Treatment of Limited Shoulder Motion: A Case Study Based on Biomechanical Considerations

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This article describes the management of a 57-year-old female patient following a fracture and dislocation of the right humeral head. The treatment of the patient involved the use of thermal agents, manual therapy, continuous passive motion, and splinting of the arm in an elevated position. We describe an approach to treatment of limited shoulder motion that is focused on identifying and applying tension to restricting structures rather than restoration of translatory gliding movements of the humeral head. Our treatment approach is based on recent data from biomechanical studies that challenge the concave-convex theory of arthrokinematic motion first described by MacConaill. We believe that tension in capsular tissues, rather than joint surface geometry, may control the translatory movements of the humeral head. The rationale for treatment involving low-load prolonged stress to tissues in the form of continuous passive motion and splinting is discussed as well as potential limitations of more brief forms of stress such as joint mobilization and manual stretching. [McClure PW, Flowers KR. Treatment of limited shoulder motion: a care study based on biomechanical considerations. Phys Ther. 1992;72:929–936.]

Key Words: *Joint instability; Kinesiology/biomechanics, upper extremity; Manual therapy; Shoulder joint; Upper extremity, shoulder.*

Various treatment approaches have been described for limited shoulder passive range of motion (PROM).[1–4] These approaches include various forms of manual therapy, electrotherapy, active exercises, and various forms of passive stretching.[1–4] There have been no well-controlled studies that have clearly established the most effective type of treatment.

We believe that proper treatment should be based on an understanding of the cause of limited range of motion (ROM). We classify causes of limited shoulder ROM into two categories. The first category of limited ROM results from structural changes in the periarticular structures. These changes include shortening of capsules, ligaments, or muscles as well as adhesion formation. These structural changes generally result from a combination of inflammation and immobilization.[5] The second category of limited ROM is caused by problems not associated with structural changes in the periarticular tissues. An example of nonstructural problems leading to decreased ROM would be pain (and associated protective muscle contractions to prevent painful movements) or the presence of a loose body within the joint space.[4] Muscle weakness could result in decreased active range of motion (AROM); however, weakness alone should not cause a limitation of PROM. Our classification system does not address the situation in which only AROM is limited. We believe the distinction between the two types of problems with PROM is important because they involve different treatment strategies.

We believe that treatment of limited PROM attributable to structural changes should be geared toward applying tension in an effort to cause elongation of the restricting tissues.[6–8] This contrast to treatment of limited ROM attributable to nonstructural changes, we believe, should focus on relieving the problem producing the limitation. For example, an acutely inflamed joint with associated pain and protective muscle action should be treated with modalities oriented toward decreasing inflammation and relieving pain.[9]

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Findings from the history and physical examination that lead us to hypothesize that PROM is limited because of structural changes are

1. A history of trauma followed by immobilization.[5]

2. A history of restricted motion greater than 3 weeks.[5]

3. Loss of passive motion in a capsular pattern.[10] (For the shoulder, greatest percentage of limitation of lateral (external) rotation followed by abduction.)

4. A capsular end-feel.[10] (A *capsular end-feel* is defined as a firm halt to passive movement with only a slight degree of give to further force.)

5. No pain with resisted isometric contractions with the joint in a neutral position.[10]

We believe that if either of the first two findings is present, then structural changes are very likely. We believe that the last three possible findings are helpful in confirming the presence of structural changes but are not sufficient evidence by themselves.

The purposes of this article are to discuss some biomechanical considerations that can be used to guide evaluation and treatment of limited shoulder ROM and to describe the management of a patient with limited shoulder ROM following a fracture and dislocation of the humerus. This article discusses limited shoulder ROM presumed to be due to structural changes in the periarticular structures.

The Concave-Convex Rule and Arthrokinematic Studies

MacConaill[11] appears to have been one of the first authors to discuss the arthrokinematic movements (movements of joint surfaces relative to one another) occurring at the glenohumeral joint. His descriptions of the movements occurring at joint surfaces were based on mechanical models rather than direct measurements. He stated that "in abduction of the humerus, the humeral head not only rolls upwards but also slides downwards upon the curved glenoid surface of the scapula."[11(p30)] More generally he stated that when a convex surface moves on a concave surface, "the direction of the slide that accompanies a roll is *opposite* to that of the roll."[11(p29)]

Kaltenborn[1] used MacConaill's descriptions[11] to propose an "indirect method" for determining the appropriate direction to apply a gliding mobilization technique that he called the *concave-convex rule*. According to the concave-convex rule, sliding of the humeral head occurs in the direction opposite movement of the humerus. For example, the head of the humerus should slide inferiorly during abduction and anteriorly during lateral rotation or horizontal abduction. Other authors[12,13] describing manual therapy techniques have since used the concave-convex rule for determining the appropriate direction of gliding mobilization.

Data are now available from studies that have measured the translatory movement of the humeral head during various physiologic movements of the arm.[14–16] These data challenge the concave-convex rule of arthrokinematic motion.

Poppen and Walker[14] studied movements of the humeral head during abduction of the arm in the scapular plane (30° anterior to the frontal plane) using radiographs. Radiographs were taken at 0, 30, 60, 90, 120, and 150 degrees of arm elevation on 12 healthy volunteers and 15 patients. The authors found the following:

> From 0 to 30 degrees, and often from 30 to 60 degrees, the humeral ball moved upwards on the glenoid face by about 3 millimeters. Thereafter it remained constant, moving only one millimeter or at the most two millimeters upward or downward between each successive position.[14(p199)]

In healthy subjects, the mean translation (±SD) for each 30-degree change in position was 1.09±0.47 mm. Seven subjects demonstrated "excessive" translation, and all of these subjects had a history of either instability or rotator-cuff tear. *Excessive translation* was defined as greater than one standard deviation from the mean translation for each 30-degree change in position. All subjects with abnormal translation demonstrated over 2 mm of translation of the humeral head.

Howell et al[15] studied humeral head movement during various amounts of horizontal abduction of the arm with and without lateral rotation. The four positions used were (1) maximum horizontal abduction and lateral rotation, (2) maximum horizontal abduction with no rotation, (3) 90 degrees of abduction (frontal plane) with full lateral rotation, and (4) 80 degrees of flexion with full medial (internal) rotation. They used a radiographic technique on 20 healthy volunteers and 12 patients with clinical evidence of anterior glenohumeral instability. All 12 patients had a history of recurrent dislocation or subluxation and demonstrated a positive anterior apprehension test result. The apprehension sensation was such that it prevented patients from maximally extending and laterally rotating the arm. All healthy subjects demonstrated a posterior translation of the humeral head of 3.9±0.8 mm when the arm was fully horizontally abducted and laterally rotated (position 1). For the healthy subjects, there was less average translation for the other positions, but the translation was still in a posterior direction. The values were 0.3±0.5 mm for position 2, 0.1±0.5 mm for position 3, and 0.4±0.4 mm for position 4. Patients with anterior instability were positioned similarly except that full lateral rotation was not combined with full horizontal abduction because of the patients' inability to stay in that position. Seven of the 12 patients demonstrated anterior translation when positioned in maximum horizontal abduction (3.3±0.6 mm) and also in position 3 (3.6±0.7 mm). The other 5 patients demonstrated a mean translation of less than 0.3 mm in all positions. The healthy subjects, therefore, demonstrated translatory motion in the opposite direction to that predicted by the concave-convex rule. Only patients with instability demonstrated translation in the direction predicted by the concave-convex rule.

Harryman et al[16] studied the humeral head translation in cadaver specimens with a device that measured motion with 6 degrees of freedom. The glenohumeral motions studied were the following: flexion, extension, lateral rotation, medial rotation, and "cross-body movement." All joints were tested under the following conditions: capsule intact, capsule vented to the air with a needle, and tightening of the posterior capsule with a suturing technique. Both flexion and medial rotation resulted in anterior translation of the humeral head, whereas extension and lateral rotation both resulted in posterior translation of the humeral head. The translation associated with the cross-body movement was variable and did not show a consistent direction. Mean values and ranges for translation were as follows (a negative value indicates posterior translation): flexion (3.79 ± 3.8 mm, -0.44 to 10.94), medial rotation (1.01 ± 2.4 mm, -1.47 to 5.64), extension (-4.92 ± 2.6 mm, -1.9 to -9.7), lateral rotation (-1.68 ± 1.8 mm, -4.81 to 1.17), and cross-body movement (-0.14 ± 2.8 mm, -3.92 to 2.91).

Venting the capsules increased mean translation for all movements, but these increases were all less than 2 mm. Tightening of the posterior capsule caused a significant shift toward greater anterior translation with all movements, especially flexion and the cross-body movement. The authors explained this finding by suggesting that a tight posterior capsule forces the humeral head anteriorly.

The results of these studies seem to challenge the concave-convex theory of arthrokinematic motion. The motion of the humeral head seems to be primarily of a spin-type motion with translation occurring mostly at end-ranges. The amount of translation also seems to be increased with both capsular laxity[14,15] and capsular tightening.[16]

The explanation put forth by Harryman et al[16] seems to offer a plausible basis for understanding translatory movement of the humeral head. In essence, they suggest that as a portion of the glenohumeral capsule becomes taut, the humeral head is forced in an opposite direction by the taut capsule. This theory could explain the data of Howell et al,[15] who found posterior translation during maximal lateral rotation and horizontal abduction in healthy subjects. As the anterior capsule became taut because of lateral rotation and horizontal abduction, the humeral head could have been pushed posteriorly. In patients with anterior laxity, anterior rather than posterior translation was observed. The lack of posterior translation could be explained by the laxity in the anterior capsule. Therefore, the direction and amount of humeral head translation may be primarily a function of tissue tension rather than joint surface geometry.

We believe that when limited ROM is thought to be due to a structural change in the periarticular tissues, the therapist should consider what structures could potentially limit that ROM. Selection of a stretching technique should then be based on what type of maneuver will best put tension on the restricting tissue.

For example, consider a patient who has limited lateral rotation of the glenohumeral joint. Authors advocating joint mobilization suggest performing anterior glides (anterior translation of the humeral head on the glenoid cavity) based on the concave-convex theory.[1,12,13] The data of Howell et al,[15] however, suggest that posterior glide is the normal translatory movement occurring during lateral rotation. Ironically, we would also use anterior gliding (rather than posterior gliding), but for a different reason. Anterior glides probably place more tension on the anterior capsule than does posterior gliding, and the anterior capsule is known to restrain lateral rotation.[17,18] To summarize, we believe treatment decisions should be based on consideration of the structures limiting motion and how to best put tensile stress on these structures rather than restoring a translatory motion that does not really occur during physiologic movement.

This may seem like a purely academic issue; however, it can have implications for treatment. There are many ways of placing tensile stress on tissues besides a gliding-type joint mobilization. If the emphasis is taken away from restoring a particular gliding motion, other forms of stretching such as AROM and PROM, continuous passive motion (CPM), and splinting become logical choices for the treatment of limited ROM. These techniques are not only appropriate, they also have the advantage of not requiring direct care from a therapist. Some stretching techniques can be done independently by patients; therefore, they can be performed more frequently and for longer periods than can therapist-conducted treatments. Home programs thus allow greater amounts of time to be spent on stretching restricting tissues. We have previously suggested that prolonged tensile stress can improve limited ROM more than can short-duration joint mobilization procedures.[2] Threlkeld (see article in this issue) points out that length changes in connective tissues produced by joint mobilization procedures are probably transient, although this question has not been studied directly. Other authors[19,20] also support the notion that the mechanical effects of brief forms of stretching on connective tissue are short-lived. The following case study illustrates how this thinking influences our treatment approach to limited shoulder motion.

Case Study

History

A 57-year-old female medical secretary fell on an icy pavement, sustaining a Neer two-part fracture with avulsion of the greater tuberosity of

Table. *Chronological Description of Treatment and Passive Range of Motion (PROM)*

Weeks Postinjury	Treatment	PROM (°)		
		Flexion	Abduction[a]	Lateral Rotation[b]
0	Fracture/dislocation			
6	Moist heat, ultrasound, pendulum, low-grade manual therapy, ice post-exercise (visits three times per week)	80	60	5
6+day	Increase to high-grade manual therapy, continuous passive motion, home program (three times per day): pendulum, wand, ice	80	60	5
8	Allow gentle activities of daily living	100	75	15
10	Reduce visits to twice per week, discontinue ultrasound, add elevation splint 1 hour four times per day	105	85	20
12	Discontinue all treatment in clinic, continue to monitor outcome of home program, add strengthening, increase splint time to 2 hours four times per day	130	105	40
13	No change	140	120	50
14	No change	155	145	65
15	No change	165	160	65
16	No change	165	165	70
25	Patient discharged	175	170	80

[a]Abduction measured with the arm 40° to the coronal plane.

[b]Lateral rotation measured with the arm by the side.

her right (dominant) proximal humerus.[21] The history obtained in the emergency department suggested a concomitant anterior dislocation. Her husband, who is a physician, reported that he manually reduced the dislocation at the scene of the fall. There was no prior history of dislocation. She was evaluated by an orthopedic surgeon in the emergency department, and her arm was immobilized in a sling combined with a swathe to hold the arm in medial rotation. After 6 weeks of immobilization, she was referred to physical therapy with the goal of increasing shoulder ROM.

Evaluation

The patient's primary complaint was restricted motion with difficulty in activities that required reaching above the level of her head. Her primary goal was to regain sufficient motion to allow for independence with dressing, hair care, and household activities (eg, cooking, cleaning, gardening). She was not participating in athletics or other strenuous recreational activities at the time of her injury.

The initial physical therapy evaluation occurred 6 weeks postinjury. The patient was unable to actively flex or abduct her arm horizontally. Passive flexion and abduction were limited to 80 and 60 degrees, respectively (see Table and Figure for all ROM data). There was no pain when she was resting the arm. Pain was elicited as the end-ranges of all passive motions were approached. The pain was confined to the anterolateral shoulder area, with no radiation proximally or distal to the insertion of the deltoid muscle. Motions in all directions were limited by capsular end-feel.[10] No atrophy was noted upon inspection by the therapist. Manual muscle testing of the shoulder muscles was not performed. Forces produced by shoulder flexion, abduction, and medial and lateral rotation were tested isometrically with the patient's arm by her side in a position of neutral rotation. The patient was able to produce moderate resistance to all motions without pain. The elbow, wrist, and digits all had full AROM, based on visual inspection, and had no gross weakness, based on the isometric testing. There was no noticeable deficit of sensibility. Cervical spine AROM did not appear limited and was pain-free.

Treatment and Results

Initial physical therapy began 6 weeks postinjury and consisted of application of hydrocollator packs for 20 minutes to the anterior aspect of the patient's shoulder while she lay supine with her arm resting at her side and with her elbow flexed 90 degrees. The moist heat was followed by 5 minutes of continuous ultrasound* at 1.5 W/cm^2. The ultrasound was directed to the anterior shoulder area while the patient's humerus was held by the therapist (KRF) at its comfortable end-range of lateral rotation in an effort to increase the compliance of the tissues passing across the anterior aspect of the glenohumeral joint. Immediately following the ultrasound, pendulum exercise was performed with a 0.91-kg (2-lb) wrist cuff

*Intellect 200, Chattanooga Corp, PO Box 4287, Chattanooga, TN 37405.

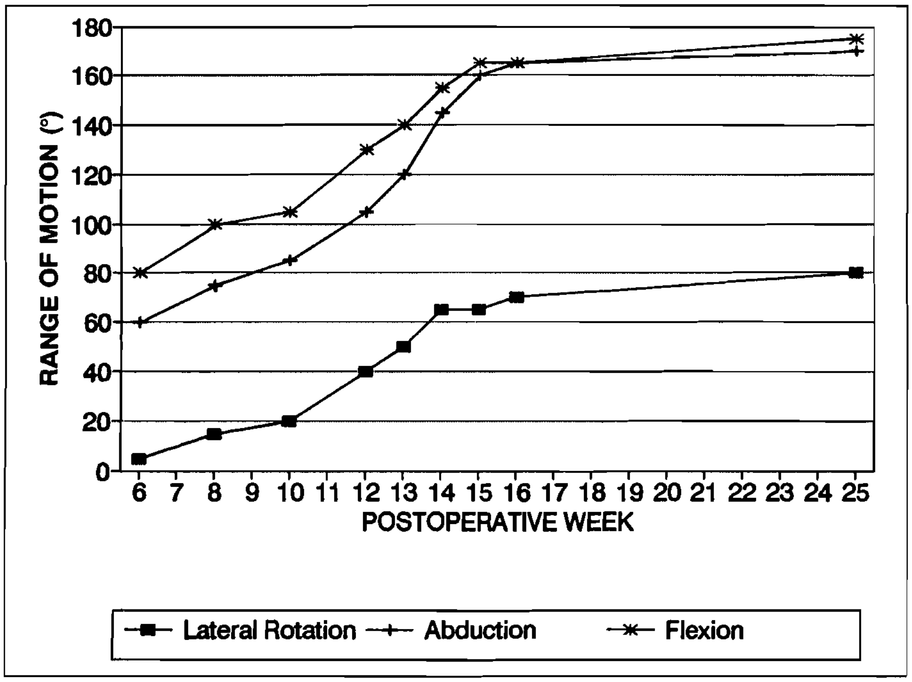

Figure. *Range-of-motion data for shoulder movements of lateral rotation, abduction, and flexion in 57-year-old female patient following fracture and dislocation of right humeral head.*

for 3 minutes. Pendulum exercise consisted of the patient leaning forward supported by her uninvolved left arm and allowing her right arm to dangle. The patient produced a pendulum-type movement by shifting her trunk forward and back, thus attempting to keep the shoulder muscles as relaxed as possible. The pendulum exercise was followed immediately by manual therapy, consisting of low-grade anterior and inferior gliding movements. We define *low-grade gliding movements* as those that do not approach the end of the available range of gliding. Our gliding movements were delivered for approximately 3 minutes each with the patient positioned supine and her glenohumeral joint in the neutral position. The purpose of the pendulum exercise and gliding techniques was to decrease pain and promote gentle stretching of periarticular tissues.

All ROM measurements were taken at this point in the session to ensure that the connective tissue had been preconditioned.[22] Preconditioning occurs with cyclic loading and unloading of connective tissues. *Preconditioning* is the phenomenon in which increases in tissue deformation occur when a given load is applied cyclically. A tissue is said to be preconditioned when tissue deformation reaches a steady state and continued cyclic loading produces no additional deformation.[22] We believe ROM measurements are more reliable and meaningful when taken with the periarticular tissues "preconditioned" (as after exercise) rather than "cold," particularly when ROM measurements taken several days apart are compared to determine changes in ROM.

The patient was evaluated the next day to assess the reaction to the prior day's intervention. As there was no increase in pain or evidence of inflammation, or any loss or gain of ROM, the vigor of the program was increased. The manual therapy was more aggressive, consisting of more forceful (ie, high-grade) anterior and inferior gliding movements. We define *high-grade gliding movements* as those that take the joint to the available end-range. A 30-minute session of CPM was added following the manual therapy. With the patient seated, a CPM device[†] oscillated the patient's arm between 60 and 80 degrees in the plane of the scapula. The purpose of the high-grade anterior and inferior gliding movements and the CPM was to apply end-range tensile stress to the restricting periarticular tissues. A relatively limited excursion was used with the CPM device to maximize the time the joint was at or near the end-range of motion.

A home exercise program was taught to the patient. The home exercise program consisted of 3 minutes of pendulum exercise followed by 3 minutes of overhead wand exercises, which moved the arm into forward flexion from the supine position. The exercise was followed by 15 minutes of ice to the anterior aspect of the shoulder. The patient was instructed to do the home exercise program three times daily. The patient was told to wear the sling at all times when she was not exercising. The swathe that held the arm medially rotated, however, was removed. The patient was told to avoid activities that involved lifting or resisted motions of the right arm. Active range of motion of the elbow, wrist, and hand was performed for 10 minutes daily to maintain full motion of these joints.

The patient was treated in this manner for six visits over a 2-week period. At 8 weeks postinjury, the patient's ROM increased modestly (20° of flexion, 15° of abduction, and 10° of lateral rotation). The patient was encouraged to wean herself from use of the sling immobilizer over the next 2 weeks. She did this without significant pain. Also at 8 weeks postinjury, she was permitted to perform any activities of daily living that did not result in sharp or lasting pain. For example, she was able to handle

[†]Invacare Corp, 899 Cleveland St, Elyria, OH 44036.

table utensils, help with bathing, and type for short periods. She was told not to drive or lift heavy objects.

Ten weeks after her injury, the patient's motion was improving more slowly than we desired, based on our experience. Because of this, the amount of time spent with the joint at end-range was increased. This decision was also based on considerations of the changes that occur with wound healing and scar formation. As a scar matures, the rate of collagen degradation and synthesis slows.[23] Because the scar is less dynamic, we consider the joint restrictions less amenable to change and we are therefore more aggressive in our treatment (ie, increasing time at end-range).

The patient's home program was increased by the addition of a static, end-range, abduction splint of the type previously described by the authors.[2] The splint was fabricated by one of us (KRF) out of thermoplastic material and an adjustable aluminum rod that was created by cutting an adjustable cane. The splint allows the arm to be held at its comfortable end-range of abduction in the plane of the scapula without attempting to control the scapula itself. Initially, the splint was worn 1 hour four times per day. Before dispensing the splint, the patient was tested for signs of suprahumeral impingement by simultaneously flexing and medially rotating her arm, which did not provoke pain.[24] Clinic visits were reduced to twice per week, and the ultrasound was discontinued. The ultrasound was discontinued because it did not appear to be making a difference in the patient's ROM or her perception of stiffness.

Twelve weeks after the injury, the patient's ROM gains had reached desired levels. Clinic visits were reduced to one per week, and all modalities, including manual therapy, were discontinued. Based on previous experience, we felt that the amount of time spent at the end-range of motion accomplished by use of the splint would be sufficient. Decisions as to what constitutes adequate gains in ROM are clinical judgments based on experience rather than attainment of specific gains in ROM. Decisions to decrease clinical visits were based on our belief that increases in ROM are directly related to time at the end-range of motion that the patient could accomplish independently using the splint and her exercise program.

The therapeutic program 12 weeks after injury, therefore, consisted only of using the splint and a strengthening program for the rotator cuff that was added. Strengthening was performed using a double strand of yellow Thera-Band®‡ for 10 repetitions each of medial rotation, lateral rotation, and abduction. Each set of repetitions was done once daily from the standing position, starting with the patient's arm at her side. Ice was applied after exercise when the patient felt it necessary to reduce pain.

The time the splint was worn was progressively increased over the next 2 weeks, based on the patient's tolerance, to a maximum daily schedule of 2 hours, four times per day. Monitoring of pain and ROM were the only subsequent physical therapy activities. Sixteen weeks after injury, visits were reduced to once per month. The patient was discharged 25 weeks after her injury.

Passive range of motion was the most important outcome measure because of the patient's primary complaint of lost motion rather than of pain or weakness. Range of motion was measured during each visit by the same therapist, and AROM was never visibly different than PROM. The ROM measurements were taken with the patient positioned supine. A large plastic goniometer was used, with the measurements recorded to the nearest 5-degree increment. The supine position was chosen to facilitate relaxation. Lateral rotation was measured with the patient's arm at her side, and abduction was measured with her humerus positioned in the plane of the scapula. This position is believed to most closely approximate the normal plane of arm elevation during function.[25] Riddle et al[26] have demonstrated good reliability of shoulder ROM measurements even when the technique used was not standardized. Medial rotation was not measured with a goniometer. We have since learned to describe medial rotation, as suggested by the American Academy of Shoulder and Elbow Surgeons,[27] by measuring how far superior the patient can place the thumb on the spine. Unfortunately, we only monitored medial rotation visually and did not quantify this motion. Although medial rotation was limited initially, functional medial rotation (ability to tuck in shirt and fasten bra) appeared to increase by 12 weeks postinjury. No attempt was made to stabilize the scapula during ROM measurements. Measurements, therefore, reflect shoulder girdle ROM, not pure glenohumeral motion. Based on observation, the limitation of motion and subsequent gains occurred primarily at the glenohumeral joint. There was no limitation of passive scapulothoracic motion, based on our manual tests. The acromioclavicular joint and the sternoclavicular joint could have potentially contributed to motion restrictions. We do not feel that passive restrictions at these joints during either physiological motion or accessory motion testing can be reliably measured in a clinical examination.

Twenty-five weeks after her injury, the patient had achieved almost full pain-free PROM (Table and Figure). She was independent in activities of daily living including dressing, bathing, cooking, typing, and lifting the types of objects she was able to lift prior to her injury. At 1-year and 5-year follow-ups, she had no complaints of pain and she had full function and ROM.

‡The Hygenic Corp, 1245 Home Ave, Akron, OH 44310.

Discussion

Initially, manual therapy was used to decrease pain and thereby facilitate relaxation in this patient.[28] For this purpose, low-grade gliding movements were selected and performed with the patient's arm at her side in a neutral position. We do not believe we can accurately discern between four grades of amplitude for gliding mobilization as described by Maitland.[29] We believe that only one distinction needs to be made, that is, the distinction between movements that take the periarticular tissues to end-range, which we call high-grade movements, and movements that do not take periarticular tissues to end-range, which we call low-grade movements. We use low-grade mobilization when trying to decrease pain, based on the theory of neurophysiologic modulation of pain produced by mild mechanical stimuli.[30] For the stiff joint, we use high-grade mobilization in order to apply end-range tensile stress to restricting periarticular structures.

In our opinion, any form of stretching dependent on therapist technique, such as high-grade mobilization, has limited application because, as Brand has noted, "any elongation of tissue accomplished by stretch will shorten again once the force is relaxed."[31(p849)] Therefore, in our view, the increase in tissue length produced by a brief session of high-grade mobilization serves only to temporarily deform the tissue rather than to produce a permanent length change. This temporary elongation achieves the "preconditioned" status of the joint structures.[22] Although this temporary elongation may be very useful for facilitating further exercise and function, permanent elongation of a tissue is probably accomplished through another mechanism—remodeling.

Remodeling, unlike the transient viscoelastic phenomenon of stress relaxation, is probably a subtle rearrangement of the collagen and cross-links within the connective tissue over time. This is the desired biological response to gentle, prolonged tensile stress.[8,19,20,31] We often prefer splints to stimulate remodeling because of the long end-range times afforded by splinting.

At 10 weeks postinjury, when the initial improvement of ROM had slowed, our emphasis shifted to increasing the end-range stress. This was accomplished with the end-range splint. Likewise, at 12 weeks, we tried to maximize the total time spent at the end-range of ROM by increasing the time the patient wore the splint.

In the splint, no attempt is made to control the scapula, allowing the humerus to come to a comfortable position at its available end-range. When the joint is taken to the point of limitation, tensile stress is being applied to the restricting structures. Because we believe that there are sufficient research data to suggest that inferior gliding is not a component of elevation, there is no provision for the motion in the splint. Our experience indicates that patients who show no signs of suprahumeral impingement prior to the application of the splint do not develop subsequent impingement problems.

Conclusion

We have discussed the management of a patient with limited shoulder ROM. Many of our treatment decisions were based primarily on clinical experience rather than direct scientific data. We believe that limited motion attributable to adaptive shortening of periarticular tissues is most effectively treated by methods that hold the joint at or near the end-range of motion for prolonged periods of time. Treatment of limited shoulder motion should be focused on identifying and applying tension to restricting structures rather than restoration of translatory gliding movements of the humeral head.

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