The Journal of Physical Therapy Science

Original Article

Changes in joint space width during Kaltenborn traction according to traction grade in healthy adults

Gui-do Moon, PT, MSc[1], Tae-ho Kim, PT, PhD[2], Jin-yong Lim, PT, PhD[1]*

[1] Department of Physical Therapy, The Graduate School, Daegu University: 15 Jilyang, Gyeongsan-si, Gyeongbuk-do 712-714, Republic of Korea
[2] Department of Physical Therapy, College of Rehabilitation Science, Daegu University, Republic of Korea

Abstract. [Purpose] The aim of this study was to analyze the joint space width of the humeral head and glenoid fossa during traction under 2 grade conditions (grade 2/grade 3). [Subjects and Methods] The subjects were 20 healthy male adults who had not experienced any shoulder injury. Three radiographs were obtained with the subjects in the supine position (resting, grades 2 and 3). The glenohumeral joint space was examined on radiography. Joint space width was measured by a radiologist at the points described by Petersson and Redlund-Johnell. A radiologist blinded to the variable "resting" or "traction" performed all radiographic measurements. The joint space widths were compared by using one-way repeated-measures analysis of variance. [Results] The results of this study indicated significant differences in the changes in joint space width according to traction grade. Compared to resting, grades 2 and 3 traction significantly increased joint space width. However, no significant difference in joint space width was found between grades 2 and 3 traction. [Conclusion] Although no significant differences were found between grades 2 and 3 traction during glenohumeral joint traction, the increase in joint space width between the glenoid fossa and humeral head was highest during grade 3 traction.
Key words: Joint space width, Glenohumeral joint, Traction

INTRODUCTION

Glenohumeral (GH) joint contracture can occur after repair of rotator cuff tears, frozen shoulder, and rheumatoid arthritis[1]. This can be caused by capsular contracture, tendon shortening, and scars[2, 3]. Manual shoulder joint test is the "end feel" that the physical therapist feels during the resistance of the tissue against the force applied manually from the different directions of the articular surface and greatly depends on subjective evaluation[4]. To test the stiffness and looseness of the articular capsule, one of the causes of limited shoulder movement, various orthopedic manual techniques are used[5, 6].

According a study on manual therapy, traction can be used as a diagnostic tool to assess joint play or as treatment to relieve pain or improve joint mobility[7]. In particular, the traction method according to the Kaltenborn-Evjenth Concept is a safe and effective method to test the condition of the articular capsule in the field of orthopedic physical therapy[8]. Traction is a technique that distracts one articular surface perpendicular to the other[9]. The joint traction grade was set at 3, as defined by Kaltenborn[9]. Grade 1 (G1) has no appreciable joint separation. G1 represents the force necessary to remove the compressive forces acting on the joint. In grade 2 (G2), the slack is taken up from the tissue surrounding the joint, which are then tightened. Finally, in grade 3 (G3), additional force is applied and the soft tissues surrounding the joint are stretched; thereby, separation of the joint surfaces is achieved.

Traction is preferably performed in the maximal loose-packed position (MLPP) of the joint (shoulder 55° abduction and 30° horizontal adduction in the transverse plane). In the MLPP, the traction is generally assumed to be most effective because the joint capsule is most relaxed[10]. Dvorak and coworkers stated that up to 5 mm of separation of the joint surfaces is physiological during joint play testing[11].

Gokeler et al. reported that in the comparison of joint space width (JSW) between the humeral head and the glenoid fossa after applying a 14-kg load to the GH joint of the asymptomatic subjects during manual traction, JSW was widened by about 0.3 mm, but difference was not significant[12]. Meanwhile, in the research by Sato et al., JSWs were compared after applying traction to the point that the maximum resistance in the hip joint was detected in symptomatic subjects[13]. The results of the research indicated that JSW was widened by about 0.9 mm, with a significant difference. Perhaps, the structural difference between the GH and the hip joints in both research studies might have affected the results. Therefore, when applying traction to the GH point, the exact degree of separation of the humeral head from the glenoid fossa is unknown. In addition, quantitative reports related to the application of traction are lacking, and traction remains dependent on the sensation felt by therapists in their fingertips. The aim of this study was to analyze the JSW of the humeral head and glenoid fossa during traction under 2 grade conditions (G2 and G3).

SUBJECTS AND METHODS

The subjects of this study were individuals who did not have medical histories of shoulder injury and damage to the nervous and musculoskeletal systems, which may affect the range of shoulder movement, and have not performed shoulder muscle strength training during the recent 6 months prior to the study. The research subjects were selected from among 20 male employees who worked at H hospital, located in Ulsan Metropolitan City. Before starting the test, they were given enough explanation on the test and participated voluntarily in the test after submitting a signed consent form. This study was approved by the Ethics Commission of Daegu University according to the Declaration of Helsinki. The general characteristics of the subject are shown in Table 1.

Traction was applied to the dominant side of the subjects' shoulder. The dominant hand, defined as the hand used for eating and writing, was the right hand in all of the subjects. The subjects lied down on the radiography table, rotating the trunk 30° to the right so that the scapula at the shooting side touched on the table. The opposite shoulder was supported by using a triangular support angled at 30° so that the subject could lie down comfortably while maintaining the rotated position. To prevent scapular movement during traction, the tester positioned the subject's shoulder abduction to 50° after the subject's palms were positioned facing up. This position was used as the resting position and the MLPP of the shoulder joint. The assistant used a goniometer while the subjects were in the MLPP. Taking the proximal humerus with both hands, the humerus was pulled toward the perpendicular direction against the glenoid fossa. The traction was performed by a physical therapist who completed educational courses on the Keltenborn-Evejenth Concept and had at least 10 years of experience with joint mobilization.

Immediately after applying traction, the therapist verbally gave an "okay" signal to the radiologist so that radiography could be started. All the radiographies were performed by the same radiologist, with anteroposterior projection (diagnostic radiography, Listem, Co., Ltd., Japan). For random assignment of order by grade, the subjects were told to pick one card after placing cards with Nos. 2 or 3 written on it in a box. For those who picked No. 3, radiography was performed by applying the resting position, G3 on the first day, and G2 on the next day. For those who picked No. 2, radiography was performed by applying the resting position, G2 on the first day, and G3 on the next day. G2 refers to a force that tightens the peri-articular soft tissue. The G3 force causes enough distraction that causes the joint capsule to stretch[9]. Radiography was performed at the same hour for the same person for 2 days. Other grades were applied in the same manner after 1 day so that the structure of the joint can return to its normal condition.

In the computer that received the images taken by using the PACS program, data were calculated by using the method suggested by Petersson and Redlund-Johnell[14]. In this position, the projection of the joint surface of the humeral head forms a semicircle, the diameter of which is the line joining the two terminal points of the joint surface projection. One point was determined each at the superior and inferior edges of the glenoid fossa, making a total of three points. Each of the three points of the glenoid cavity was connected to the center point of the humeral head by placing the ruler. The mean value was obtained after measuring each distance. The radiologist was told how to conduct the measurement before the test and made to practice adequately how to measure by using the shoulder joint pictures obtained by other radiologists. In addition, information on the traction grade was withheld until all the measurements were finished.

SPSS 18.0 was used for statistical processing. Prior to the analysis, data normality were tested by using the Kolmogorov-Smirnov. $ICC_{(3.1)}$ (ICC, intraclass correlation coefficients) was used to derive the intra-rater reliability of the JSW measurements. To compare JSW according to GH traction grade, one-way repeated-measures analysis of variance (ANOVA) was performed, and a least square difference was performed for post hoc analysis. The significance level was set at 0.05.

Table 1. General characteristics of subjects (n = 20)

Characteristics	Mean ± SD
Age (years)	31.7±2.9
Height (cm)	174.6±3.7
Weight (kg)	70.5±7.0
BMI (kg/m^2)	23.1±2.0

BMI: body mass index

Table 2. Joint space width by the shoulder traction grade (mean ± SD)

Group	Resting	Grade 2	Grade 3
JSW (mm)	4.0±0.3	4.5±0.4‡	4.7±0.5§

‡Significant difference between resting and grade 2 traction ($p < 0.05$)
§Significant difference between resting and grade 3 traction ($p < 0.05$)
JSW: joint space width

RESULTS

The results of the statistical analyses are shown in Table 2. The results of the one-way repeated-measures ANOVA to verify the changes in JSW according to grade indicated significant differences in JSW. Post hoc analysis showed that the JSW was significantly higher with G3 traction than with G2 traction and resting position. However, no significant difference in JSW was found between G2 and G3. The intra-rater reliability for JSW measurements was good to excellent (ICC$_{3,1}$ = 0.88–0.98)

DISCUSSION

This study was performed to analyze the changes in JSW between the glenoid fossa and humeral head, while GH traction was applied according to grade. The JSW for the resting position was 4 mm. In the Kaltenborn-Evjenth Concept, G1 traction is explained as the stage to remove the pressure force to the joint without separation of joint[10]. Therefore, in this study, G1 traction was not applied in the resting position.

In the G2 traction, JSW was 4.5 mm, increased significantly by 0.5 mm from that in the resting position. G2 traction refers to the moment that the slack of the articular capsule is released, and the collagen fibers within the tissue become tight by increasing the tension gradually. It means that JSW is increased at that moment.

In addition, the JSW in the G3 traction was 4.7 mm, increased significantly by 0.7 mm from that in the resting position. In the G3 traction, greater force than the traction given in G2 was applied to the tissue, stretching the collagen fiber. In this moment, it does not cross the rupture point of the collagen fiber, which explains the reason why JSW in the G3 traction was increased by 0.2 mm, more than the 0.5 mm in the G2 traction. Sato et. al. reported that JSW was increased significantly by 0.9 mm, from 3.86 to 3.95 mm, as a result of hip joint traction in the maximum relaxation position in the healthy adults[13]. However, Goker et al. applied a 14-kg force, which is equivalent to the GH traction, to a healthy person for repair of the scapula, and the JSW was increased by approximately 0.3 mm[12]. The difference is due to the position of the subject during traction. In this study, traction was performed in the supine position; whereas in the research by Goker et al., it was performed in the sitting position. Considering that in the sitting point, the humerus is affected by gravity, the resistance of the tissue might be increased while in the sitting position. As the resistance of the tissue was small because most of the connective tissues are not affected by the gravity, JSW is considered to be increased even more.

Dvorak and coworkers stated that up to 5 mm of separation is normal in the MLPP during joint play testing but did not provide evidence to support their statement[11]. The results of the present study do not support these statements. When G3 traction was applied, only an increase of 0.6 mm was observed. JSW was increased by 0.2 mm in G2 and G3, but without significant difference. This means that JSW was not increased greatly even when greater force was applied through the G3 traction to the joint capsule stretched tightly in the G2 traction. However, the therapists can adequately feel the difference in the end feel of the tissue during the G3 traction.

The limitations of this study are as follows: First, as the number of the subjects was small, the study results are hard to generalize. Second, as this study was performed with healthy persons, we could not apply traction to the shoulder joint of patients with a frozen shoulder. Finally, the amount of force was not measured while applying traction. Thus, future research should take these factors into consideration.

Many physical therapists have used traction according to the Kaltenborn-Evjenth Concept, but because they judge the grade subjectively, simply depending on the sensation of the therapist and the end feel of the joint, they could not know exactly how much space within the joint is separated, until recently. In conclusion, in this study, we found that although the G2 and G3 tractions during the GH traction in the healthy persons did not significantly differ, the increase in the JSW between the glenoid fossa and the humeral head was highest during the G3 traction. This is deemed to provide help for therapists in the safe and effective application of traction techniques in clinical cases.

REFERENCES

1) Hatakeyama Y, Itoi E, Pradhan RL, et al.: Effect of arm elevation and rotation on the strain in the repaired rotator cuff tendon. A cadaveric study. Am J Sports Med, 2001, 29: 788–794. [Medline]

2) Do Moon G, Lim JY, Kim Y, et al.: Comparison of Maitland and Kaltenborn mobilization techniques for improving shoulder pain and range of motion in frozen shoulders. J Phys Ther Sci, 2015, 27: 1391–1395. [Medline] [CrossRef]

3) Warner JJ, Greis PE: Instructional Course Lectures, The American Academy of Orthopaedic Surgeons—The treatment of stiffness of the shoulder after repair of the rotator cuff. T J Bone Jt Surg Am, 1997, 79: 1260–1269.

4) Magee DJ: Orthopaedic physical assessment. Philadelphia: W.B. Saunders, 1992, pp 61–64.

5) Deodato F, Cristiano S, Trusendi R, et al.: A functional approach to the TMJ disorders. Prog Orthod, 2003, 4: 20–37. [Medline]

6) Gong W, Lee H, Lee Y: Effects of Gong's mobilization applied to shoulder joint on shoulder abduction. J Phys Ther Sci, 2011, 23: 391–393. [CrossRef]

7) Mink A, Ter Veer H, Vorselaars JT: Extremiteiten: functie-onderzoek en manuele therapie. Bohn: Scheltema & Holkema, 1990, pp 32–35.

8) Brandt C, Sole G, Krause MW, et al.: An evidence-based review on the validity of the Kaltenborn rule as applied to the glenohumeral joint. Man Ther, 2007, 12: 3–11. [Medline] [CrossRef]

9) Kaltenborn F: Fisioterapia manual columna. Madrid: McGraw-Hill Interamericana, 2000, pp 193–204.

10) Kaltenborn FM, Evjenth O: Mobilization of the extremity joints. Oslo: Olaf Norlis Bokhandel, 1989, pp 15–16.

11) Dvořák J, Schneider W, Dvorak V, et al.: Musculoskeletal manual medicine: diagnosis and treatment. New York: Thieme, 2008, p 240.

12) Gokeler A, van Paridon-Edauw GH, DeClercq S, et al.: Quantitative analysis of traction in the glenohumeral joint. In vivo radiographic measurements. Man Ther, 2003, 8: 97–102. [Medline] [CrossRef]

13) Sato T, Sato N, Masui K, et al.: Immediate effects of manual traction on radiographically determined joint space width in the hip joint. J Manipulative Physiol Ther, 2014, 37: 580–585. [Medline] [CrossRef]

14) Petersson CJ, Redlund-Johnell I: Joint space in normal gleno-humeral radiographs. Acta Orthop Scand, 1983, 54: 274–276. [Medline] [CrossRef]