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Immediate Effects of Angular Joint Mobilization (a New Concept of Joint Mobilization) on Pain, Range of Motion, and Disability in a Patient with Shoulder Adhesive Capsulitis: A Case Report

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Patient: Female, 53
Final Diagnosis: Adhesive capsulitis
Symptoms: Pain • limited range of motion
Medication: None
Clinical Procedure: Manual therapy (joint mobilization)
Specialty: Physical Therapy

Objective: Unusual or unexpected effect of treatment

Background: Adhesive capsulitis is a common disabling condition, with reviews reporting up to 5.3% of the population being affected, the burden placed upon individuals and healthcare services may therefore be considered substantial. For recovering the normal extensibility of the capsule in individuals with adhesive capsulitis of the shoulder, passive stretching of the capsule through end-range mobilization has been suggested. Recently, the concept of joint mobilization into angular joint mobilization (AJM), which is rotational joint mobilization with joint axis shift, was proposed. This case report aimed to investigate the immediate effect of AJM on pain, range of motion (ROM), and disability in a patient with shoulder adhesive capsulitis.

Case Report: The patient was a 53-year-old woman who was diagnosed with left shoulder adhesive capsulitis. Her left shoulder gradually stiffened, affecting functional activity. The patient attended 12 joint mobilization sessions over a period of six weeks (two times per week). The intervention consisted of rotary oscillations of the left shoulder, which were applied with overpressure and stops before the end of the pathological limit. After intervention, the patient reported 3/100 pain intensity on the visual analogue scale (VAS) (before versus after: 58 versus 3). Active ROM improved by 51° in flexion, 76.4° in abduction, 38.7° in external rotation, and 51.4° in active internal rotation. Passive ROM improved by 49° in flexion, 74.6° in abduction, 39.4° in external rotation, 51.4° in internal rotation. The total shoulder, pain and disability index (SPADI) score improved by 53.9%.

Conclusions: The patient reacted positively to AJM, resulting in improved shoulder pain, ROM, and disability, and the results suggest that AJM allow consideration in the management of individuals with adhesive capsulitis.

MeSH Keywords: Adhesive Capsulitis • Case Reports • Restraint, Physical • Shoulder Joint

Abbreviations: **AJM** – angular joint mobilization; **ROM** – range of motion; **SPADI** – shoulder pain and disability index

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Background

Adhesive capsulitis, also referred to as frozen shoulder, is a common disabling but self-limiting condition from progressive fibrosis and ultimate contracture of the glenohumeral joint capsule. The condition is associated with pain, limited range of motion (ROM), sleep deprivation, anxiety, and disability that may be hugely disruptive and impact nearly every aspect of daily living and occupational activities of an individual [1–5]. The average duration of the condition is 30.1 months (range 1 to 3.5 years) but it may be substantially longer, and the burden placed upon individuals and healthcare services may therefore be considered substantial [5]. However, the etiology for primary adhesive capsulitis remains unknown [1,2]. Preferentially women 30–60 years old are affected, but it can occur in patients of any age [6]. The prevalence of primary adhesive capsulitis is reported to affect 2% to 5.3% of the general population and secondary adhesive capsulitis related to diabetes mellitus and thyroid disease is reported to be between 4.3% and 38% [7].

Traditionally, for recovering the extensibility of the shoulder capsule in individuals with adhesive capsulitis, passive stretching of the shoulder capsule in all planes of motion by end-range mobilization has been suggested [8,9]. These approaches have been described in the literature [9–11]. Based on these approaches, physical therapists have used an anterior glide of the humeral head to improve external rotation ROM, according to the convex-on-concave concept of joint surface motion [11–13]. In this manner, with the glenohumeral joint as a ball-and-socket joint coupled to Kaltenborn convex-concave rule, mobilization for the glenohumeral joint were introduced in which roll and glide occurred in the opposite direction. In spite of that, this approach has never been validated by intra-articular kinematic studies, and supporting clinical data is lacking. In addition, particularly, more studies are in contrast with Kaltenborn convex-concave rule [14–27].

Johnson et al. suggested that a posteriorly directed joint mobilization was more effective than Kaltenborn convex-concave based on anteriorly directed mobilization for improving external rotation ROM in individuals with adhesive capsulitis. This approach can be based on the capsular constraint mechanism where the tight capsule caused humeral head translations in the direction opposite to the tightened region [25], however, this capsular constraint mechanism is also debatable [29–32].

Baeyens et al. suggested redefining mobilization techniques for the glenohumeral joint in terms of rotation of the humerus and translation of the geometrical center of the humeral head [18]. Based on this background, the authors theorized that joint restriction was due to impaired rotation with possible joint axis shift impairment of the rotary motion joint. And then, the authors revised the idea of joint mobilization and named it angular joint mobilization (AJM), which is rotational joint mobilization with joint axis shift. However, no studies have investigated the possibility of this approach in individuals with adhesive capsulitis. Thus, this case report aimed to investigate the immediate effect of AJM on pain, ROM, and disability in a patient with adhesive capsulitis of the shoulder.

Case Report

Patient history and systems review

The patient was a 53-year-old woman, right hand/arm dominant, with a height of 160.02 cm and weight of 54.43 kg. Her symptoms began approximately seven months before being seen for an evaluation for physical therapy. She was referred to physical therapy by an orthopedic surgeon who diagnosed her with left shoulder adhesive capsulitis. Aside from taking meloxicam, the patient was not taking any other medications. There was no history of manipulations under anesthesia or surgery. She reported tripping, but reached out with her left arm to avoid the fall (mild trauma), while walking in her garden. She experienced a sudden sharp pain in her shoulder, which worsened a few days later after she accidentally hit her left shoulder on a door lock. Her left shoulder gradually stiffened, affecting her functional activity. She spent most of her time in the garden to grow vegetables. She had never experienced any shoulder pain before. During her visit to her primary care physician or orthopedic surgeon, radiography revealed no abnormalities/fracture and degenerative joint disease. She had nephrolithiasis previously and, at the time of the initial physical therapy evaluation, reported no other health problems. Further screening showed no signs or symptoms indicative of a possible underlying serious pathology including cervical disc disorders/radiculopathy, shoulder dislocation/subluxation, muscle power deficits/rotator cuff syndrome, and tendonitis/bursitis. The patient complained of constant pain in her left shoulder. This pain awakened her approximately four or five times per night while lying on the left side and with position change. The patient's goals for physical therapy were to return to her previous level of function such as washing her back, resuming household chores including putting items on the top shelf, carrying a bag of fertilizer, and growing vegetables.

Examination

The patient initially received a physical therapy evaluation that showed shoulder pain and limitations to active and passive ROM in flexion, abduction, external and internal rotations.

Shoulder pain was examined by using the visual analogue scale (VAS, 0 to 100). The patient completed the VAS questionnaire before the intervention, during the intervention, and after the intervention per session at resting position.

Both active (AROM) and passive ROM (PROM) were measured with a goniometer. Measurements were performed in shoulder flexion, abduction, external rotation in 57° abduction, and internal rotation in 57° abduction in both AROM and PROM, three times.

Within the international classification of functioning, disability and health (ICF) framework, the constructs of "activity limitations" and "participation restrictions" were examined by using the shoulder pain and disability index (SPADI) before and after the intervention.

Clinical impression

At the initial examination, the patient stated experiencing moderate levels of pain, with the VAS score being 58. Compared with the mean (SD) normative values, she had limited shoulder AROM in flexion (111.7°; normative value, 180°), abduction (57.3°; normative value, 180°), external rotation at 57 abduction (17.0°; normative value, 70°), internal rotation at 57° abduction (32.3°; normative value, 90°). In addition, she had limited shoulder PROM in flexion (116.3°; normative value, 180°), abduction (62.7°; normative value, 180°), external rotation at 57° abduction (22.3°; normative value, 70°), and internal rotation at 57° abduction (34.3°; normative value, 90°). In the SPADI for testing activity limitations, the patient demonstrated a pain score of 60, disability score of 72.5, and total score of 67.7. Tables 1 and 2 lists the baseline outcome measures.

Interventions

The immediate goals of the intervention strategy were to improve the patient's shoulder pain, and improve the limited ROM and restricted shoulder function. The patient's long-term goal was to participate in daily activities at her previous level. After the examination, direct intervention using AJM was initiated. The patient attended 12 joint mobilization sessions over a period of six weeks (two times per week for six weeks). The intervention started with an informative and explanatory session, and was applied for 20 minutes per session. To apply joint mobilization, the patient assumed the supine position comfortably. Before applying each AJM for flexion, abduction, external rotation, and internal rotation, the direction of the joint shift was identified by the therapist together with the patient's report of feeling the most joint structure stretching, lesser pain, and increase ROM. Grade II AJM were applied on all 12 sessions, in which rotary oscillations were applied with overpressure but stopped before the end of a joint's pathological limit. Joint tissues were slack at the beginning of the arc of movement and joint stretching occurred from mid to end range of the arc of movement. For flexion AJM, inferior shift was applied on the first to the sixth session (Figure 1A); posterior shift was applied from the seventh to the twelfth sessions (Figure 1B). For abduction AJM, posterior shift was applied from the first to the tenth sessions (Figure 1C); rotational shift was applied on the eleventh session (Figure 1D); posterior shift was applied on the twelfth session (Figure 1C). For external rotation AJM at approximately 57° abduction angle, posterior shift was applied from the first to the sixth sessions; inferior shift was applied on the seventh session; posterior shift applied from the eighth to the tenth session; rotational shift applied on the eleventh session; and posterior shift applied on the twelfth session. For internal rotation AJM at approximately 57° abduction angle, posterior shift was applied from the first to the twelfth session.

Angular joint mobilization

AJM has three steps. The first step is the primary joint mobilization. The direction is determined by the limited motion of the long lever arm going into end range with overpressure to tolerance. This is done passively but can also be active or active assisted. The second step is called the joint shift (assistive joint mobilization). This is sustained pressure but can also be overpressure. Joint shift includes not only glide, but also rotation, spin, compression, and distraction. The most joint structure stretching and lesser pain will determine the direction of the joint shift. It does not follow the convex-concave rule as the approach plane is not parallel to the concave joint surface (not a flat surface). The third step is combined movement, which is used at an advanced stage.

Primary joint mobilization is applied at the pathological limit but stops before the anatomical limit of a joint's range of motion. This technique should not produce sharp pain, even with overpressure. The primary joint mobilization grading in AJM is as follows: grade I (a painful joint) is rotary oscillations which are applied with slight overpressure at the start of the pathological limit. Like a swinging pendulum, the joint tissues are on slack at the beginning to the mid-range and joint stretching occurs toward the end the arc of movement. Grade II is rotary oscillations which are applied with overpressure and stopped before the end of the pathological limit. Joint tissues are slack at the beginning of the arc of movement, and joint stretching occurs from mid to end of the arc of movement. Grade III (in a non-painful joint) is rotary oscillations with overpressure which are applied to the end of the pathological limit (Figure 2). The following are the three types of joint shifts: In joint shift, sustained pressure is applied at the start of accessory movement limit while primary joint mobilization is applied. In joint shift (+), sustained overpressure is applied in between the start of accessory movement limit and end of accessory movement limit while primary joint mobilization is

Table 1. Outcome on the AROM, PROM, and VAS.

Clinical outcome measure	Baseline	Week 3 (visit 6)	Week 6 (visit 12)
AROM, degree			
Flexion			
Pre-	111.7	135.3	155.7
Post-	126.7	147.0	162.7
Abduction			
Pre-	57.3	88.7	127.0
Post-	68.3	100.0	133.7
ER at abduction			
Pre-	17.0	35.7	39.7
Post-	28.3	42.3	55.7
IR at abduction			
Pre-	32.3	55.7	81.3
Post-	41.7	62.7	83.7
PROM, degree			
Flexion			
Pre-	116.3	147.7	160.0
Post-	132.3	151.7	165.3
Abduction			
Pre-	62.7	103.3	129.3
Post-	70.3	109.7	137.3
ER at abduction			
Pre-	22.3	40.3	53.3
Post-	34.7	47.7	61.7
IR at abduction			
Pre-	34.3	60.7	82.7
Post-	50.3	67.0	85.7
VAS (0–100)			
Pre-	58	18	13
During	96	77	81
Post-	34	13	3

AROM – active range of motion; PROM – passive range of motion; VAS – visual analog scale; ER – external rotation; IR – internal rotation.

Table 2. Outcome on the disability Index.

Clinical outcome measure	Baseline	Week 6 (visit 12)
SPADI, score		
Pain	60.0	14.0
Disability	72.5	13.8
Total	67.7	13.8

SPADI – shoulder, pain and disability index.

applied. In joint shift (o), overpressure is applied to the end of accessory movement limit while primary joint mobilization is applied then brought back to slack.

Results

The patient attended 12 intervention sessions over the course of six weeks. Clinical outcomes, including VAS score and ROM were collected at baseline and at every session (Table 1, Figures 3, 4).

The SPADI results were collected at baseline and at the last session (Table 2). At the last session, the patient's active range of motion improved by 51° in flexion, 76.4° in abduction, 38.7° in external rotation, and 51.4° in internal rotation. In addition, the patient was reported to have an improvement of 49° in passive flexion ROM, 74.6° in passive abduction ROM, 39.4° in passive external rotation ROM, and 51.4° in passive internal rotation ROM. Total pain score in SPADI improved by 46%, total disability score in SPADI improved by 58.7%, and total SPADI score improved by 53.9%.

The patient met almost all of her functional goals at the end of 12 intervention sessions, which were washing her back with some effort, putting light items on the top shelf, resuming house chores, carrying a bag of fertilizer, and growing vegetables. The patient had several setbacks on pain: on the fourth session because she helped at her son's garage sale, lifting heavy items at waist level and did some gardening, and on the ninth and the twelfth session because of gardening and yard work.

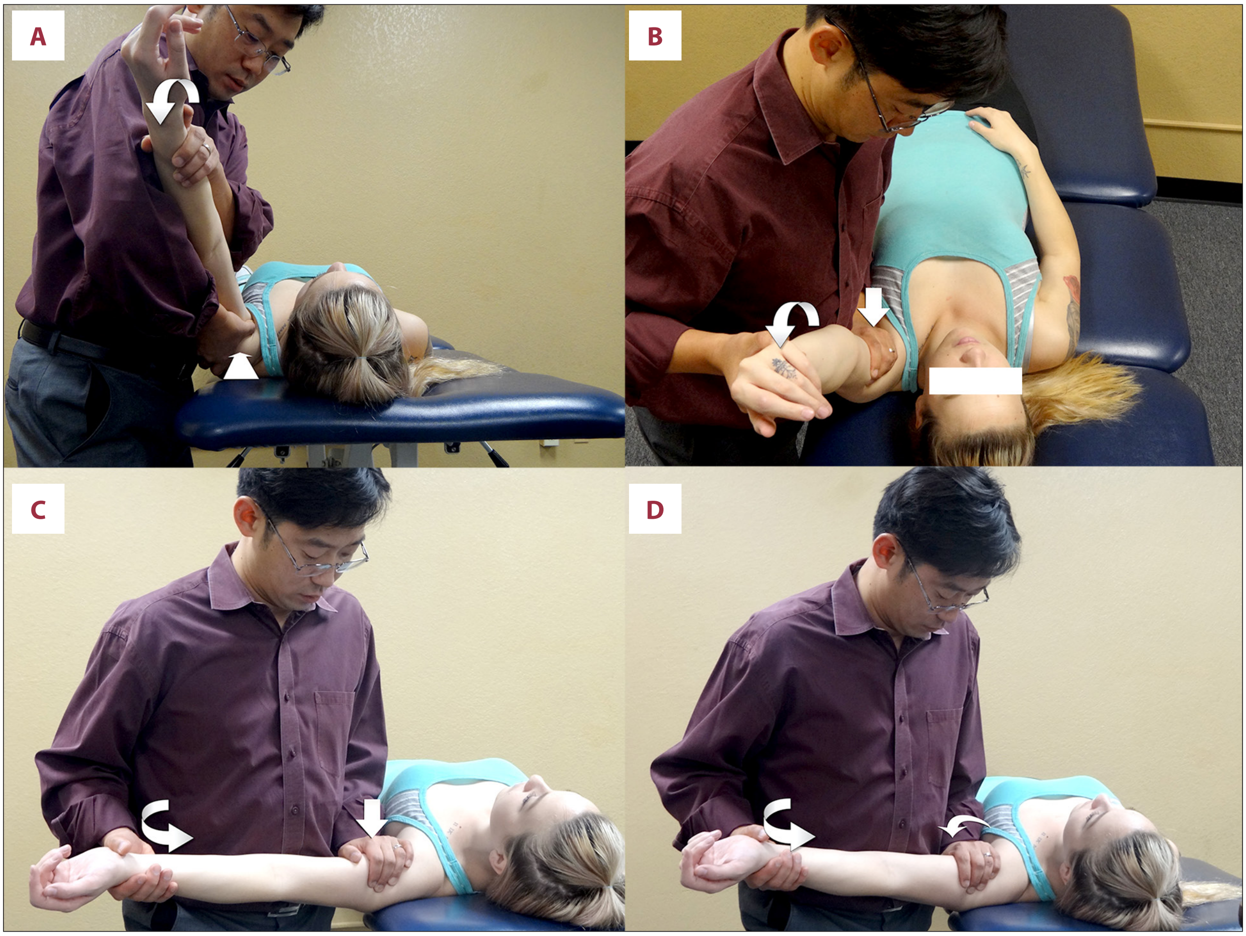

Figure 1. (**A–D**) Angular joint mobilization of shoulder joint.

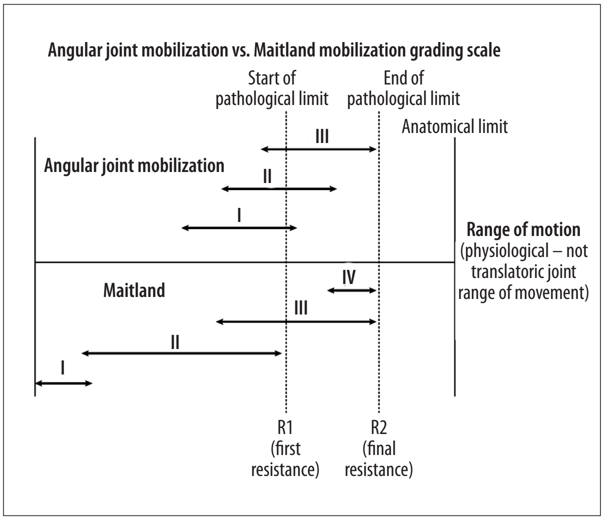

Figure 2. Grades in angular joint mobilization.

Discussion

The convex-concave rule of arthrokinematics has been widely accepted and practiced in manual therapy. The convex-concave rule is a didactic simplification of determining the direction of translatoric joint mobilization during rotatory movements of the joint [33]. Rotatory movement also referred to as rotary motion, in biomechanical terminology is called "angular displacement" (osteokinematic view), which is movement of a segment around a fixed axis. However, in a human rotary motion joint, all joint axes shift at least slightly during the motion [34] and joint surfaces not only glide but also simultaneously roll on the opposite joint surface (arthrokinematic view) [12]. Kaltenborn hypothesis (convex-concave rule) suggests that a restricted joint movement (i.e., hypomobility) is due to impaired joint gliding [11]. However, when joint rolling occurs without its associated gliding, the instantaneous axis of movement shifts to an abnormal location [11]. If this joint movement occurs based on Kaltenborn theory, then rolling will lead to dislocation, but dislocation does not occur on restricted joint movement. A few studies have suggested that the direction of mobilization is controversial [21,33,34]; and more studies were in contrast with Kaltenborn convex-concave rule [14–23,25–27,35,36]. For example, the joint axis shifts superiorly rather than inferiorly in glenohumeral joint abduction movement [14,18,20,23,26,27,35,36]. In addition, Baeyens et al. suggested the need to redefine mobilization techniques for the glenohumeral joint in terms of rotation of the humerus and translation of the geometrical center of the humeral head [21,37].

In the arthokinematic view, a single point on the concave articular surface contacts multiple points on the convex articular surface regardless of joint congruency when a convex articular surface moves on a concave articular surface, which is a simultaneous movement of roll and glide in the opposite direction (Figures 5, 6). In addition, a single point on the concave articular surface contacts multiple points on a convex articular

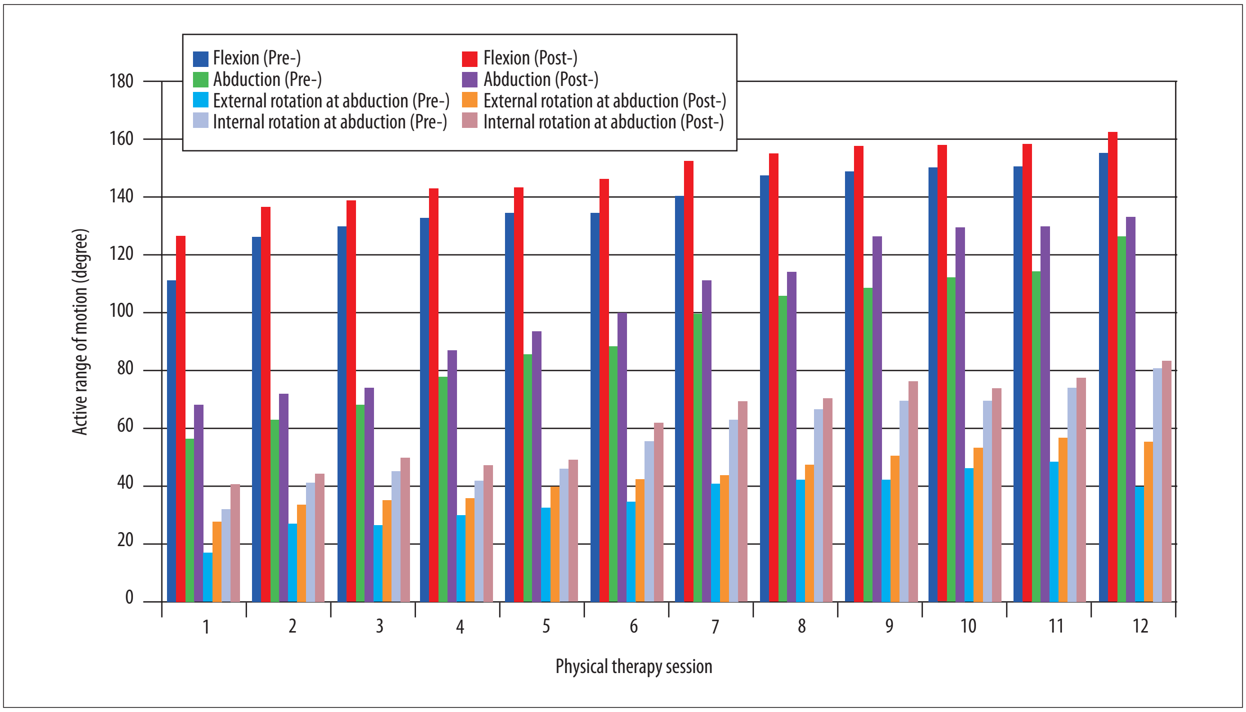

Figure 3. Shoulder AROM pre- and post-angular joint mobilization at each physical therapy session.

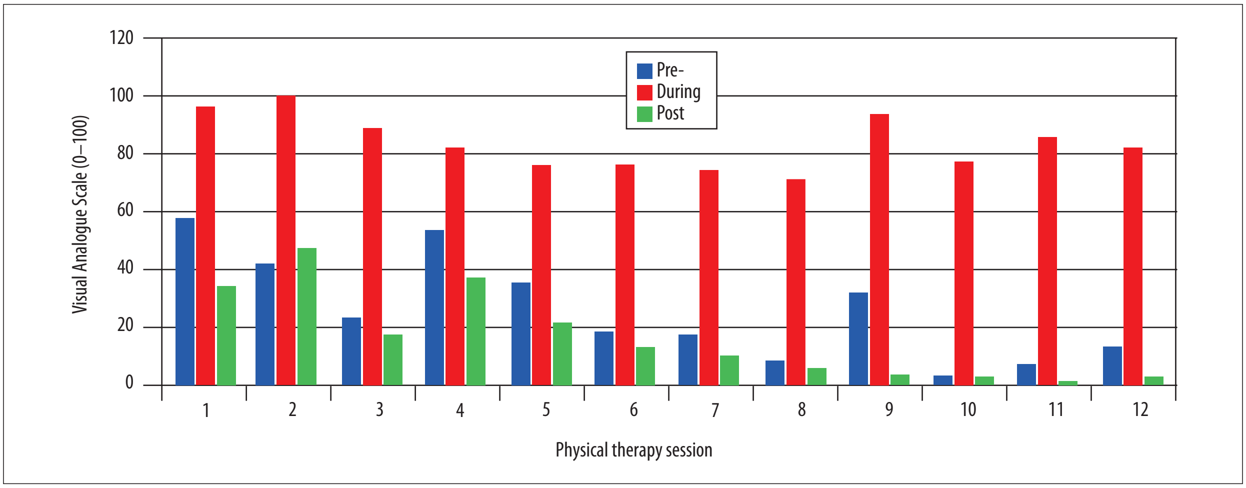

Figure 4. Shoulder pain pre- and post-angular joint mobilization at each physical therapy session.

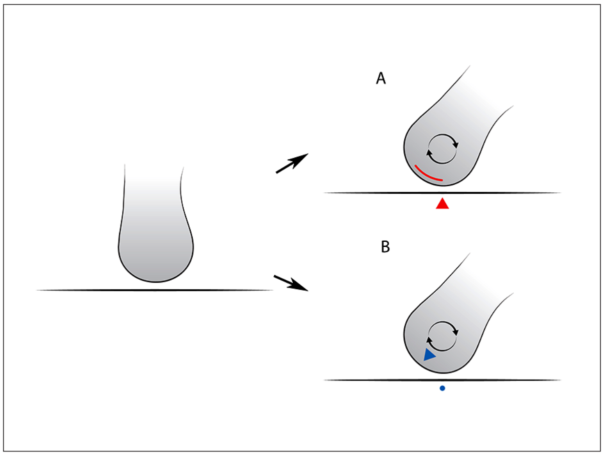

Figure 5. Arthrokinematic rotation on incongruent joint. A) A single point on the concave surface contacts multiple points on the convex surface and B) a single point on the convex surface does not contact any other points on the concave surface.

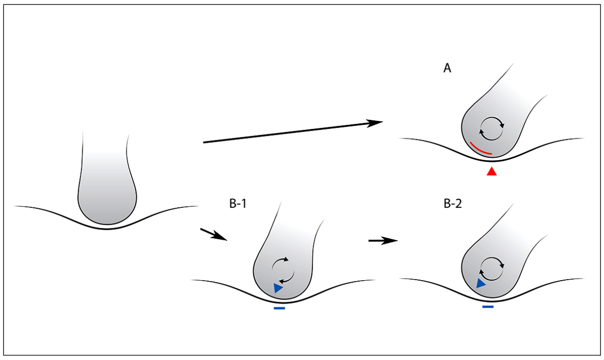

Figure 6. Arthrokinematic rotation on congruent joint. A) A single point on the concave articular surface contacts multiple points on the convex articular surface; B-1) a single point on convex surface contacts more points (compared to incongruent joint surface) on concave surface but B-2) a single point on convex surface does not contact any more points on concave surface as rotation continuously occur.

surface regardless of joint congruency when a concave articular surface moves on a convex articular surface which is a simultaneous movement of roll and glide in the same direction. So whether it is a convex on concave or concave on convex joint, a single point on the concave articular surface contacts multiple points on the convex articular surface regardless of joint congruency, plus a single point on a convex surface contacts more points on a concave surface in a congruent joint [16,38]. This is completely different from glide, in which one point on the convex joint surface contacts new points on the concave joint surface, and from roll, in which new points on each surface comes into contact throughout the motion. This suggests that this motion is arthrokinematic rotation. For example, when glenohumeral joint abduction occurs, the glenohumeral center also translates superiorly. If the rotation is divided into roll and glide, then inferior glide (a component of rotation), and superior glide (the center of the humeral head superior shift) will conflict with each other. Even if there is decreased gliding movement due to two opposite directions of glide and joint shift, joint movement is still rotation, as a single point on each surface contacts multiple points on the opposite surface. If the distance of the superior joint shift and inferior gliding becomes equal, then joint movement will be just roll. When glenohumeral joint abduction occurs, arthrokinematic movement is arthrokinematic rotation with glide, and osteokinematic movement is rotation with joint shift.

However, rotation is not a simultaneous movement of roll and glide at all. In order to analyze this joint movement, arthrokinematics and osteokinematics (axis movement) have to be considered at the same time. Joint axis moves when roll or glide occurs, but joint axis does not move when rotation occurs (known as a simultaneous movement of roll and glide). When a hinged door is being opened or closed, rotation occurs, but roll and glide cannot occur since the axis is fixed. Rotation is a completely independent movement from roll and glide even though combined roll and glide can mimic the movement; it still is not a true rotation.

Restricted joint movement is thought to have restricted gliding and predominant rolling between the joint surfaces instead of restricted rotation [11], but it is impossible to identify which one is the restricting factor between gliding and rolling. Roll and glide are strictly two-dimensional (2-D) terms that do not include the shift along the helical axis (axis of rotation, screw axis, and twist axis) but shifts along it [21].

Based on this background, authors have theorized that joint restriction is due to impaired rotation with possible joint axis shift impairment of the rotary motion joint, and this impaired rotation with possible joint axis shift impairment might be from not only impaired passive subsystem (ligaments, bursas, cartilages, meniscoids, joint surfaces, joint capsules, etc.) but also from the active (muscles, tendons) and control subsystem (nerves, central nervous system) [24]. Through this theory, AJM which is rotational joint mobilization with joint shift was suggested and investigated on our patient with shoulder adhesive capsulitis. The results of our case report suggest that AJM for improving pain, ROM, and disability warrants consideration in the management of individuals with adhesive capsulitis by restoring normal relations of the shoulder structures: meniscoids, capsule, and articular surfaces. The AJM may be an effective intervention for improving symptoms in patients with adhesive capsulitis. However, this case report has several limitations. First, only one patient was included in the case report. Second, there was a small possibility that the cause-and-effect relationship between the intervention and the outcomes may not be established, as changes could have been related to the natural recovery or a placebo effect. Third, the authors were not able to confirm the effect of the intervention in the long-term. Therefore, more research will be needed to establish an effect of AJM.

Conclusions

The results of this case report suggest that AJM, which is rotational joint mobilization with joint axis shift, may be an effective intervention for improving shoulder pain, ROM, and disability in individuals with adhesive capsulitis. However, this case report has several limitations. Thus, a future study should further investigate the use of the intervention in the care of adhesive capsulitis.

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