Original Article

Clinical Study on 16 Conservatively Treated Acute Compression Fracture Patients with Focus on Compression Ratio

Joh Byung-jin · Koh Pil-seong · Yi Won-il · Baek Yong-hyeon · Nam Tong-hyun and Park Dong-suk

Dept. of Acupuncture and Moxibustion, College of Oriental Medicine, Kyung Hee University

국문초록

급성 흉요추부 압박골절 환자 16례의 보존 치료에 따른 Compression Ratio에 중점을 둔 임상 고찰

조병진 · 고필성 · 이원일 · 백용현 · 남동현 · 박동석

경희대학교 한의과대학 침구학교실

목적 : 한양방 협진을 통한 보존적 입원 치료를 받은 급성 흉요추 압박골절 환자군에서의 압박골절 compression ratio의 급성기 내의 변화를 기록 분석하여 차후 환자군의 예후를 예측하고자 하였다.

방법 : 한양방 협진병원 척추센터에 입원하여 보존치료를 시행한 발병 2주 내의 압박골절 환자 중 2회 이상의 시점에서 압박골절 부위의 측면 X-ray 영상이 있는 환자 16명의 기록을 수집하였다. X-ray상 급성 압박골절이 발생한 추체(n=19)의 anterior wall과 posterior wall의 높이를 입원 1주차, 입원 2주차, 입원 3주차와 최종 영상 확보 시점의 X-ray에서 측정해 wedge fracture에 해당하는 anterior column fracture가 있는 추체(n=14)에 한해 anterior height/posterior height의 공식을 통해 compression ratio를 산출하였다.

2차적 지표로 입원 1주차에서 입원 3주차까지 환자의 VAS(visual analog scale) 통증 척도 점수를 분석하였다. 그 외 연령, 성별, 입원 기간, 총 치료기간, 당뇨, 골다공증, 골밀도, 압박골절 기왕력, 압박골절의 형태의 빈도와 비율을 분석하였다.

결과 : 1. 전방 골주 단독 골절에서의 compression ratio는 입원 1주차에서 3주차, 그리고 최종 영상 확보 시점까지 각각 20.92±10.42, 25.22±10.90, 25.57±11.04, 25.07±11.94로 기록되었다. 시점간에는 통계적으로 유의한 compression ratio의 차이가 나타나지 않았다.

2. 통증 VAS 점수 평균은 입원 1주차부터 3주차까지 각각 7.44±2.07, 4.67±1.63, 3.00±1.80으로 기록되었다. 시점간 모두 통계적으로 유의한 감소가 있었다(1주차-2주차 p=.003, 1주차-3주차 p<.000 2주차-3주차 p= 0.021).

결론 : 본 연구의 협진 입원치료 압박골절의 compression ratio는 입원 1주차 시점에서 최종 follow-up 시점까지 유의한 차이를 보일 만큼의 추가적인 추체 높이 감소를 보이지 않아 향후 좋은 예후를 예상할 수 있다. 통증 VAS 점수는 모든 주별 시점간에서 유의하게 감소되었다.

핵심 단어 : 협진, 압박골절, compression ratio, compression fracture, anterior column fracture

I. Introduction

Vertebral compression fractures(VCFs) can be recognized both as a clinical event or a radio-graphic one. Silverman notes that the prevalence of VCFs in women at or over 50 has been estimated at 26% when defined as a reduction in vertebral height greater than 15%. 84% of clinically found VCFs were related with pain. A VCF can be defined clinically as an event marked by acute pain and loss of vertebral height[1].

The treatment modality of compression fracture is closely related with the kyphosis angle and anterior height loss. There is debate on the exact degree and loss of height when surgical treatment is needed, but the literature on treatment modality decision for compression fracture generally recommends surgical or invasive treatment if the kyphosis angle is more than 30 to 40 degrees or if anterior height loss is greater than 30 to 60 percent[2-4].

The extent of the deformity corresponds with the likelihood of pain and disability. Decrease in vertebral height causes discomfort from the rib cage as it causes downward weight bearing on the pelvis. A kyphotic thoracic spine, lumbar lordosis, and a protruding abdomen with horizontal skin folds can be found in people with VCF. Also, even a single vertebral fracture poses increased risk for additional VCF and peripheral fractures[5].

In the Eastern medical setting, the low back is seen to have a close relationship with the Kidney. Traditional literature dictates that the spine, which forms part of the low back and houses the Kidney, may form pain after trauma[6-8]. Treatment of the compression fracture therefore may center around treatment of trauma or medication which tonifies the Kidney according to syndrome differentiation.

Vertebral body height and angle are important in compression fracture, as they are direct and objective measures of anatomical disfiguration. Anatomical disfiguration of the vertebral body may result in increased kyphotic angle and associated problems such as persistent back pain and cosmetic deformity. But currently there is no clinical literature on vertebral body measurement in the Eastern or combination medical setting. Since compression ratio as a measurement of the vertebral body represents an important factor in estimating the prognosis of compression fracture patients, the authors investigated changes in compression ratio, with pain as a secondary outcome, in acute compression fracture patients admitted to the Department of acupuncture and moxibustion in the Spine clinic at the East-West Neo Medical Center.

II. Subjects and methods

1. Subjects

Charts of acute thoracolumbar compression fracture

patients admitted within 2 weeks from onset to the Department of acupuncture and moxibustion in the Spine clinic at the East-West Neo Medical Center from 2006. 6. 1 to 2008. 11. 8 were reviewed.

Compression fracture repair is a bone healing process; therefore, chronic patients were not likely to show additional collapse since ossification has already occurred. The authors aimed to evaluate the effect of combination conservative treatment on this disorder; therefore, patients admitted after 2 weeks were not included in the study. Patients with less than 2 lateral x-ray views or those without an x-ray view at admission were also excluded, as they could not be evaluated. Patients with metastatic fracture and fractures from tuberculosis were also excluded.

2. Method

1) Treatment
① Acupuncture

Sterilized stainless steel needles(0.30×40mm, Dongbang Acupuncture Co. Korea) were used. The acupoints frequently used were LI_4, LR_3, GB_{34} and LU_8, KI_7, SP_3, and KI_4 as part of the Four needle technique when severe pain was present, and BL_{21} to BL_{25} were used bilaterally[9] in addition after severe pain remission. The needles were inserted at depths around 1 to 2cm when applying the Four needle technique. BL_{21} to BL_{25} were inserted at depths around 3 to 4cm. All needles were retained for 20minutes.

② Bee venom

Freeze-dried *Apis mellifera* bee venom (Kyung Hee Hospital Oriental Pharmaceutical Dept. Seoul, Korea) diluted with normal saline to a ratio of 1 : 30,000 was injected every other day in doses ranging from 0.4 to 0.8ml. The points frequently used were BL_{21} to BL_{25} and ouch points. Injection of diluted bee venom solution per point ranged from 0.03 to 0.1ml.

③ Herbal medication

Prescriptions for removing stagnant Blood were used in the first week, and were followed by tonifying prescriptions such as *Chunglijagam-tang(Qinglizikan-tang)*, *Ssanghwa-tang(Shuanghuo-tang)*, and *Bojungikgi-tang(Buzhongyiqi-tang)*. The cortex of *Cinnamommum cassia*, root of *Astragalus membranaceus* and Pueraria thunbergiana, rhizoma of *Coptis chinensis*, cortex of *Amebia euchroma*, and stem branch of Uncaria sinensis were selectively broiled and added according to their Eastern medicinal properties and their osteoblastic activity[10].

④ Cupping therapy

Cupping therapy was applied along the Bladder Meridian from acupoints BL_{21} to BL_{26} for 3 to 7minutes every day.

⑤ Moxibustion

Moxa cones approximately 1cm wide at the base and 1.5cm high were made with Dongbang Gold Moxa mogwort(Dongbang Acupuncture Co Korea). The cones were applied and burnt from top to bottom 5 to 9 times consecutively at acupoints BL_{21} to 25 of both sides in patients with pain and limitation of motion. The cones were removed when the patients expressed discomfort, which was generally around when two-third to three-fourths of the cone was burnt.

⑥ Transcutaneous Electrical Nerve Stimulation(TENS)

TENS was applied daily for 15minutes at the region of skin above the fractured vertebra in patients with pain.

⑦ Thoraco-lumbar spinal orthosis(TLSO)

Patients were fitted with a TLSO(Kyung Hee Orthotics) at the 8th day after admission. Patients were instructed to put on the TLSO whenever they had to assume sitting or standing posture. The patients were also instructed to put on and take of the TLSO while in lying position and not in an

upright or tilted position. They were taught to pull the device firmly down to the iliac crest and to fasten the straps very tightly so the spine would be firmly supported.

⑧ Absolute bed rest

Patients were not allowed or only allowed to assume standing position while using the bathroom for the first 7days. After TLSO administration, they were allowed to assume sitting position while eating, but still maintained absolute bed rest until the third week. Ambulation using walking aids was allowed if no mobility was seen at the affected vertebral body in dynamic view X-rays on the third week of admission.

⑨ Western medication and treatment for pain control

6 patients(37.5%) with moderate pain were given lumbar physical therapy from the second week. 5 patients(31.25%) were given muscular relaxants and NSAID(mulex 50mg tid, prodag 500mg tid). 2 patients(12.5%) were given muscular relaxants and analgesic(mulex 50mg bid, ultracet bid). 2 patients (12.5%) with severe pain at onset were each given one set of steroid facet blocks at the level of fracture.

2) Chart review

The VAS(visual analogue scale) scores for pain were recorded from the first to third week based on charts of patients meeting the criteria stated above(n=16). Sociodemographic data including age and gender was recorded. Admission period and total treatment period were measured in weeks. Charts were evaluated for diabetes mellitus or osteoporosis presence. Bone mineral density(BMD) was recorded as the lowest T value. The number and level of previous thoracolumbar fractures were recorded.

3) X-ray review

Two independent skilled spine clinicians each measured the height of the anterior and posterior walls of the fractured vertebra twice using the Piviewstar medical imaging program from Infinitt, Korea. The mean of the four values were used as the height of the walls in compression ratio calculation. The formula for compression ratio calculation is as described underneath(Fig. 1) :
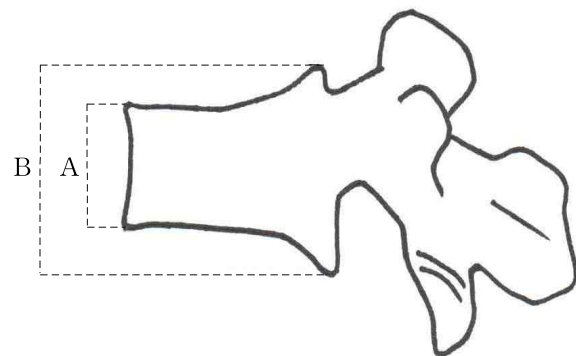
$$compression\ ratio =$$
$$(1 - Anterior\,wall\,height\,(A)/Posterior\,wall\,height\,(B)) \times 100$$

Fig. 1. Diagram of measures taken for compression ratio calculation
Compression ratio is calculated as (1-A/B)×100.

The authors regarded a week to start from the date of admission. The compression ratio for the first week to the third week and for the last X-ray follow-up were recorded and the mean±S.D. for each week were calculated and presented. The X-rays were typically taken at the start of the week, such as on admission which would have been counted as the first week image. When multiple images were present in one weekly time block, the image taken closest from the starting day of the week was chosen.

The fractures were also categorized by fracture column according to Denis[11,12]. Fractures were grouped as those with only anterior column damage, which are called wedge fractures, and those with multicolumn damage including damage of the middle column, called burst fractures. The compression ratio was calculated for only wedge fractures, since the posterior wall height would be compromised in burst fractures and would not provide proper compression ratio.

4) Statistical analysis

All analysis was performed using SPSS 12.0 for windows from LEAD techonlogies. The Kruskal-Wallis test was used to determine differences between compression ratio and pain VAS values at different weeks. Mann-Whitney testing was used for determination of p value for pain VAS difference between weeks. Kendall's tau-b and Spearman's rho test was used to check for correlations between BMD and compression ratio.

III. Results

1. Sociodemographic data & treatment periods

The 16 acute thoracolumbar fracture patients showed a gender distribution of 6 men(37.5%) and 10 women(62.5%), with a ratio of 1:1.667. Mean age was 68.44±11.72 years. All other time periods are presented as weeks. The mean admission period was 4.31±1.70. Mean total treatment period was 10.63±8.97(Table 1).

Table 1. Background Data and Related Factors

Background data and related factors	Acute compression fracture patients(n=16)
Age(vears mean±SD)	68.44±11.72
Gender(n/%)	Men 6(37.5%) Women 10(62.5%)
Admission period(mean±SD)	4.31±1.70
Total treatment period(mean±SD)	10.63±8.97
Diabetes mellitus(n/%)	1(6.3%)
Osteoporosis(n/%)	13(81.3%)
Bone mineral density(mean±SD)	−4.19±1.38
Fractures before admission(mean±SD)*	1.19±1.87

All time periods expressed as weeks. Digits rounded off to the 2nd decimal place.
n : number. SD : standard deviation.
* : Fractures that caused the present admission were not counted.

2. Underlying factors and history

Diabetes mellitus was found in only 1(6.3%) patient. Osteoporosis was common with presentation in 13(81.3%) patients. The mean bone mineral density was −4.19 with a standard deviation of 1.38. The average number of fractured vertebrae before current fracture was 1.19±1.87(mean±SD).

3. Classification by types of fracture

Of the 19 acutely fractured vertebrae, 15(78.9%) were anterior column fractures, also classifiable as wedge fractures. 4(21.1%) were 2 column fractures involving the anterior and middle column, classifiable as burst fractures and therefore not subject to compression ratio measurement(Table 2).

Table 2. Types of Acute Vertebral Fracture

		Fractured vertebrae(n=19)
Fractured column	Anterior column only(wedge) (n/%)	15(78.9%)
	Anterior and middle column(burst) (n/%)	4(21.1%)

n : number. Digits rounded off to the 2nd decimal place.

4. Level of fracture

17(47.22%) previous thoracolumbar fractures, other than the 19(52.78%) acute fractures, were

Table 3. Fracture Incidents by Vertebral Level

	Acute fractures	Old fractures	All fractures
T3	0	1	1(2.78%)
T6	0	1	1(2.78%)
T7	2	0	2(5.56%)
T11	2	1	3(8.33%)
T12	4	4	8(22.2%)
L1	4	2	6(16.67%)
L2	3	3	6(16.67%)
L3	2	2	4(11.11%)
L4	1	2	3(8.33%)
L5	1	1	2(5.56%)
Total	19(52.78%)	17(47.22%)	36(100%)

found in the 16 patients included in this study, making a total of 36 fractures observed. Fractures were most commonly found at T12 with 8(22.2%) fractures, with 6(16.67%) fractures each at L1 and L2. Fractures at the T-L junction(T11-L2) consisted of 23 cases(63.89%) and accounted for more than half of the total, as noted in other works such as the work by Lim et al[13](Table 3).

5. Compression ratio of anterior column fractures

The mean compression ratio for anterior column fractures(n=15) at the first to third week and at the last follow-up are, respectively, 20.92±10.42, 25.22± 10.90, 25.57±11.04, and 25.07±11.94. Kruskal-Wallis test showed no significant difference between the means(Chi-square 1.803, Asymp. Sig=.614)(Table 4).

Table 4. Compression Ratio from the First to Third Week and at Last Imaging Follow-Up

	Acute anterior column fracture(n=14)		
Time at X-ray	Range	Mean	SD
First week(n=14)	4.62-40.88	20.92	10.42
Second week(n=12)	3.23-42.34	25.52	10.90
Third week(n=10)	5.91-42.49	25.57	11.04
Last follow-up(n=14)*	4.07-38.16	25.07	11.94

n : number. SD : standard deviation.
Digits rounded off to the 2nd decimal place.
* : The mean last follow-up was made at 10.38±8.33 (mean±SD, week).

6. Changes in pain VAS scores

The mean pain VAS scores at the first to third week in acute thoracolumbar compression fracture patients(n=16) are 7.44±2.07, 4.67±1.63, and 3.00±1.80 respectively. Kruskal-Wallis test showed significant differences between the weeks(Chi-square 18.989, Asymp. Sig=.000). Mann-Whitney testing showed significant differences between all three weeks(first and second week p=.004, first and third week $p<$.000, second and third week p=.021)(Table 5).

Table 5. Pain Visual Analog Scale Scores from the First to Third Week

	Acute compression fracture patients(n=16)	
Time at measurement	Range	Mean+SD
First week(n=16)	5-10	7.44±2.07[*,†]
Second week(n=15)	2-8	4.67±1.63[*,‡]
Third week(n=14)	0-6	3.00±1.80[†,‡]

n : number. SD : standard deviation.
Statistical significance ∗ : p : 0.004. † : $p<$0.000. ‡ : p : 0.021.
Digits rounded off to the 2nd decimal place.

7. Correlation between BMD and compression ratio

Kendall's tau test and Spearman's rho test was performed between BMD and compression ratio at the first week and at last follow-up in order to find out if BMD has correlation with compression ratio. There was no correlation found(Table 6).

Table 6. Results of Nonparametric Correlations Between Bone Mineral Density and Compression Ratio

	Kendall's tau-b		Spearman's rho	
	CC	Sig (2-tailed)	CC	Sig (2-tailed)
First week	-0.078	0.730	-0.116	0.720
Last follow-up	-0.233	0.300	-0.344	0.273

CC : correlation coefficient. Sig : significance.
No significant correlation found. Digits rounded off to the 3rd decimal place.

Ⅳ. Discussion

Stability is the major factor to consider when selecting treatment for thoracolumbar spinal fractures. In the study of Reid et al., fractures with kyphosis less than 35° and anterior height loss less than 60% were accepted as stable[14]. Compression ratio was chosen as the main measurement value in this study since it is an objective measurement of height loss in wedge fractures, and thus provides

important information on stability and prognosis.

The authors have evaluated acute stage patients in a 3-week admission period. This time window was chosen because patients gain clinically functional fracture stability after immobilization for that period of time[15]. Bedbrook has also reported that patients with unstable fractures gain clinical stability after that time[16]. This may be due to the fact that the bone healing process is in the middle of the regenerative phase at that point. Our compression ratio results back this hypothesis ; there is a slight increase in mean compression ratio at the last imaging follow-up compared to the third week. The results showed almost no change in mean compression ratio from the second week to last follow-up.

The mean total treatment period was 10.38±8.33 weeks. Follow-up was finished in all patients at the same follow-up when the last X-rays were taken. This time point is roughly in accordance with the recommended bed rest period, and is in a time frame past that of the acute compression fracture stage when collapse occurs. Therefore, the authors cautiously suggest that the results imply good prognosis for the long term period as well.

The patient population showed a gender ratio of 1 : 1.667 favoring women. Other clinical studies on the Eastern medical hospital inpatient group showed even bigger percentages of women patients. The study of Lee et al[17]. on 20 hospitalized stable compression fracture patients showed a ratio of 1 : 3. Oh et al.'s[18] study on 40 hospitalized thoracolumbar fracture patients showed a ratio of 1 : 2.64.

The reproducibility and reliability of the anterior and posterior wall height measurements were calculated by intraclass correlation coefficient(ICC) analysis. The interobserver and intraobserver ICC values were 0.9508 and 0.9707 respectively. According to the criteria proposed by Landis and Koch, a value between 0.81-1 indicates almost perfect correlation[19].

Kim et al. in a retrospective clinical study of 83 conservatively treated osteoporotic compression fracture patients in an orthopedic setting reported a mean compression ratio of 24.74±12.03% at injury and an additional collapse of 21.68±11.43% at the last follow-up[20]. This is in concordance with the current knowledge that vertebral compression itself is increased during conservative treatment.

Our study shows a similar rate of compression at injury but shows no significant additional compression at the end of the follow-up period. This may be due to the difference in last follow-up time from injury, since our paper had an average follow-up period of 10.63±8.97 weeks from onset, while the paper by Kim included only patients with over 1 year of follow-up at data recruitment. It may also be due to the differences in research design, as the authors looked at patients with acute VCF, and Kim et al. focused on OCF patients. But no significant additional collapse was seen in our study at 10.38±8.33 weeks after admission which is a point past the acute compression stage, and the average BMD is lower in our patient group at -4.19±1.38 compared to -3.07±1.12 in Kim's group, which makes these hypotheses less plausible.

The exact treatment given under the term of conservative treatment was not elaborated in Kim's paper. It may be the differences in treatment such as additional Eastern medical treatment provided to our group, or undocumented differences in ward care that caused the difference. The authors have used large doses of root of Pueraria thunbergiana in all patients with compression fracture. The root of Pueraria thunbergiana has been found to have a potent osteoblastic effect, and the authors suspect that usage of this herb during the regenerative period of the bone healing bone repair may have provided assistance in strengthening of the medullary bone structure[10].

Vertebroplasty is a minimally invasive procedure widely used in the Western medical setting which involves the injection of cementing material at the fractured vertebra, allowing the material to solidify and strengthen the fractured body. It has known effects on alleviation of pain[21], and its effect on vertebral height restoration[22] is widely being researched with varying results, with compression

ratio as a tool of choice in measuring the changes in vertebral height. But there is some evidence that vertebroplasty may cause additional vertebral body fractures at adjacent levels, and this is thought to be due to the continued mechanical stress that the hardened vertebroplasty injection imposes on the neighboring vertebrae[23]. The present study may be free from such side effects, and further studies on this subject are warranted.

The limitations of this study are its short follow-up period, small number of subjects, and lack of control. And at present, there are more studies on compression angle measurement than those on compression ratio. Further studies on these patients in the Eastern medical setting with consideration for these factors are needed.

V. Conclusion

Charts of acute thoracolumbar compression fracture patients admitted within 2 weeks from onset in the Spine clinic at the East-West Neo Medical Center from 2006. 6. 1 to 2008. 11. 8 were reviewed. Compression ratio, pain, and other related factors were analyzed to produce the below results.

1. Mean compression ratio for acute anterior column fracture at the first to third week and at last imaging follow-up(10.38±8.33 weeks, mean±SD) were measured as 20.92±10.42, 25.22± 10.90, 25.57±11.04, and 25.07±11.94 respectively. No statistically significant differences were found between time periods.
2. Mean VAS for pain were 7.44±2.07, 4.67±1.63, 3.00±1.80 respectively for the first to third week, and showed statistically significant differences between weeks(first and second week p=.003, first and third week $p<.000$, second and third week $p=0.021$).

The authors conclude that there was no significant increase in compression ratio and thus no additional collapse at the last follow-up compared to the first week in patients who underwent conservative treatment in this study. VAS scores for pain in these patients were significantly reduced between all weekly time blocks.

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