Review Article

Physical Therapy Intervention in Post Stroke Shoulder Subluxation: A Narrative Review

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Abstract

Objective:
The purpose of this narrative review is to summarize the recent advances in Glenohumeral subluxation (GHS) treatment approaches.
Background:
Glenohumeral subluxation (GHS) subluxation is found 81% of the individuals following stroke, a preventable secondary complication often accompanied with poor upper limb function. GHS is also considered as an important risk factor for shoulder pain and other problems. GHS is a complex phenomenon with very little understanding of its pathomechanics.
Method:
The literature was obtained by searching in computerized database. Evidence was obtained from articles published in peer-reviewed journal and published in English language.
Discussion and Conclusion:
Ultrasound measurements are considered the best method of quantifying GHS. Clinical evaluation such as finger breadth method and sulcus sign can be useful and quick clinical assessment tool. Novel methods such as Functional electrical stimulation and tapping method are effective in an acute stage of hemiplegia and arm slings have been shown a negative impact on rehabilitation of GHS, However, it shall be used for a shorter period of time.

Key Words
Stroke rehabilitation, Glenohumeral subluxation, physiotherapy intervention.

الملخص:
الاهداف:
الغرض من هذا الاستعراض السردي هو تلخيص التطورات الأخيرة في نهج العلاج تحت خلع غلينوهومرال.
الخلفية:
تم العثور على خلع غلينيوميرال الجزئي قي ٨١٪ من الأفراد الذين اصيبوا بالسكتة الدماغية، ومن المضاعفات الثانوية المرافقة والتي يمكن الوقاية منها في الغالب هي ضعف وظيفة الطرف العلوي.
ويعتبر خلع مفصل الكتف أيضا عامل خطورة مهم لآلام الكتف وغيرها من المشاكل، كما هو ظاهرة معقدة مع القليل جدا من فهم الميكانيكا الباثولوجية الخاصة به.
الطريقة:
تم الحصول على الخلفية العلمية من خلال البحث في قاعدة البيانات المحوسبة. تم الحصول على الأدلة من المقالات المنشورة في مجلات عالمية مراجعة ونشرت باللغة الإنجليزية.
المناقشة والاستنتاج:
تعتبر قياسات الموجات فوق الصوتية أفضل طريقة لقياس خلع مفصل الكتف.
التشخيص السريري مثل طريقة الفحص التقويمي يمكن أن تكون أداة مفيدة وسريعة للتقييم السريري، بينما اثبتت أساليب وظيفية جديدة مثل التحفيز الكهربائي فعاليتها في مرحلة حادة من الشلل النصفي للذراع كانت ذات أثر سلبي على إعادة تأهيل خلع مفصل الكتف، ومع ذلك، فإنه يجب أن تستخدم لفترة أقصر من الزمن.
الكلمات الدالة:
إعادة تأهيل السكتة الدماغية، خلع مفصل الكتف، تدخل العلاج الطبيعي.

Introduction

The Shoulder Joint is highly mobile but its mobility comes with the cost of its stability[1].The Glenohumeral joint is the major joint of the shoulder complex. It is a ball and socket variety of synovial joint formed by the articulation of glenoid cavity medially and head of humerus laterally.[2] Laxity in the articular capsule and a large humeral head facilitates wide degree of freedom of movement.[3] Glenoid fossa of scapula covers less than one third of the head of humerus leaving it incongruent. Therefore, its stability mainly depends on integrity of static restrains by joint capsule and ligaments and balanced activity of dynamic restrains (rotator cuff, deltoid)[4]leading to lower levels of activity and a diminution in autonomy. Current physical therapies (PT[5]

Static stability of the glenohumeral joint dependents on joint capsule, shape of articular surfaces and glenoid labrum.[6] While as, Dynamic stability of shoulder complex is derived from three major muscle groups.[7] The scapulohumeral group consists of rotator cuff muscles (subscapularis, infraspinatus, teres minor, and subscapularis). The axioscapular group consists of muscles that act on the scapula, they are, rhomboids, trapezius, serratus anterior, and levator scapula. The axiohumeral group formed by the muscles that originate on the thorax and insert on the humerus they are latissimus dorsi and pectoralis major muscles.[8]

The compression forces generated by the rotator cuff muscles during dynamic activity improves stability by approximating the head of humerus against glenoid fossa.[9] Upward rotation of the scapula produced by steering activity of trapezius and serratus anterior increases the congruency of the articular surfaces during overhead activity.[10] Supraspinatus initiates the shoulder abduction and also checks the superior translation of the head of humerus, thereby preventing impingement.[11] Paralysis of muscle activity and Hypotonicity during the initial phase of stroke, predominantly to the supraspinatus and deltoid, overstretches the weak inferior capsule and ligaments by the weight of the dependent arm resulting in pain.[12]

Instability of the shoulder joint is further worsen due to impairment of muscular and capsuloligamentous structures following stroke[13] consequently resulting in shoulder subluxation among 17 to 81 percent of patients.[14] Its also known as Glenohumeral subluxation (GHS). Inferior subluxation of the shoulder joint is the most frequently encountered impairment than anterior posterior, medial and lateral subluxation.[15] Incidence of GHS is most commonly seen in patients with flaccid hemiplegia and usually develops within first 3 weeks following stroke.[16] Lack of self-care, poor positioning and left hemiplegia are associated with higher risk of developing GHS.[17] Flaccidity and inactivity of the supporting muscles, leaves a shoulder joint vulnerable to subluxation and pain.[18] Electromyography data revealed the posterior fibers of deltoid and supra-spinatus muscles provide dynamic stability to the shoulder joint. These muscles restrain inferior trans-

lation of humerus thereby, maintaining the correct alignment of Glenohumeral joint.[19]

Shoulder pain is often associated with GHS but research has proven that the amount of pain doesn't correlate with the degree of subluxation.[20] Ultrasound studies have confirmed the involvement of soft tissue around shoulder joint such as joint effusion and tenodesis of long head of biceps brachii and supra-spinatus.[21] Available data suggests no direct relationship between GHS and Shoulder pain (SP) but GHS may predispose to many painful conditions.[22] Clinically, the Glenohumeral subluxation is diagnosed by placing the finger between inferior aspect of the acromion and the superior aspect of the humeral head.[23] Glenohumeral subluxation is confirmed in cases where the gap is more than one finger. Sulcus sign is another clinical tool to detect ligament laxity and inferior instability of shoulder by applying a gentle inferior traction on the humerus.[24] In addition, appearance of visible groove under the acromion is the positive indication of GHS.[25]

There are three simple methods to qualify the amount of GHS. Palpation is the method by which an examiner palpates the space between acromion process and head of the humerus.[26] Finger breadth method is also used frequently, herein, the examiner places the fingers in the space between acromion process and head of the humerus.[27] Brohannon and Andrews[28] recommended to use the thumb as a tool to measure the amount of subluxation. Anthropometric evaluation using Caliper or a tape is also used to measure the distance between two reference points. Proximal distal point is acromion process and distal is lateral epicondyle or head of the humerus.[29] Lastly thermoplastic Jig is used to measure the distance between acromion process and head of the humerus. The device is L shaped made up of thermoplastic material, sliding marker, tape and a thumbscrew.[30]

GHS changes the biomechanical alignment between the glenoid cavity and head of humerus. Hypotonicity of the shoulder muscular following stroke leads to the palpable gap between the acromion process and the head of humerus.[31] Significant number of patients show symptoms of shoulder hand syndrome characterized by pain, edema and restricted freedom of movement of shoulder joint.[32] Shoulder hand syndrome is also characterized by increased skin temperature, change in skin color.[33] Although the mechanism of SHS is not fully understood, various helpful measures have been proposed to prevent it,[34] including special orthotic devices.[35] In one of the Cochrane review,[36] sufficient evidence is not present to prove the contribution of such devices to improve or prevent shoulder joint subluxation. Interventions used by physiotherapists at various stages of stroke ranges from electrotherapeutic modalities like functional electrical stimulation, to mechanical support from slings and special tapping methods.[37][38] The literature review, revealed number of RCT studies published comparing various methods of tapping techniques and electrical stimulation.[39] This review is intended to reveal the best

evidence at present in the current literature.

Search Strategy

Database was searched electronically from 1990 up to June 2017 to identify relevant trials for this narrative review. MEDLINE®, EMBASE® and Saudi Digital Library(SDL) was searched for relevant literature using combinations of the key words "shoulder," "subluxation," "pain," "stroke," and "hemiplegia." This research provided 69 articles in MEDLINE, 10 articles in EMBASE and 43 articles in SDL Grey areas like reference lists and bibliographies of related journal articles and books for additional trials. This additional research provided 21 articles (6 abstracts, 3 books or chapters of books, and 12 articles not indexed or published before 1990). We limited our search for articles published in English language and articles published in peer reviewed journal.

Review of literature:

Intervention Available Robotic Therapy

Many authors have recommended the use of robotic technology in upper limb stroke rehabilitation.[40][41][42] Dijkers et al[43] was one of the few researchers to utilize simple robotic therapy. He emphasized on repetition and record of movement, however author didn't evaluate the quality of movement and amount of patient participation.

Simulation environmental for arm therapy (SEAT)[44] developed at VA Palo Alto Rehabilitation R&D center and Stanford University by Johnson et al in 1999, works on the principle of mirrored-image. The subjects performed bimanual tasks like rotating a steering wheel, which was equipped with sensors to provide assistance and resistance torque. The system was also equipped with a low resolution screen to provide traffic scenes.

The SEAT method includes 3 diverse therapy types: normal, active and passive. Normal type evaluates the participation of both the upper limbs on the steering wheel in terms of force and coordination. Active type encourages the use of paretic side while relaxing the non-paretic side lastly passive type assists the paretic side guided by non-paretic limb.

Based on the concept of mirror imaging Mirror-image Motion Enabler (MMIME) [45] was constructed at the VA Palo Alto rehabilitation and R&D center. Initially Puma 260 robot[46] was developed with force torque sensor attached to the arm support. Later it was replaced by more advanced Puma-560 robot. [47] The MMIME method moves the paretic arm by mimicking the pattern of movement in the non-paretic side. The system manipulates the amount of assistance as soon as system detects the efforts made by the subject. Many authors[48][49][50] concluded that the robotic therapy has no negative effects and also it's safe and effective in neuro rehabilitation.

Slings

Slings to support shoulder joint are mostly used in acute phase of stroke rehabilitation. The basic purpose of these slings are to support the soft tissue of shoulder joint against pull of gravity or reduce GHS and pain.

There are a wide variety of slings available. Most commonly prescribed and researched slings include the Bobath roll

sling[51], Harris single-strap sling[52] and Humeral cuff sling[53]. The Harris sling is a single-strap traditional sling worn around the neck which supports the elbow and wrist keeping the shoulder joint in adduction and internal rotation. The Bobath roll sling utilizes a foam roll kept under the axilla to keep the arm in adduction and external rotation (anti-spastic pattern). Many researches have reported that the Bobath sling is ineffective[54][55] in preventing inferior subluxation, moreover creates a harmful lateral displacement of humerus. The Roylan Humeral cuff sling[56] consists of a cuff around the proximal humerus for correction of glenohumeral alignment. The main advantage of this sling is that it allows freedom of movement. A recent Cochrane review[57] reported that none of the slings prove to be effective in preventing GHS rather they restrict the functional activity of upper limb. However, the slings can be used for a short period of time during ambulation by counteracting against the traction on joint by weight of the arm and gravitational pull. A systemic review revealed that an orthosis which comprises of humeral support are less effective as compared to orthosis with forearm support. It was concluded that wearing the orthosis which supports the shoulder through elbow, is effective in reducing vertical subluxation. There are some researches[58][59] which suggests that wearing the orthosis for four weeks would reduce the level of shoulder pain.

Lap boards and arm troughs

Lap boards and arm troughs are mostly utilized while the patient is seated. The main aim of these instruments is proper positioning of the arm. An arm trough is an adjustable plastic box covered with foam to support the paralytic arm by raising the hand above elbow. It is fixed on the arm rest of a wheel chair on affected side whereas lap boards are flat broad surface that can be attached to any arms of wheel chair. Both of these aids have shown to assist[60] in correcting shoulder subluxation and produce little contracture and tonal variation that are usually associated with slings. There are a few disadvantages[61] associated with these devices as they tend to overcorrect the subluxation and are only suitable to patients who are wheelchair bound.

Shoulder strapping

Shoulder strapping involves application of a wide variety of adhesive tape over the skin of the shoulder joint. They provide little stretch in the direction of the muscle fibers mainly posterior fibers of deltoid and supraspinatus in order to reduce shoulder subluxation. There is research evidence[39] that the correct tapping technique could delay the development of HSP by 14 days. The beneficial effect of strapping over slings is that, it allows the freedom of shoulder movement. Kinesiology tapping[62] seems to be promising method of shoulder strapping but little evidence is available to prove its efficacy. Overall, the strapping method is not a useful method in the management of shoulder subluxation. There are other disadvantages[63] associated with strapping such as skin irritation and vascular compromise.

Functional Electrical Stimulation

Functional Electrical Stimulation (FES) is the application of electrical current to stimulate the motor nerves and muscles fibers causing functional muscle contraction. FES used in cases of GHS is primarily used to reduce subluxation by correcting the glenohumeral alignment.[64] Electrodes are placed over the posterior fibers of deltoid and supraspinatus, as these muscles act as dynamic stabilizers during traction of the humerus in normal subjects. Generally the treatment last 6 hours a day, 5 to 6 days a week and for 6 weeks. Normally the intensity and duration of electrical stimulation is such that the muscle is in the state of tetanized muscle contraction. Ratio of contract: relax is modulated to avoid fatigue. There are research proven benefits of FES, such as reduction in subluxation[65], decrease in level of pain, and improvement in functional range of motion.[66] FES can also be used prophylactically, as it is believed to help prevent stretch damage to the joint capsule.[67]

Linn at el [68] reported that the use of electrical stimulation (ES) resulted in no significant difference in level of pain but a visible improvement in Passive humeral lateral rotation (PHLR).Improvement in PHLR is strongly associated with reduction in shoulder subluxation. Subjects gained pain free range following ES might be due to improvement in muscle strength and cerebral plasticity following afferent nerve stimulation.

Hemiplegic shoulder pain is effectively treated with percutaneous neuromuscular electrical stimulation (NMES)[69] and intraarticular corticosteroid injections.[70] Although corticosteroid injections produce immediate satisfactory results but its use inevitability cause post injection flare and ruptured tendon.[71]

Percutaneous NMES in a procedure which involves insertion of electrodes subcutaneously and is associated with a risk of electrode-related infections. Surface electrodes are more readily used in clinics to stimulate muscles and nerves of the affected area. Transcutaneous electrical nerve stimulation[72] is a widely used intervention to reduce pain in post-stroke upper limb dysfunction. Normally TENS is used for pain relief at the sensory level, without causing muscle contraction.

Handling and positioning techniques

Proper Positioning of paretic upper limb plays an important role in the treatment of GHS. Pillows are placed to position the paretic upper limb in neutral position in lying, sitting. It is believed to prevent muscle contractures, wasting and prevent undue stretch injury during acute phase of stroke. A study by SF Tyson and C Chissim[73] reported a handling technique to properly manipulate the hemiplegic shoulder. They compared two different handling techniques to move a hemiplegic shoulder, i.e. axilla hold and distal hold. They suggested that supporting the paretic shoulder at axilla while maintaining the external rotation will result in greater degree of pain free range of shoulder movement. It is believed that axillary hold would restore shoulder locking mechanism and lost scapula-humeral rhythm, thereby avoiding traction injuries and soft tissue entrapment. Scapular mobilization prior

to Passive range of motion in vital to prevent sub-acromion injury. During the shoulder must not be abducted beyond 90 degree unless it's accompanied with upward rotation of scapula and external rotated of humeral head.

Extracorporeal shock wave therapy

Extracorporeal shock wave therapy (ESWT)[74] is a non-invasive method of treating shoulder pain post stroke. ESWT a series of sonic waves, with a peak pressure up to 100 MPa, abrupt stress rise (<10ns), and a very short duration of pulse (10 μs). During ESWT, sonic shock waves are emitted by a generator to a target area by an applicator tip. Depth of penetration ranges from 0-30 cm from the skin surface.

Brain-computer interface (BCI)

Brain-computer interface (BCI)[75] is an advance system of neurorehabilitation through neuro-feedback. The BCI captures the neuronal signals from brain by using electroencephalogram, magnetoencepalogram and converts the information into meaningful motor response. The information obtained from neuronal activity of brain is amplified and fed to biofeedback equipment's like FES or robotic assist devices. Consequently such interface overcomes the limitation of FES system by achieving conscious participation of the subject. BCI controlled FES system is used as neuro-rehabilitation treatment for training the upper limb impairment after stroke. This system enables the participants to directly control the activity of upper limb motor system through voluntary brain commands. Few researches[76][77] have reported the significant improvement in shoulder flexion and abduction in stroke patients.

Acupuncture

Acupuncture is one of the old traditional treatment for various conditions, chronic pain, musculoskeletal problem, and neurological aliments. Randomized control trails[78] have reported positive effects of acupuncture in the treatment of shoulder subluxation. A recent systematic review[79][80] revealed the effect of acupuncture in the treatment of post stroke shoulder pain.

Summary

GHS is the most common complication associated with the flaccid paralysis post stroke. Subluxation of the shoulder predisposes to painful shoulder although no direct link has been found. Following stroke, the subluxed shoulder joint cause's functional limitations and affects quality of life. Current treatment is limited in number and feasibility of use. These include shoulder slings, tapping techniques, arm troughs, lap boards and FES. There are other options like surgery, kinesiology tapping, but the evidence supporting these are not so conclusive. Lastly, ultrasound assessment has been found to accurately measure shoulder subluxation, and FES is the best choice in shoulder subluxation preventive as well as curative.

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