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A CASE REPORT OF THERAPEUTIC MASSAGE TO RELIEVE AXILLARY WEB SYNDROME, A RESTRICTIVE SOFT TISSUE CONDITION CAUSED BY BREAST CANCER SURGERY

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Abstract

Background: *Axillary web syndrome (AWS) is a not-uncommon consequence of axillary (underarm) surgery conducted as part of breast cancer staging. The abnormal cord or web of fibrotic tissue may appear within a few weeks or months after surgery, readily palpated along the inner aspect of the arm from axilla to elbow and even wrist, causing tightness when the arm is raised or extended. This limits range of motion (ROM) of elbow and shoulder joints, often with associated pain and discomfort. No standard of care has been established. Current treatments focus on physical therapy and other manipulation-based methods to variable effect, and often require numerous sessions.* ***Method:*** *We describe the presentation and treatment of a young woman with breast cancer who developed AWS of the left upper extremity following ipsilateral simple mastectomy plus axillary surgery. At presentation, self-reported pain upon arm extension was 5/10 (0 is no pain, 10 is severe pain), and shoulder ROM was 140° (normal is 180°). Cording was clearly evident and taut from axilla to elbow and elbow to wrist. She received two sessions of therapeutic massage using dynamic angular petrissage, a treatment approach developed by one of us (PL). This incorporates petrissage and non-petrissage techniques with purposeful, controlled passive-relaxed movement of the affected arm, by the therapist, through all possible angles of the client's ROM. Using the arm as a lever, stretch and tension of soft tissues including the cord were modified while defined therapeutic techniques were applied. Care was taken to loosen the tension of the cord without breaking it.* ***Results:*** *After two treatment sessions within four days, plus prescribed home-care exercises, the client was free of ROM restrictions and movement-associated pain. The cord was apparent only upon hyperextension of the arm and caused no pain. Treatment did not cause the client additional pain or discomfort. Three months later, she was free of any AWS signs or symptoms. Conclusions: We propose that dynamic angular petrissage may be used to efficiently and safely eliminate the cording tautness, pain, and restricted mobility of AWS. In our hands it has also proven helpful for other conditions characterized by pain and restricted ROM caused by soft tissue adhesions or contractures, such as Guillain-Barre syndrome. This treatment approach can be readily taught to massage and other manual therapists, and is amenable to clinical research.*

Keywords: axillary web syndrome; cording; axillary surgery; breast cancer; massage therapy; dynamic angular petrissage; soft tissue restriction

NB: A glossary of key terms is given at the end of this paper.

INTRODUCTION

Therapeutic massage can be of considerable benefit for a wide variety of soft tissue conditions in which the client has functionally restricted movement. Mechanisms by which this may be achieved include the mechanical, physiological and psychological and their interactions. Mechanically, adhesions and fibrosis that constrain movement can be disrupted, blood flow increased to ischemic tissue, reflex dilation of blood vessels stimulated, lymphatic drainage improved, and muscle spasms reduced by stimulation of proprioceptors. Each of these effects induces physiological changes persisting beyond the massage session. Psychologically, massage reduces stress, anxiety and depression and gives the client a general feeling of well-being; these benefits are most pronounced in clients who have experienced tissue trauma or pathology. Together, these processes combine to favourably impact pain and promote healing.(1)

We have found the combination of manual massage techniques and passive-relaxed movement (that is, conducted by the therapist, unaided by the client) of the affected limb relieves locally impaired range of motion (ROM) and associated pain. This approach has proven effective in our hands (second author, PL) where a single limb is involved as in the case described in this report, as well as for the soft tissue pain and debilitation associated with paralysis or paresis, where the client is unable to move of their own volition (active movement).

Axillary web syndrome (AWS) is a not-infrequent complication of surgery to the axilla, such as for breast cancer staging and regional disease control.(2-11) This condition, considered a variation of Mondor's disease,(4) manifests as cording or webbing of the affected arm, with externally visible and palpable rope-like structures (cords) evident under the skin of the inner arm. The cords may extend from the site of incision (surgical trauma), along the medial aspect of the arm to the antecubital fossa of the elbow and even into wrist and thumb (Figure 1A).(4-6,12) Etiology is unclear, but the cords are thought to involve angiolymphatic and fibroblastic structures, exacerbated by surgical trauma and the tightness of the surrounding tissue.(2-8,13-15) In the context of breast cancer, risk for AWS appears to be greater with axillary dissection (removing a few, several or many lymph nodes) than with axillary sentinel lymph node biopsy alone (removing only specific nodes receiving lymphatic drainage from the breast), although not all investigators agree.(16-17) Generally speaking, risk is elevated if more nodes are removed (greater surgical trauma), in women of younger age, those with lower body mass index (leaner physique), and/or if the surgical procedure includes mastectomy.(5) While recovery from AWS can be spontaneous after some weeks or months, the experience of physical therapists strongly indicates that AWS may persist chronically, with associated pain and disability.(2,5,10,18-22)

No standard of care for AWS has been established, although various non-invasive, surgical and pharmacologic approaches have been investigated.(5,22) Current treatments focus on manual approaches including massage and physical therapy, usually as conservative treatments given in several sessions over weeks or even months with varying degrees of success in symptom reduction and cord resolution.(5,8-10,19-21,23) A notable exception is application of firm digital pressure to rupture the cord: this is reported to relieve pain and movement limitations in a single session,(24) but patients were apparently not followed for possible negative consequences or durability of response.

In this retrospective case report, we describe the application of a novel therapeutic massage technique, dynamic angular petrissage, in two sessions to completely relieve the signs (cording) and symptoms (pain and restricted ROM) of AWS in the case of a young woman who had recently undergone simple mastectomy and axillary dissection for breast cancer.

DESCRIPTION OF CASE

Client: The client provided consent for her clinical information, photos (including one photo provided unsolicited by the client), treatment, outcomes, and candid comments to be included in this report.

The client was a 45-year-old Caucasian woman residing in Toronto, Canada who presented with visibly evident cording of the upper left extremity from axilla to wrist (Figure 1A), accompanied by movement-associated pain and restricted ROM. She reported having had a left simple mastectomy combined with axillary surgery (sentinel node biopsy plus axillary dissection that included removal of breast tissue, underlying fascia and skeletal muscle of the

axilla) for breast cancer, 6.5 weeks earlier. She had not received any radiotherapy or chemotherapy. Despite receiving basic rehabilitative post-surgery physical therapy care, for several weeks she continue to experience movement-associated pain and diminished ROM. Massage treatment given by one of us (PL) 4.0 weeks after surgery provided considerable improvement, and no cording was noted at that time. However, cording soon became apparent extending from the axillary surgical scar through the entire length of the arm. When her surgeon could offer no treatment suggestions, she again sought massage treatment.

At presentation, the client described "pain, tightness, a 'tugging' under the skin [of her left arm] and a visible ropey tightness ... . This 'rope' extends all the way down my arm, especially with pain at the elbow and again at the inner wrist. When I press anywhere on this pathway down the arm, there's a stinging tight pain. ... [The rope] originates near a bubble of stitched skin at my axilla". Her therapeutic objectives were to regain freedom of movement of shoulder, elbow and wrist; to be free of movement-associated pain; and to be free of the cording and associated interference with normal activities, in particular self-care such as underarm shaving.

Treatment Principles: Soft tissue problems suitable for massage intervention often involve adhesions, fibrosis, ischemia, inflammation, muscle atrophy, edema and/or stimulated pain trigger points. Conditions involving restricted ROM, as seen in AWS, are particularly amenable to massage when the appropriate techniques are combined with passive movement of the affected joint(s) and tissues(s).

To this end, one of us (PL) has developed a therapeutic treatment approach termed dynamic angular petrissage. It uses specific established, evidence-based manual massage techniques of petrissage (e.g. Swedish methods such as light muscle stripping, kneading, pincer grasping, c-scooping) and non-petrissage (such as stretching and myofascial release) techniques(25) in an innovative manner that incorporates purposeful and directed passive-relaxed movement ("dynamic") of the affected limb through the available range of motion. As shown in a demonstration video,(26) by carefully moving the limb with hand A through different angles ("angular") the therapist is able to gently lengthen and relax the target tissue, from proximal to distal (i.e. segmentally). At the same time adhesions and other restrictions (lesions) are gradually released by hand B. The intent is to gradually release any constrictions on the fascia, muscles and connective tissues without engaging the stretch reflex (protective contraction), and to thereby interrupt the deleterious cycle of pain, fear of pain, and physical guarding against anticipated pain. This in turn facilitates an alternative proprioceptive environment that allows (rather than forces) tissues associated with the cord to release. The goal is to reduce all sources of tension and thus regain the original resting length of the tissue. This treatment approach can have immediate and powerful effects on muscle and connective tissues, and can be effectively applied to soft tissue injuries in both acute and chronic situations.

Once the soft tissue lesion (muscular knot, adhesion, or as in the case of this client, the cord) has been identified and localized, digital pressure is applied with thumb, hand and/or fingertips of hand B to the proximal aspect (closest to the body) of the lesion. Digital pressure is maintained at the barrier (the point where tissue resistance increases in response to temporarily sustained pressure) and the tissue is gently kneaded (petrissage) with hand B. Simultaneously the tissue is lengthened by moving the limb with hand A in a passive manner. That is, while hand B gently kneads (petrissage) the soft tissue, simultaneously hand A manipulates limb position and angle to passively increase (lengthen) and decrease (shorten) tension on the target tissue. As the barrier releases, both the kneading hand (hand B) and limb position (controlled by hand A) are readjusted to adapt to a new barrier. In this way the limb serves as a lever, changing the working tension on the tissues between the limb and hand B in a controlled, passive manner. Utilizing the muscle's line of pull and attachment—changing the lever angles—simulates the natural movement of the limb.

Should the client experience discomfort at a specific angle or position, the applied pressure or stretch is reduced; the same target area may then be addressed from a different angle without discomfort. The therapeutic purposes of this treatment method are to reduce soft tissue restrictions that compromise movement and generate associated pain, and to reduce the time spent in rehabilitation and speed recovery, all the while treating within the client's improving ROM and comfort zone. In this way, as the

treatment session progresses the comfortable ROM is gradually extended.

Therapeutic Intervention - Session One: (90 minutes) Functional assessment is used to assess the client's ability to functionally move and to determine the source of the presenting issue(s). The tests assist the therapist to determine the course of action required to address the source of the issue(s) and reduce or eliminate the symptoms, and also support the rationale for the areas addressed, the techniques used and client positioning.

Assessment measures used with this client are detailed elsewhere.(27) Briefly, she was examined to identify the locations from which pain and restrictions originated. Assessment included visual inspection of client posture; palpation of upper extremities, shoulder and neck; active-free ROM testing of the upper extremities (observing movement as performed by the client unaided by the therapist); passive-relaxed ROM testing (movement performed by therapist unaided by the client); measuring her ability to move the extended arm forward from a resting position paralleling the body to a position directly above the head (glenohumeral (GH) flexion) with normal being 180° as measured with a goniometer; client self-rated movement-associated pain on the 0 to 10 Oxford Numeric Pain Rating Scale where 0 is no pain and 10 is severe pain;(28) visual inspection and palpation of cording for extent, tautness, and texture; visual inspection and palpation for evidence of lymphedema; and client query of any additional signs and symptoms.

Consistent with the client's history and complaint, she was observed to have slight anterior rotation of the left shoulder (Table 1). Bilateral active-free functional testing and palpation of upper extremities including neck and shoulder revealed high resting tension of the left levator scapula restricting cervical movement to the right, and restricted ROM of the GH joint in abduction and during flexion (maximum 140° flexion as compared to the normal of 180°). Pain on movement was self-rated by the client as 5/10. Active-free ROM testing of elbow and wrist revealed restricted extension of these joints also, with self-rated pain levels 4/10 and 2/10, respectively. She stated the restrictions and pain were due to the cording, which was clearly evident in abduction as a rope-like structure from axilla to antecubital fossa of the elbow, and as a finer dental floss-like structure from elbow to the radial side of wrist (Figure 1A). Visual inspection and palpation of shoulder and arm revealed no evidence of lymphedema (a known complication of axillary surgery), and the client denied observing any lymphedema signs or symptoms.

The treatment plan was designed to reduce the pull of the cord on musculature, adhesions, and underlying structures from axilla to wrist and thereby reduce the tension of involved tissues and restrictions on ROM (a detailed treatment protocol is provided elsewhere [27]) An important consideration was to avoid tearing the cord, which might initiate a local inflammatory process and conceivably increase risk for lymphedema, particularly if the cord is indeed primarily lymphatic and relevant to lymphatic drainage of the arm.

With the client in a supine position, integrative lymph drainage techniques were applied to neck and shoulder areas with preventive intent. Treatment then addressed all accessible structures that may have directly or indirectly contributed to the client's signs and symptoms, particularly interrelationships between clavicle, GH and scapulothoracic joint which are critical in helping with full functional ROM.(29) Light effleurage strokes were applied to neck, shoulder, and pectoral regions to warm and prepare the tissues.

Methods of dynamic angular petrissage were then applied to the ipsilateral (left side only) pectorals, deltoids and sub-scapularis, bilateral (left and right) cervical and upper trapezius, and ipsilateral biceps, triceps, forearm extensors, and forearm flexors. Long petrissage strokes and/or short segmental strokes were used in the dynamic and angular manner described above to gradually and segmentally lengthen the target tissue; by this method, movement of the joints beyond the presenting limitations was gently achieved.

The scapula was then mobilized along with gentle oscillations to the sternoclavicular joint and acromioclavicular joint with the purpose of structurally assisting scapulothoracic movement; similarly, to assist with GH joint ROM, gentle traction was applied (to slightly loosen the joint and decompresses the articular surface) prior to posterior glide mobilization (to assist with ease of movement of the GH joint during flexion) and then long axis traction (to assist with abduction). Oscillations, traction with posterior glide mobilization, and long axis traction were all applied at Grade 1 levels (i.e., gently) utilizing

available joint play to loosen the capsule without stretching any tissues beyond existing laxity.(30) Finally, light effleurage was applied to the entire limb and neck area, working from distal to proximal.

The client was instructed in home care exercises specifically designed to mobilize and lengthen the tissues associated with the GH joint, including chest muscles, rotator cuff, and shoulder, interscapular, back, cervical, and elbow and wrist muscles. These exercises included "L"-circles (with elbow bent and forearm raised to form a capital letter "L" the fingers are placed on top of the shoulder at the acromion and the elbow is moved in a circle, leading a circumduction at the GH joint), and wrist and elbow extensor exercises. They were to be repeated several times per day.

In post-treatment assessment, the client self-reported movement-associated pain at GH joint, elbow, and wrist as 0/10 (complete resolution; Table 1). Active-free GH ROM was improved by 30°, to 170°. Hyperemia (increased blood flow) was observed in treated areas as superficial redness. Whereas on pre-treatment palpation the cord was prominent and distinct from the other tissues, post-treatment the cord felt as part of the arm structure and was visibly reduced but not torn or ruptured (Figure 1B). The client reported she did not feel any pain during treatment. One day later, she called to report the axillary cording was only half as initially prominent: "The whole web or cord system seems to have relaxed to the point where I can basically move my arm how I want, with little-to-no pain." The most "annoying" pain had been at wrist and elbow "and these are where I'm feeling a massive relief." In all, the client described improvement in her condition as 70%. For the first time since detection of AWS she was able to shave her underarm area.

Therapeutic Intervention - Session Two: (60 minutes): The client returned four days later, reporting she had practiced the home care exercises as instructed, that she had full ROM of her arm with no pain (0/10) or distress on GH flexion or abduction, that extension of wrist and elbow were also without pain (0/10) or restrictions, and that minimal residual restriction of extension remained only upon her customary hyperextension of elbow and wrist. On bilateral active-free testing (i.e. performed by the client), she had full ROM with no restrictions; neither the rope-like band from axilla to antecubital fossa, nor the dental-floss-like structure from elbow to wrist, were evident. Residual cording could be detected visually and on palpation only on hyperextension of elbow and wrist (Figure 1C). No signs of lymphedema were observed, nor did the client report any symptoms.

After assessment and integrative lymph drainage, with the client in a supine position, light effleurage warm-up strokes were applied to neck, shoulder, and pectoral regions. Therapeutic massage using methods of dynamic angular petrissage was applied to the same areas and structures as in Session One. During the final 25 minutes of the session, other areas of the body were treated as requested, including abdominal region, legs and lower back. The client was instructed to continue home care exercises.

In post-treatment assessment with active-free functional testing of shoulder, elbow, and wrist, the cord was residually apparent in the axilla, but the client reported that she did not feel any restriction during extension or even upon hyperextension (Figure 1C; Table 1). ROM of the GH joint was unrestricted. She self-rated her pain levels associated with movement after treatment as 0/10 in GH joint, elbow, and wrist. She again reported that she did not feel any pain during treatment.

Short-term Follow-Up: The client telephoned (unsolicited) 8.5 weeks after Session One to report that the cord was now localized to just the vicinity of the scar and that movement was without pain (Table 1), and emailed a photo (Figure 1D, taken in a mirror).

Three-Month Follow-Up: The client returned for scheduled follow-up 14.5 weeks after Session One, with no further intervention other than home care exercises. Active-free ROM testing revealed no movement restrictions, and no palpable or visible signs of AWS (Figure 1E; Table 1). The client reported that she remained free of movement-associated pain (0/10 at GH joint, elbow, and wrist) and of AWS restrictions or cording, and had not experienced any treatment-related pain or negative consequences following her therapy. She was free of any signs or symptoms of lymphedema.

DISCUSSION

In our experience, post-surgical mastectomy patients can experience a variety of issues—singly or in combination—including pain and altered sensation in

the hands and in the surgical site, restricted range of motion and secondary lymphedema, all of which can benefit from therapeutic massage. A commonality is trauma resulting in soft tissue damage, scarring and consequent restrictions of normal tissues.

Therapeutic massage using the dynamic angular petrissage treatment approach specifically addresses soft tissue restrictions, and is based upon the therapist's detailed knowledge of all structures and functions involved. Indeed, for this client with AWS, unlike with some other standard massage and physical therapy approaches used for this condition,(5) particular care was taken to ensure that the cord was not ruptured, as determined by lack of a sudden change in cord tension or audible popping sound. This avoided possibly initiating a local inflammatory process or damaging lymphatic tissue, which could conceivably interfere with healing and increase the risk of lymphedema.(5) Until the etiology and pathophysiology of AWS and also of lymphedema are better understood, such caution may be prudent.

The highly controlled soft tissue stretching-and-relaxation methods of dynamic angular petrissage were applied while simultaneously carefully assessing for any pathologic resistance from non-contractile elements (e.g., fascia, tendons, ligaments, scar tissue, adhesions and of course the AWS cording). Technique combinations and applied intensities (speed of movement, degree and duration of pressure, amount of drag) were modified according to the conditions of the tissues being worked and the desired restriction release. During treatment, changes in tautness, texture, and attachment of the AWS cord to surrounding tissues were readily evident by palpation. Although the precise etiology and pathophysiology of AWS are unclear, tightness of surrounding tissue may exacerbate emergence and tautness of the cord.(5) We therefore suggest that the pressure and manipulations released any adhesions and other soft tissue constrictions(25) associated with the cord, rendering it both less obvious and restricting of movement.

The client described here experienced clinically meaningful relief from signs and symptoms of AWS, and reported rapid, substantial and permanent reduction in movement-associated pain from 5/10 to 0/10 (Table 1). In appreciation, she provided unsolicited interim follow-up and self-photos, and gladly consented to have her case reported in the literature in the hopes that other women with AWS may benefit from this treatment approach.

The mechanisms by which therapeutic massage relieves chronic pain are poorly understood, involving a combination of physical, physiological and psychological factors.(1,31-32) With the release of restricting soft tissues (here involving the cord) the anticipated pain associated with movement may have become less threatening to the client, thereby interrupting the deleterious cycle of pain, fear of pain, and physical guarding against anticipated pain which may have created tensions in the entire shoulder girdle and forearm and maintained and tightened the cord once it arose. We propose that the application of massage techniques directly released the involved tissues and interrupted the cycle of pain, facilitating an alternative proprioceptive environment that allowed (rather than forced) the tissues associated with the cord to release. In this regard, the importance of keeping the movement and pressure within the client's comfort zone may be critical to treatment success.

The second author (PL) is currently using the passive-relaxed dynamic angular petrissage therapeutic approach to successfully treat other AWS clients as well as clients with other conditions in which soft tissue adhesion or contracture causes pain and restricted ROM, including those with paralysis or paresis or who are otherwise unable to actively participate in physical rehabilitative efforts.

FUTURE DIRECTIONS

Because dynamic angular petrissage can be readily taught and applied according to a defined protocol, application in therapeutic massage practice and unbiased testing via clinical trials of efficacy in the context of AWS and other soft tissue contractures is anticipated to be both feasible and valuable. One painful and highly debilitating condition in which the client responds positively in our hands (PL) to dynamic angular petrissage is Guillain-Barre syndrome, characterized by rapid and severe onset, and progressing quickly to bilateral paralysis and medical emergency. Although massage cannot prevent Guillain-Barre syndrome, given the therapist's scope of practice it is possible (after Intensive Care Unit [ICU] care is complete) to maintain, rehabilitate and augment physical function in a person who is

rendered dysfunctional by this debilitating condition. With the recent appearance and ongoing geographic spread of the Zika virus and its very likely causal link to Guillain-Barre syndrome,(33) efficacy trials of dynamic angular petrissage for this condition in particular may be especially relevant.

CONCLUSION

Axillary web syndrome is not rare, and no standard of care has yet been established. In this case, two treatment sessions of dynamic angular petrissage (with added home care exercises) resolved all of the client's signs and symptoms and without causing the client any additional discomfort.

Given these results, coupled with long-term (3-month) continued efficacy and absence of any evident negative consequences, we suggest that dynamic angular petrissage has the potential to be of considerable use in the treatment of AWS and other soft tissue problems characterized by reduced ROM and associated pain.

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Conflict of Interest Notification: The authors have no conflict of interest regarding this work. The treatment method described was developed by the second author (PL) but is not proprietary. No outside funding sponsorship was provided.

Therapist Background and Experience: All treatment was provided by the second author, Mr. Paul Lewis, BA, RMT, CDT. Mr. Lewis is a Registered Massage Therapist in private practice in Canada, with six years of clinical experience at the time of this case. He is registered in Canada with the College of Massage Therapists of Ontario (CMTO), in the US with the American Massage Therapy Association (AMTA), and in Great Britain with the Federation of Holistic Therapies (FHT). A graduate of the Sutherland-Chan School and Teaching Clinic in Toronto, Canada, his experience includes ambulatory care clinics; spinal cord rehabilitation; high-risk pregnancy and post-partum; management of breast implants, TRAM reconstruction, lumpectomy, mastectomy, and post-radiation massage; lymphatic movement and drainage; combined decongestion therapy, and sports massage and reflexology.

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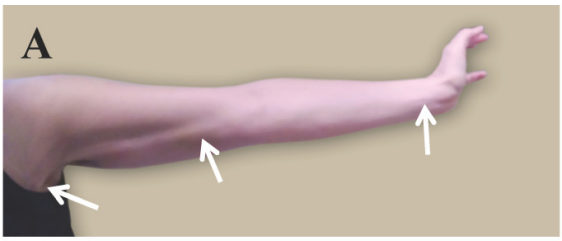
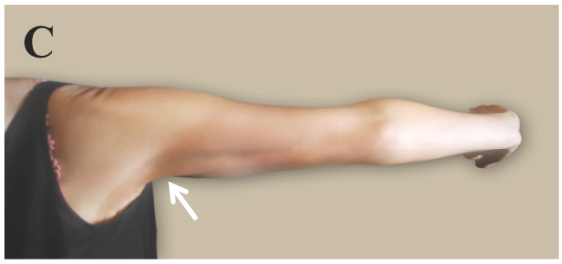
Figure 1. Cording Before and After Treatment Using Dynamic Angular Petrissage.



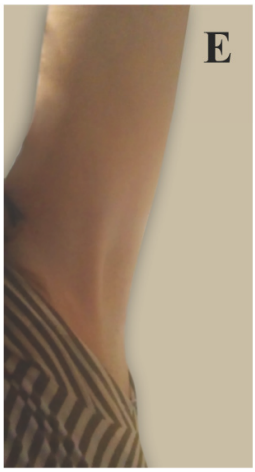
A) Before first treatment: cording (arrows) is clearly seen from axilla to elbow and wrist.

B) Immediately after first treatment: cording prominence (arrow) is reduced, and range of motion increased.



C) Before second treatment: cording (arrow) is visible only on hyperextension.

D) At 8.5 weeks after first treatment: cording (arrow) is localized to vicinity of the surgical scar, seen on full extension. (Photo was provided by patient, taken using a mirror.)



E) At 14.5 weeks after second treatment: cording is no longer visible, even on extension.

TABLE 1: Summary of Left Upper Extremity Baseline and Outcome Measures

Assessment	Anatomic Site	Session One (Week 0)		Session Two (Week 0.5)		Phone Call (Wk 8.5)	Follow-Up Visit (Wk 14.5)
		Pre (Baseline)	Post	Pre	Post		
Stance and Posture (visual inspection)	Shoulder	Slight anterior rotation	No apparent anterior rotation	No apparent anterior rotation	No apparent anterior rotation	--	No apparent anterior rotation
Active-free ROM functional testing (movement performed by client)	Cervical	Restricted abduction and rotation to left	No restrictions	No restrictions	No restrictions	--	No restrictions
	GH joint	Restricted flexion and abduction	Somewhat restricted flexion and abduction	Full flexion and abduction, no restrictions	Full flexion and abduction, no restrictions	--	Full flexion and abduction, no restrictions
	Elbow and wrist	Restricted extension	Somewhat restricted extension	Full extension; Some restriction on hyper-extension	Full extension, even on hyperextension.	--	Full extension, even on hyperextension
Passive-relaxed ROM testing (movement performed by therapist)	GH joint	High resting tension of LS, restricted ROM on abduction and flexion	--	Not assessed*	--	--	Not assessed*
	Elbow and wrist	Springy end-feel, restricted ROM	Normal end-feel, no restrictions	Normal end-feel, no restrictions	Normal end-feel, no restrictions	--	Normal end-feel, no restrictions
Movement-associated pain (self-rated, using pain scale)	GH joint	5/10	0/10	0/10	0/10	0/10	0/10
	Elbow	4/10	0/10	0/10	0/10	0/10	0/10
	Wrist	2/10	0/10	0/10	0/10	0/10	0/10
GH flexion (goniometer)	GH joint	140°/180°	170°/180°	Not measured*	Not measured*	--	Not measured*
Cording (visual inspection)	UOQ to AF	Prominent (Fig.1A)	Less prominent (Fig.1B)	Minimal (Fig.1C)	Residual in axilla only	Axillary scar area (Fig.1D)	None (Fig.1E)
	Elbow to wrist	Prominent	Less prominent	None	None	None	None
Cording (palpation)	UOQ to AF	Prominent, taut, rope-like	Diminished	Minimal	Residual only	--	None

Assessment	Anatomic Site	Session One (Week 0)		Session Two (Week 0.5)		Phone Call (Wk 8.5)	Follow-Up Visit (Wk 14.5)
		Pre (Baseline)	Post	Pre	Post		
	Elbow to wrist	Prominent, taut, floss-like	Diminished	Minimal, only on hyper-extension	Residual only	--	None

AF = antecubital fossa; GH = glenohumeral; LS = levator scapula; ROM = range of motion; UOQ = area of chest wall where breast upper outer quadrant was prior to mastectomy (see arrow, Figure 1A); Wk = week.

* Active-free results showed no restrictions at GH joint, therefore goniometer measurement was not taken and passive-relaxed assessment was not needed.

GLOSSARY OF KEY TERMS

Abduction	Movement of a body part away from the midline or resting position; in this case, the client has restricted ability to lift the arm from its resting position out to the side and up alongside the ear.
Acromioclavicular joint	Synovial joint between the acromion (highest bone of shoulder) and the clavicle.
Acromion	Highest bone or top of the shoulder girdle.
Active-free	Active movement by the client, free from any intervention by the therapist.
Adhesions	Non-elastic scar tissues that form in response to inflammation, infection, surgery, etc., abnormally joining other tissues and/or organs together
Angiolymphatic	Comprised of blood vessel and lymphatic vessel elements.
Antecubital fossa	Shallow depression of the forearm, just below the elbow.
Anterior rotation, shoulder	The shoulder is pulled forward on the chest, suggesting problems with GH joint stability or tension.
Articular surface	Surface of bone or cartilage that makes normal direct contact with another skeletal structure, in this case the GH joint.
Axilla	Underarm, armpit
Axillary dissection	Surgical removal of lymph nodes from the axilla, used to determine whether breast cancer cells have spread to lymph nodes.
Axillary web syndrome (AWS)	Abnormal cord or web of tissue extending under the skin from the axilla along the underside of the arm, that sometimes develops after axillary surgery.
Barrier	During massage, the increase detected in tissue resistance in response to temporarily sustained pressure.
Breast cancer staging	Determine whether the cancer has spread (in this case from the breast), and if so where it has gone in the body. Methods include imaging and surgery.
Capsule	The envelope surrounding a structure, in this case the membrane enclosing the synovial GH joint.
Cervical	Pertaining to the neck.
Circumduction	Circular movement of the upper arm around the shoulder (GH joint).
Constrictions, soft tissue	See Soft Tissue Restrictions
Contractures	Shortened and hardened soft tissues, often caused when normally stretchy (elastic) tissues are replaced by non-stretchy fibrous tissues. Often leads to deformity and rigidity of joints.
Digital pressure	Pressure applied using the fingers (digits), thumb or other part of the hand.
Distal	Located away from the center of the body, generally referring to part of a limb or muscle.
Dynamic angular petrissage	Treatment developed by one of the authors (PL), incorporating specific movements of a joint so as to control muscle length and tension, while simultaneously performing massage techniques to gradually release soft tissue constrictions.
Edema	Excess fluid in a tissue, causing swelling.
Effleurage	Soothing, stoking movements used to warm up the muscles and other soft tissues prior to deep tissue work using petrissage.

Etiology	Set of causes, or manner of causation, of a disease or condition.
Extensor exercises	Contracting the muscles to extend the joint.
Fascia	Band or sheet of connective tissue, which encloses or separates specific muscles or internal organs. May also serve to attach or stabilize muscles or organs.
Fibroblastic	Comprised of fibroblasts (cells of connective tissue fibers, and in this usage non-elastic).
Fibrosis	Scarring and thickening within an organ or tissue, due to growth of non-elastic scar-like tissue (fibrous; fibrosis).
Fibrotic tissue	Non-elastic connective tissue, formed in response to injury or healing.
Flexion, GH	Forward and upward movement of the upper arm.
Glenohumeral, GH joint	Shoulder ball-and-socket joint formed between the humerus (upper arm) and scapula (shoulder blade).
Goniometer	Simple instrument to measure or define an angle, as to measure joint range of motion or flexibility.
Guillain-Barre syndrome	A rare disorder in which peripheral nerves are attacked by the immune system, causing weakness, tingling and paralysis which can be life threatening.
Hyperextension	Extension of a body part beyond the normal range of motion.
Ipsilateral	Same side (of the body), in this case the same arm as the axillary web syndrome
Ischemic	Having inadequate blood supply.
Laxity	In this case, the at-rest tension within a joint.
Levator scapula	Muscle attached to the upper side of the neck and the scapula (shoulder blade), which functions to hold the scapula in its proper position.
Long axis traction	Moving the bone of a joint away from and parallel to the joint surface; in this case moving the humerus down from the acromion towards the hip (parallel to the long axis of the body).
Lymph drainage, integrative	Manual massage techniques specifically designed to accelerate normal functioning of the lymph vessel system.
Lymphedema	Abnormal localized fluid retention and tissue swelling caused by a compromised or damaged lymphatic system, such as in this case damage to axillary lymph nodes and vessels.
Manual massage	Manipulation of soft tissues, using the hands.
Mastectomy	Surgical removal of the breast.
Mobilized	Using manual movement of a joint or muscle, to improve ease of movement.
Mondor's disease	Cord-like inflammatory condition of veins close to the skin, thought to involve clotting and be caused by trauma.
Non-petrissage	Massage techniques including stretching and myofascial release.
Oscillations	Rhythmic movement about a central point, in this case tiny movements at the specified joints.
Pain trigger points	Hyperirritable spots located in taut muscle that cause pain and tightness, often experienced in another location.
Palpable	Able to be touched or felt by the hands, as in palpation.
Palpated	Examined by touch.

Paresis	Slight or incomplete paralysis, with weakness or reduced muscle power.
Passive-relaxed movement:	Movement performed on a joint by the therapist, while the muscles of the joint are relaxed. In this case changing the position of the arm, with the client neither contributing to the movement nor resisting it.
Pathophysiology	Disordered physiological processes associated with disease, injury or healing.
Petrissage	Massage techniques (e.g. kneading, rolling and other techniques) applied with pressure to compress underlying soft tissues.
Posterior glide mobilization	To physically move the convex surface of a joint posteriorly, along the concave surface; in this case to move the head of the humerus towards the back within the GH joint.
Preventive intent	Conducted specifically to prevent a condition or disease, in this case to prevent development of lymphedema.
Proprioceptors	Sensory receptors that tell the central nervous system about the position and movement of the various parts of the body (proprioception).
Proximal	Located towards the center of the body, generally referring to part of a limb or muscle.
Radial side, of wrist	The thumb side of the wrist.
Range of motion (ROM)	The movement potential of a joint. ROM may be limited by problems affecting the joint itself or associated soft tissues (muscles, tendons, etc.)
Resting tension	The partial contraction of a muscle during the resting state.
Scapulothoracic joint	The site where the scapula (shoulder blade) glides against the rib cage; not a true joint, but a point of physiologic articulation.
Segmentally	Bit by bit, a section at a time.
Sentinel lymph node biopsy	Removal of the first (sentinel) lymph node to which lymphatic fluid drains from the vicinity of the cancerous tumor, to see if cancer cells have spread to the lymph nodes.
Simple mastectomy	Surgical removal of the breast including nipple, areola and most of the skin, but not underlying muscle.
Soft tissue	Non-bone tissue, such as muscle, skin, fatty tissue, fascia, tendons, ligaments, scar tissue.
Soft tissue restrictions	Restrictions of range of motion or position caused by soft tissue injury, scarring or disorder. This includes adhesions, fibrosis and increased static muscle tension.
Sternoclavicular joint	Synovial joint between the sternum (breast bone) and clavicle.
Stretch reflex	Reflexive muscle contraction that occurs in response to stretching within the muscle, to regulate muscle length.
Supine	Lying face upwards.
Traction	Sustained pull applied to a limb, joint or muscle.
Working tension	The tension created within a muscle by actively manipulating it.