate the significance of the difference between means of two groups in all variables (age, BMI, VAS, ODI, back flexibility, radiographic variables, and serum CRP) at baseline. Significance of difference from baseline in VAS, ODI, back flexibility, radiographic variables, and serum CRP was tested by paired t-test or Wilcoxon signed ranks test depending on data distribution in each group. The independent t-test or Mann-Whitney test was used to test whether or not changes from baseline in the PM group significantly differ from those in the control group.

3. Results

3.1 Baseline characteristics

General characteristics at baseline in the PM (n = 20) and the control (n = 18) groups are presented in Table 1. The participants (n = 38) had a mean age of 47.7 ± 5.3 yrs (40-60 yrs) and a mean BMI of 22.5 ± 2.7 kg/m². A mean serum CRP level of all participants was 0.09 ± 0.16 mg/dL (0.01-0.73 mg/dL) at baseline and was not significantly changed after 8 weeks (0.07 ± 0.07 mg/dL). Duration of back pain was classified into four categories: less than 1 year (n = 6); more than 1 year and less than 5 years (n = 16); more than 5 year and less than 10 years (n = 6); more than 10 years (n = 13). There were no significant differences between two groups at baseline in age, BMI, ODI, back flexibility, serum CRP, and all spino-pelvic parameters except VAS ($p < 0.05$).

Table 1. Baseline Characteristics of Subjects

| Variable | PM (n = 20) | Control (n = 18) |
|--------------------------------------|----------------|---------------------|
| Age (y) | 47.4 ± 6.0 | 48.0 ± 4.5 |
| Body mass index (kg/m ²) | 22.3 ± 2.3 | 22.8 ± 3.2 |
| C reactive protein (mg/dL) | 0.1 ± 0.2 | 0.1 ± 0.2 |
| Pain duration | | |
| Less than 1 year | 2 (10.0) | 1 (5.6) |
| 1-5 years | 7 (35.0) | 9 (50.0) |
| 5-10 years | 2 (10.0) | 4 (22.2) |
| More than 10 years | 9 (45.0) | 4 (22.2) |

Data are presented as mean ± standard deviation or n (%).

PM: Pelvic manipulation.

3.2 Back pain and flexibility

Results of VAS, ODI, and back flexibility are presented in Table 2. After 8-week intervention, VAS significantly decreased in the PM group ($p < 0.001$), whereas it significantly increased in the control group ($p < 0.05$). After 8 weeks, the mean change from baseline in VAS in the PM group was significantly greater than that of the control group ($p < 0.001$) indicating that PM reduced pain intensity.

ODI significantly decreased in the PM group ($p < 0.001$), meanwhile it tended to increase in the control group ($p = 0.053$). The extent of change in ODI was greater than that of the control group ($p < 0.001$). Back flexibility significantly increased in the PM group ($p < 0.001$) but it was not significantly changed in the control group. The extent of change in back flexibility was greater than that of the control group ($p < 0.001$).

These results suggest that PM induced improvements in pain-related disability and physical function.

Table 2. Changes in Back Pain and Flexibility

| Variables | Group | Baseline | Week 8 | Week 8 - Baseline |
|-----------------------|---------|-----------|------------------------|-------------------------|
| VAS (mm) | PM | 45.7±20.9 | 6.5±5.5** | -39.1±21.3 [#] |
| | Control | 32.9±14.7 | 42.6±21.0 [*] | 9.7±18.4 |
| ODI (%) | PM | 22.5±9.1 | 7.2±6.2** | -15.2±11.1 [#] |
| | Control | 18.3±6.8 | 23.3±8.0 | 5.1±10.3 |
| Back flexibility (cm) | PM | 10.3±10.3 | 14.8±8.5** | 4.5±4.2 [#] |
| | Control | 8.7±8.4 | 7.1±7.0 | -1.7±3.9 |

Data are presented as mean ± standard deviation.

PM: Pelvic manipulation.

VAS: Visual Analogue Scale.

* $p < 0.05$, ** $p < 0.001$: Significance of difference between baseline and week 8 in each group was tested by paired t-test or Wilcoxon signed ranks test.

[#] $p < 0.001$: Significance of difference between the control and PM groups was tested by independent t-test or Mann-Whitney rank-sum test.

3.3 Spino-pelvic parameters Back pain and flexibility

Table 3 shows the results from radiographic analysis of the sagittal spino-pelvic parameters. Sacral slope tended to decrease in the PM ($p = 0.08$), whereas it was not significantly changed in the control group. However, the difference between groups in the mean change from baseline was statistically significant ($p < 0.05$). Lumbar lordotic angle significantly increased in the PM group ($p < 0.05$), whereas it was not

Table 3. Radiological Parameters of Anterior and Sagittal Spino-Pelvic Alignments

| Variables | Group | Baseline | Week 8 | Week 8 - Baseline |
|-------------------------------------|---------|------------|--------------------------|---------------------------|
| Lumbar lordosis (°) | PM | 40.4 ± 6.8 | 42.6 ± 4.2 [*] | 2.2 ± 4.6 [#] |
| | Control | 37.7 ± 5.5 | 37.9 ± 5.4 | 0.3 ± 1.4 |
| Sacral slope (°) | PM | 40.1 ± 5.8 | 38.7 ± 4.3 | -1.4 ± 3.2 [#] |
| | Control | 36.9 ± 5.1 | 37.1 ± 5.2 | 0.2 ± 0.4 |
| Pelvic incidence (°) | PM | 55.1 ± 9.3 | 54.6 ± 8.3 | -0.5 ± 3.6 |
| | Control | 53.4 ± 7.4 | 53.6 ± 7.3 | 0.2 ± 0.7 |
| Pelvic crest unleveling (mm) | PM | 5.5 ± 3.0 | 1.6 ± 1.9 ^{***} | -3.9 ± 2.8 ^{###} |
| | Control | 6.3 ± 4.6 | 6.4 ± 4.7 | 0.1 ± 0.3 |
| Femoral head height inequality (mm) | PM | 5.8 ± 4.5 | 2.6 ± 2.4 ^{**} | -3.2 ± 4.1 ^{##} |
| | Control | 6.4 ± 4.9 | 6.4 ± 4.9 | 0.1 ± 0.4 |

Data are presented as mean ± standard deviation. PM: Pelvic manipulation.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$: Significance of difference between baseline and week 8 in each group was tested by paired t-test or Wilcoxon signed ranks test.

[#] $p < 0.05$, ^{##} $p < 0.01$, ^{###} $p < 0.001$: Significance of difference between the control and PM groups was tested by independent t-test or Mann-Whitney rank-sum test.

significantly changed in the control group. The extent of change in lumbar lordosis was greater than that of the control group ($p < 0.05$). Pelvic incidence was not significantly changed in both groups. No significant difference between two groups was observed in the extent of change in pelvic incidence. Pelvic crest unleveling ($p < 0.001$) and femoral head height inequality ($p < 0.01$) decreased in the PM group whereas they were not significantly changed in the control group. The extent of change in pelvic unleveling ($p < 0.001$) and femoral head height inequality ($p < 0.01$) was greater compared to the control group suggesting that PM decreased the extent of the leg-length difference.

4. Discussion

The primary finding of the present study was that pelvic adjustment relieved back pain with improvement of back function in middle-aged women with chronic low back pain when compared with no treatment. Subjects in the PM group demonstrated a significant decrease in back pain intensity measured by VAS and daily disabilities measured by ODI and a significant increase in back flexibility after 8-week intervention. These findings are consistent with results from previous study that reported the reduction of pain and improvements in physical function in women with chronic back pain following pelvic adjustment[27].

The magnitude of the minimally clinically important change on the VAS and ODI scores for the improvement of health status in patients with chronic low back pain was reported to be 20 mm and 10 points, respectively[37,38]. In this study, after 8-week PM intervention the VAS and ODI scores were decreased by 39 mm and 15 points, respectively. Therefore, the effect of the PM may have a clinical impact on relief of low back pain.

Spino-pelvic alignments have been proposed to be associated with chronic back pain mostly in

cross-sectional studies and suggested to mediate effects of treatment for chronic back pain[16,17,21,22]. The sagittal spinal balance such as lumbar lordosis is closely related to the morphology and orientation of the pelvis that can be characterized by pelvic parameters including pelvic incidence and sacral slope[19]. Pelvic incidence is anatomically involved with the sacral vertebrae, the posterior segment of the iliac bone, and the sacroiliac joints[19]. The dysfunction of the sacroiliac joints has been suggested as a possible cause of low back pain[39,40]. The inconsistent results about association between sagittal spino-pelvic parameters and low back pain have been reported[11,14]. However, recently sagittal spino-pelvic alignment measured by pelvic incidence, sacral slope, and lumbar lordosis was reported to be different in patients with chronic low back pain compared with asymptomatic adults[16].

Leg length inequality and pelvic crest unleveling have been also suggested to be related to low back pain[21,22,25,41]. It has been reported that pelvic adjustment could decrease leg length discrepancy in asymptomatic adults[26]. Therefore, we initially hypothesized that a favorable effect of PM on back pain may be in part associated with changes in sagittal spino-pelvic parameters including pelvic incidence, sacral slope, and lumbar lordosis and anterior pelvic parameters including differences in pelvic crest levels and femoral head heights on the left and right sides.

In the present study, we observed a greater magnitude of change in lumbar lordotic angle and sacral slope after the 8-week pelvic adjustment compared with no treatment in patients with chronic low back pain. However, we found no significant changes in pelvic incidence after pelvic adjustment. In addition, in the present study we found that the magnitude of pelvic unleveling and femoral head height inequality significantly reduced after the 8-week pelvic adjustment compared to no treatment. These findings are consistent with results of previous study that has reported the improvements in the pelvic

balance with pelvic adjustment combined with physical therapy in patients with chronic low back pain[28].

Little study has been conducted to determine whether spino-pelvic parameters could be altered by spinal or pelvic adjustment in patients with low back pain in association with pain relief. It may be worth to note that our investigation of the effect of pelvic adjustment on spino-pelvic parameters in patients with low back pain is the first report to the best of our knowledge.

A primary limitation of the presented study may be the type of control group used because it cannot be ruled out the possibility that the observed treatment effects of PM could be at least in part due to a placebo effect. Thus, in future studies, a sham control group for PM will be needed to more precisely evaluate the effect of PM on chronic low back pain. In addition, the small number of sample size is likely to be a study limitation. In the present study, we observed that there were no changes in pelvic incidence after the 8-week pelvic adjustment. The lack of statistically significance could be due to the small sample size or short-term treatment duration. Therefore, continuous studies with a larger sample size and with a long-term treatment are needed to elucidate the effect of pelvic adjustment on spino-pelvic alignment. Nonetheless, we expect that the results from our preliminary study could contribute to a better understanding how the spino-pelvic adjustment relieves back pain.

5. Conclusions

Our study suggests that pelvic adjustment decreases pain intensity and improves functional disabilities in patients with chronic low back pain. We propose that pelvic adjustment may be effective for chronic low back pain at least in part resulting from changes in spino-pelvic alignment. Future studies with a larger sample size will be needed to confirm our findings.

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