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Masterclass

Lateral epicondylalgia: a musculoskeletal physiotherapy perspective

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SUMMARY. **Tennis elbow or lateral epicondylalgia (LE) is a challenging musculoskeletal condition to treat. This is largely due to the lack of research-based evidence of the clinical efficacy of the myriad of treatment approaches espoused in the literature. In view of this, successful rehabilitation of LE is based on choosing treatments that address the physical impairments found during clinical examination. The primary physical impairment in LE is a deficit in grip strength predominately due to pain and its consequences on motor function. Hence the mainstay of successful management of this condition is therapeutic exercise, providing it is not pain provocative. Adjunctive procedures such as manipulative therapy and sports taping techniques have recently been shown to provide substantial initial pain relief. Early relief of pain in the rehabilitation program helps accelerate recovery and most importantly motivates the client to persist with the therapeutic exercise program. The manipulative therapy and taping treatments presented in this masterclass warrant consideration in the clinical best practice management of LE, and serve as a model for other similar musculoskeletal conditions.**

INTRODUCTION

Pain over the lateral humeral epicondyle which manifests during activities involving the hand in gripping or manipulating an object, such as that required when lifting a tea cup, shaking hands, dressing and desk or house work, will to most musculoskeletal health care practitioners signal the provisional diagnosis of 'tennis elbow' or more correctly lateral epicondylalgia (LE) (Vicenzino & Wright 1996). The cardinal physical signs of LE are pain to direct palpation over the lateral epicondyle and reproduction of pain and weakness during grip strength testing. Commonly, resisted contractions of the extensor muscles of the forearm, particularly the extensor carpi radialis brevis are also painful. No diagnostic imaging is usually required to confirm the diagnosis, although diagnostic imaging techniques, such as radiographs or CAT scans, can be used to exclude other conditions and injury of the underlying bone.

Epidemiological evidence indicates that LE is reasonably prevalent in the broad community (3% of general population (Allander 1974)) accounting for 5–7 in every 1000 general medical practitioner visits (Assendelft et al. 1996). Many sufferers of this condition who present to clinics for treatment do not play tennis, making the term 'tennis elbow' inappropriate for them. At risk populations, such as tennis players, fish processing workers, and those working in industries requiring repetitive manual tasks, express the condition in higher proportions, some found to be as high as 15% (Chiang et al. 1993; Ranney et al. 1995).

Lateral epicondylalgia is an intriguing condition because while it presents with a reasonably uncomplicated clinical picture its underlying aetiology is not readily understood (Vicenzino & Wright 1996). It is also regarded as an overuse injury that is difficult to treat, prone to recurrent bouts and may last for 48 months (Murtagh 1988).

AETIOLOGY PERSPECTIVE

The aetiology of LE has not been fully elucidated but on current evidence it would appear that the condition in its chronic form is not one of acute

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inflammation. Studies conducted on biopsy material taken at the time of surgical treatment for LE have identified a lack of inflammatory markers (Ljung et al. 1999); instead, degenerative changes in connective tissue have been reported (Nirschl 1989; Regan et al. 1992; Verhaar et al. 1993). Degenerative changes have also been shown in other chronic tendinopathies (Nirschl 1989; Khan & Cook 2000; Khan et al. 2000).

A recent microdyalysis study at the common extensor origin in four patients with chronic LE identified increased levels of glutamate, an excitatory amino acid, when compared to control asymptomatic subjects (Alfredson et al. 2000). This study also confirmed the lack of prostaglandin E2, a biochemical marker of inflammation at the study site. This suggests a disordered nociceptive system and concurs with findings from previous studies that used qualitative sensory testing to characterise LE pain. In brief, these qualitative sensory testing studies have indicated that the pain mechanism of LE may be one of secondary hyperalgesia (Wright et al. 1992, 1994; Smith & Wright 1993). The mechanism of secondary hyperalgesia represents disordered neural processing characterized by central sensitization (Sluka 1996; Sluka & Rees 1997).

One of the characteristics of secondary hyperalgesia is that it is found in an area that is neurologically related to, but not at, the injured tissue site. Some evidence exists to support the involvement of the cervical spine (Gunn & Milbrandt 1976) and upper limb neural tissues (Yaxley & Jull 1993; Wright et al. 1994) as a source of chronic LE.

Although clients with LE will classically report pain as the main feature of their condition they will invariably present with marked deficits in their muscle system. Weakness with grip dynamometer and isokinetic testing is a characteristic of LE (Stratford et al. 1993; Vicenzino et al. 1996, 1998; Pienimaki et al. 1997b).

Recently the sensory-motor system changes that occur in this condition have been studied (Pienimaki et al. 1997a). Pienimaki et al. (1997a, b) evaluated sensory-motor function in 32 people with unilateral, chronic LE and showed that the affected arm had reduced performance on a number of tasks of reaction time, speed of movement and coordination. Interestingly, the unaffected side also displayed deficits compared to age and gender-matched controls, possibly implicating a central motor control problem.

Abnormal muscle activation patterns of forearm extensor muscles and poor posture of the upper limb have been identified in LE sufferers (Kelley et al. 1994). Kelley et al. (1994) conducted a study of high-speed cinematography and electromyography of the forearm during the performance of a back hand tennis stroke in eight tennis players with LE and found that the extensors developed higher levels of electrical activity at ball impact when compared to 14 asymptomatic subjects. Extensor carpi radialis brevis exhibited less activation in the early preparatory phase prior to ball impact in injured players, possibly representing impaired stability at the wrist. There was a 'leading elbow' posture during the back hand at ball impact in which the wrist was extended more in LE sufferers than the non-injured tennis players and the arm was further internally rotated (Kelley et al. 1994).

In summary, the condition of LE is characterized by muscle and motor dysfunction as well as disordered pain system function. These changes should be evaluated in the physical examination and the findings form the basis of the physiotherapy management program.

EVIDENCE-BASED PRACTICE PERSPECTIVE

The numerous treatments for LE described in the literature mirror the unknown elements of the condition's aetiology and underscores the impression that it is a difficult condition to manage successfully. Labelle et al. attempted a meta-analysis of published research findings on the treatments for this condition and reported that it was not possible, mainly due to the poor methodological quality of the research (Labelle et al. 1992). Since Labelle's paper, several Cochrane reviews have been published for some suggested treatments (e.g. acupuncture (Green et al. 2002a); orthotic therapy (Struijs et al. 2002); shock wave therapy (Buchbinder et al. 2002b); oral non-steroidal anti-inflammatory medication (Green et al. 2002b); surgery (Buchbinder et al. 2002a) with little advancement in the conclusions of Labelle et al. (1992). Not surprising, there are no reviews of manipulative therapy as manipulative therapy is perceived to be joint therapy and LE is an apparent soft tissue disorder.

A MUSCULOSKELETAL PHYSIOTHERAPY PERSPECTIVE

Pain relief and restoration of muscle condition are primary objectives of rehabilitation. Restoration of muscle condition is best effected through a progressive resistance exercise program of the upper limb muscles, concentrating on the extensors of the wrist and hand (Pienimaki et al. 1996, 1998). Pienimaki et al. (1996) studied the clinical efficacy of a progressive and slowly graduated program of strengthening and stretching exercises in 39 sufferers of chronic LE who had failed other forms of treatment. They found improvements in the exercise group to be significantly superior to a control group.

Most importantly the exercise program was not pain provocative.

In order to treat pain and to facilitate pain free exercise a number of physical therapy modalities may be used. Interestingly, for a condition that is conceptualized as being predominantly a soft tissue injury, there are several manipulative therapy treatments that appear to provide useful short-term pain relief and restoration of function, allowing therapeutic exercise to progress optimally, or possibly at an accelerated rate. These treatment techniques include Mulligan's Mobilization With Movement (MWM) (Mulligan 1999) and Elvey's cervical lateral glide (Elvey 1986). Self-treatment with manual therapy and specific sports taping procedures are necessary in maintaining pain relief outside the clinical visits. In addition, there is a view that the chronicity and severity of the condition will be unduly protracted should some simple advice not be followed. This advice involves rest from activities that aggravate the pain in the initial stages of rehabilitation (including treatments used in rehabilitation). It is also important that clients avoid lifting objects with the hand facing the floor as this subjects the extensor muscles of the forearm to increased loads that frequently exacerbate pain.

Therapeutic exercise program

The primary physical impairment in LE, which occurs in the muscle system, is best characterized as a deconditioning response of the forearm muscles to the pain. Hence, all cases of persistent tennis elbow will require a therapeutic exercise program for the forearm muscles ($\pm$ general forequarter muscles). As a bare minimum exercises for the muscles that are directly affected in LE should be performed. That is, exercises that involve pain free gripping tasks (Fig. 1) and the extensor muscles (Fig. 2). Ideally, other muscle groups of the forearm should also be exercised, as this will encourage a more functional activity pattern of all forearm muscles and provide the stimulus for coping with real world tasks. For example, exercises for flexion (Fig. 3), supination and pronation (Fig. 4) as well as radial and ulnar

Fig. 1—Pain-free gripping exercise with exercise putty. Exercise putty will allow practice of many different gripping actions.

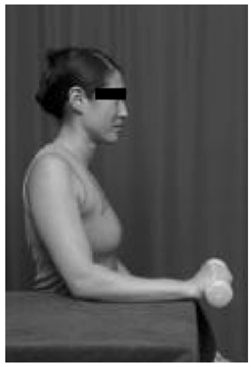

Fig. 2—Forearm extensor muscle exercise using a free standing dumbbell and 6–10 s per repetition. Note that the forearm is fully stabilized by the bench and upper body in sound postural alignment.

Fig. 3—Dumbbell weight exercise for the forearm flexor muscle. Note that the forearm is fully stabilized by the bench and upper body in sound postural alignment. Duration per repetition should approximate 6–10 s.

Fig. 4—Exercises for the supinator and pronator muscles of the forearm performed here with an imbalanced adjustable dumbbell weight. At home the client may use a broom stick for a light weight or a hammer. The movement extends from end of range of supination to end range pronation with the client maintaining full active control of the weight. The arm is stabilized besides the trunk and the elbow bent to 90°. Duration per repetition is 6–10 s. Progressions in load imposed on the muscles can be achieved by increasing the weight or by increasing the distance between weight and hand.

deviation (Fig. 5) should be incorporated in the therapeutic exercise program. Many forms of resistance and load may be used, such as, free weights (Figs. 2–5), rubber bands, manual resistance, isokinetic dynamometry or isometric contractions. The load mode is largely dictated by the circumstances and availability of equipment.

If the client has been absent from the workforce, then before re-introduction into the workforce the client should have work-specific tasks and activities incorporated in the therapeutic exercise program. This may involve, grasping and placing of objects starting with light and easy to grasp objects and move in accordance with the overload principle to progressively heavier and harder to grasp objects.

Any deficiency in other upper quadrant muscles should also be addressed, including correcting any poor postural alignment (Fig. 6) and movements of the upper limb. It is essential that all exercises that are performed for the upper limb must be done with sound alignment of the spine, trunk and proximal arm. Figures 7–11 show some of the base exercises that may be performed 2–3 times per week to address proximal limb weaknesses and deconditioning (three sets of 8–12 repetitions).

The conditioning protocol that would be utilized is typically three sets of 8–12 repetitions (e.g. muscle

Fig. 7—Modified bench press with one arm using an exercise ball in this instance. Alternative benches to the ball are the floor, bed or an exercise table. Care should be taken to extend the arm upwards and slightly inwards so that the end point is vertically over the anterior shoulder.

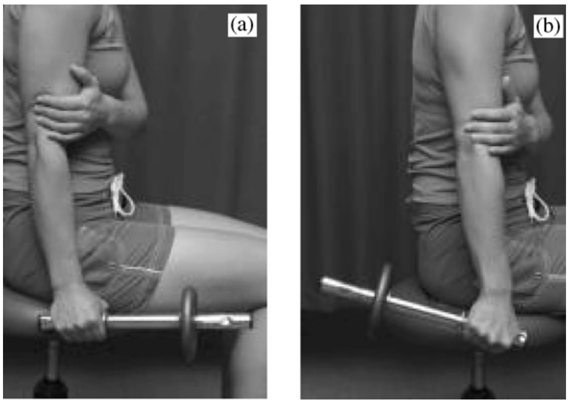

Fig. 5—Radial and ulnar deviation exercises, A and B, respectively, are performed with similar equipment shown in Fig. 4 and with similar guidelines.

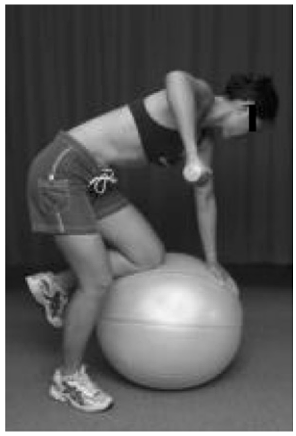

Fig. 8—Bent over rowing with the elbow vertically aligned over the hand and weight. In this example an exercise ball is used to stabilize the trunk; a low sturdy table, bench or chair may be substituted. Note that the scapula undergoes a full range of motion with this exercise and the trunk and spine assume a near neutral alignment.

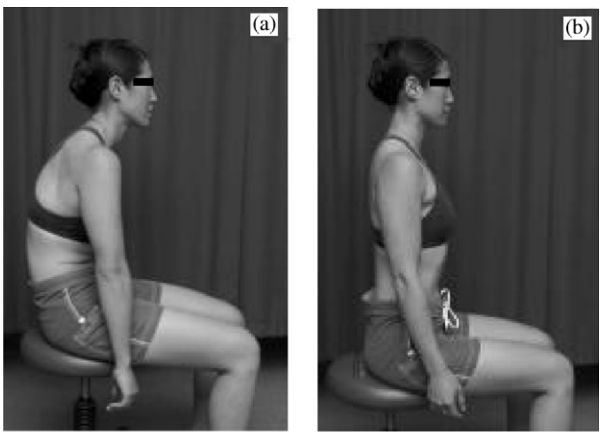

Fig. 6—(A) poor and (B) corrected posture: A common upper body postural alignment shown here. Key points are: a kyphotic thoracic spine, lordotic cervical spine, poked chin, protracted scapulae, internally rotated arm and pronated forearm (A). Educating the client to recognize and correct the poor posture involves reversing the posture by starting at the pelvis and then working up to the neck. Once the spine and trunk are aligned more optimally then the upper limb position should be addressed (B).

Fig. 9—Unilateral shoulder press with elevation being performed in the plane of the scapula. The start position is elbow flexed and arm by side and the end position is the elbow extended and the arm fully elevated such that the hand is vertically above the shoulder.

Fig. 10—Biceps exercise with the arm by the side and the movement going from elbow extension to full flexion and back to extension.

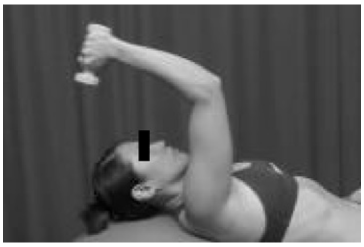

Fig. 11—Triceps extensions performed with the trunk supported (exercise ball in this case) while the arm is maintained perpendicular to the floor and the elbow moves from flexion to extension and back.

strengthening regimen (McArdle et al. 1996)). In some cases of chronic LE the deconditioning of the muscle is so severe that one set per exercise session is all that is possible. If this is the case then at least two sessions per day should be encouraged. It is advisable that each repetition be performed slowly (e.g. 6–10 s duration). It appears that stretching the exercised muscles following exercise may offer advantages in the conditioning process and aid in the desensitization of the painful soft tissues even though stretches do not appear to have a role in the prevention of injury (Shrier 2000). Stretching exercises should be performed in a slow and sustained manner and should only engender a stretching sensation over the exercised muscles. A stretching session would typically involve 3–5 repetitions of 20–30 s holds for each muscle group. All exercises should be performed on both the affected and unaffected arms to encourage any cross midline adaptations in muscle and motor function and provide a practical means of timing the rest periods between sets if more than one set of exercise per session is performed.

Factors governing the safe and optimum prescription of exercises are numerous and include:

- No exacerbation of symptoms (pain) during or after exercise.
- Maintaining correct form and posture throughout the exercise. Close monitoring by regular reviews with the therapist facilitates this.
- Accounting for the amount of incidental exercise that the muscles undergo at work, home and recreational activities to avoid aggravation of symptoms.
- Ensuring compliance by using positive strategies such as regular review and progression of exercises by the therapist.
- Allowing sufficient rest between sets (approximately 1–2 min) to ensure adequate time for recovery.
- The intensity of the exercises should not be such that delayed onset muscle soreness is a feature of the training response and therefore daily exercise sessions should be possible without exacerbation of the condition.

Manipulative therapy and sports tape

In order to describe a systematic approach to the manual therapy management of LE it is helpful to categorize presenting clients into five types in which:

(a) Pain-free grip strength deficit is much larger than pain elicited on direct palpation of the lateral epicondyle (i.e. the pressure pain threshold).
(b) Pressure pain threshold deficit is larger than the pain-free grip strength deficit.
(c) There is a similar magnitude of deficit in pain-free grip strength and pressure pain threshold.
(d) Past not current history of cervical spine-related pain or dysfunction.
(e) Night pain.

In essence the criteria used in this classification process are pain-free grip strength, palpation pain or pressure pain threshold, and findings on physical examination of the cervical spine and neural tissues. Pressure pain threshold is a means by which to quantify the pain provoked on direct manual palpation of the lateral epicondyle. The amount of pressure required to elicit pain is the index used with this method and is usually measured with an algometer (for example see Vicenzino et al. (1996)).

(a) *Pain-free grip strength deficit predominates*: A treatment approach that can be applied to the elbow and has been proving to be extremely beneficial in relieving pain and simultaneously restoring function is the Mulligan's (1999) MWM. In brief, the MWM techniques can be described as the application of a manual force ('Mobilization') across a joint that is sustained during the performance of an impaired action ('Movement'). The impaired action could be a movement but more commonly in LE is a muscle contraction. The manner in which the manual force is applied to the elbow is determined by a number of factors, the predominant one being the degree of pain relief and improvement in impairment that is achieved during the application of the treatment technique. That is, the direction of the glide and the amount of force are determined on an iterative process in which feedback on the outcome either modifies the application or serves to validate its continued use. Most importantly the treatment technique is not deemed to be effective and should not be used unless there is a substantial improvement in pain and impairment, for example, greater than 50% improvement (Mulligan 1999).

The technique of choice and the first one to be attempted in the physical treatment of a client with persistent LE is usually a sustained lateral glide across the elbow joint while the client performs a gripping action (Sustained Lateral Glide With Pain-Free Grip: SLGWPFG) (Figs. 12–14). See Table 1 for technical details of this technique. There is some evidence substantiating the claims that this treatment technique provides a substantial initial amelioration of pain and dysfunction (Vicenzino & Wright 1995;

Fig. 12—Sustained lateral glide with pain free grip strength (SLGWPFG): Client supine with upper limb fully supported on treatment bed. Upper limb position is arm internally rotated, forearm pronated and the hand gripping a dynamometer. Therapist's right hand blocks the distal humerus from moving and the left hand effects a lateral glide at the elbow joint. The application point of force on the left hand is the palmar surface of the first metacarpal and proximal finger. See Table 1 for technical details. Note the grip dynamometer used to measure pain-free grip strength.

Table 1. Elbow sustained lateral glide with pain-free grip (SLGWPFG)*

Indication

Pain over lateral elbow on gripping that is worse than tenderness to direct palpation over the lateral epicondyle

Positioning

Client	Supine with upper limb fully supported on treatment table
Upper limb	Relaxed extension of the elbow with pronation of the forearm
Therapist	Adjacent to the affected elbow facing across the body of the client
Therapist hands	*Stabilizing hand:* heel and first web space placed on the lateral surface of the distal humerus *Gliding hand:* index finger and first metacarpal placed on the medial surface of the ulnar just distal to the joint line

Application guidelines

- First ensure that the client has a reproducible aggravating action prior to applying glide (i.e. pain-free grip in this case)
- A grip dynamometer is used to quantify the outcome measure, allowing for accurate assessment of treatment effects
- Apply a laterally directed glide across the elbow joint
- While sustaining the glide have the client repeat the isometric gripping action until the onset of pain and no more
- Note the grip strength obtained before relaxing the grip and then release the glide
- Repeat several times (6–10X) in a session, BUT ONLY IF there is a substantial relief of pain during the application of the technique and there is no latent pain immediately following the treatment technique

Comment

- Ensure that the stabilizing hand does not compress the lateral epicondyle in such a way to cause pressure pain that reproduces the client's symptoms
- Directing the glide in a purely lateral or slightly posterior of lateral (approx. 5°) direction will be effective in most cases (Abbot et al. 2001). If pain relief is not achieved then inclining the glide anterior to lateral some 5° or slightly caudad should be trialed before discarding the technique. Attempt no more than four trials to elicit a positive response in any one treatment session, as failure to relieve pain over this number of trials will prove counter productive
- Do not release the sustained lateral glide before grip has been relaxed
- We have evaluated in a pilot study the amount of force that should be applied during this treatment technique and found it to be approximately two-thirds that of the therapist's maximal force application across the joint (McLean et al. 2002)

Variations

- Alternate position as in Figure 13 can also be used
- A treatment belt (Fig. 14) may be used to lessen the manual work load on the therapist but care should be taken not to be overly vigorous
- Taping techniques (Fig. 15) that replicate the manual glide force are also beneficial in providing maintenance of pain relief outside of treatment in the clinic
- Self-treatments in which the client performs the glide outside of treatment sessions (Fig. 16) are mandatory if gains made in treatment sessions are to be maintained and the condition ameliorated on a more longer term basis (Mulligan 1999)
- Different elbow positions may be necessary in some clients
- Substitute wrist and hand extension as the movement or other pain producing activity if they are more pain provocative than grip

*See Figures 12–16.

Fig. 13—SLGWPFG performed in an alternative position to Fig. 12 in which the upper limb is not resting on the bed, now supported, instead, by the therapist. The therapist's right hand is stabilizing the distal humerus while the left hand performs the lateral glide (Mulligan 1999). Note that the lateral side of the first metacarpal and proximal phalange are the point of force application. See Table 1 for technical details.

Fig. 14—SLGWPFG as in Fig. 12 and Table 1 but with a treatment belt used to replicate the manual force (Mulligan 1999). Therapist's right hand stabilizes distal humerus and the left hand maintains the forearm position. The therapist is in a walk stand position facing across the client and towards the client's feet in a position such that the belt is over the right shoulder and the right shoulder is directly over the elbow. The treatment belt force is almost vertically up from the floor such that a small knee bend and extension by the therapist exerts the desired treatment force to the elbow.

Abbott 2001; Abbott et al. 2001). In a single case study we demonstrated the expected clinical pathway of a case successfully treated by this treatment technique (Vicenzino & Wright 1995). Clinically relevant was the finding that improvements in pain and function were highly correlated and that the pain improved earlier and at a faster rate than function. This supports the notion that the manual therapy treatment technique was useful in alleviating pain and rapidly restoring function.

In the early stages of treatment, in which deficits in muscle strength and function still exist, it is important that self-treatment by the client is performed regularly. The client should develop a level of confidence to self-treat in the event of an exacerbation outside of scheduled visits to the clinic. Options available to extend the benefits of the MWM treatment technique beyond the treatment session, such as, the application of rigid sports adhesive tape (Fig. 15) and self applied manual therapy treatment (Fig. 16). Both these self-treatment techniques should be evaluated in the clinic to ensure effectiveness.

If there is also reproduction of pain with movements of the elbow then the lateral glide of the elbow is performed while the offending movement is repeated (Sustained Lateral Glide with Movement: SLGWM) (Figs. 17 and 18, Table 2).

Fig. 15—Sports taping technique with the tape starting medially on the proximal forearm and tracking laterally across the joint line to anchor off on the distal humerus above the joint line, thus attempting to replicate the forces applied during the SLGWPFG. Non-elastic sports tape with adhesive backing is used (38 mm wide, BDF Australia).

Fig. 16—This photo shows the client performing a lateral glide of the elbow using the unaffected hand to apply the glide force to the proximal ulnar on the medial side and a belt to stabilize the distal humerus. Alternatively the client could prop the lateral arm up against a wall or door jam and hold it there by direct apposition to the trunk while performing the glide as shown here. Once the lateral glide is in place the client can perform a number of tasks, replicating the clinic MWM, e.g. gripping or flexion–extension. At no times should there be pain due to direct contact pressure from the belt or wall or door jam.

In the event that the SLGWPFG or SLGWM are not effective then a sustained postero-anterior glide of the radio-humeral joint (Sustained P-A Glide with Pain-Free Grip: SPAWPFG) should be attempted. Figure 19 shows this technique and Table 3 describes the key technical aspects. Client self-treatment by way of self-manipulation (Fig. 20) and tape (Fig. 21) is applied with the same guiding principles described for the SLGWPFG.

High-velocity thrust of the elbow, particularly the radio-humeral joint, is not performed frequently but should be considered when there is marked hypomobility on accessory glide testing of the radio-humeral joint and initial attempts with MWM treatment have proved less than optimal. The high-velocity

Fig. 17—This is an example of hand placement for the sustained lateral glide with movement (SLGWM) for elbow flexion. It is like that shown in Fig. 13 with the exception that for flexion the hands must be placed such that they do not prevent obtaining end of range flexion. To achieve this, the heel of the right hand blocks the distal humerus from moving laterally and the lateral side of the first metacarpal and phalange is used to apply the lateral glide while allowing full unimpeded flexion motion. The SLGWM for extension is exactly as shown in Fig. 13 but without a dynamometer in-situ. See Table 2 for further details. Note that once pain-free end of range is achieved, overpressure is added to optimize the effect.

Fig. 18—This shows use of the treatment belt to effect a SLGWM into flexion. Notice how the therapist's right elbow, which blocks the distal humerus on the lateral side, propped up against the therapist abdomen and lies inside the treatment belt to allow unimpeded motion into flexion and out into extension. The difference between end range flexion and extension with this technique is in the therapist's position. In flexion the therapist moves cephalad with the forearm and in terminal extension the therapist performs a small cephalad translation of the body as he/she pivots in a counter-clockwise direction on the right foot to accommodate the carrying angle of the elbow. See Table 2 for further details.

Table 2. Sustained lateral glide of the elbow with movements of the elbow (SLGWM)*

Indication
- Pain over the lateral elbow that is worse with movements of the elbow
- After the SLGWPFG when there may be pain on first moving out of the extended position

Positioning	
Client	Supine with upper body fully supported on treatment table
Upper limb	Arm positioned by side with sufficient abduction to allow therapist access to medial side of the upper limb
Therapist	Facing across the body of the client's head
Therapist hands for Flexion	*Stabilizing hand:* heel on the lateral surface of the distal humerus *Gliding hand:* lateral border of second metacarpal placed on the medial surface of the ulnar just distal to the joint line
Therapist hands for Extension	*Stabilizing hand:* first web space and lateral border of second metacarpal placed over the lateral surface of the distal humerus *Gliding hand:* first web space placed on the medial surface of the ulnar just distal to the joint line

Application guidelines
- Determine which motion (flexion, extension or both) are painful and or limited
- Apply a laterally directed glide across the elbow joint in a non-painful part of the range (i.e. start in extension if flexion is the problem and vice versa)
- While sustaining the glide have the client repeat the painful movement
- Only release the sustained glide when the movement has returned to the start position
- Repeat several times (6–10X) in a session

Comment In addition to comments in Table 1.
Therapist should foresee any restriction to flexion movement that may be due to the placement of digits over the anterior part of the joint and avoid this scenario

Variations
- A treatment belt (Fig. 18) may also be used with care being taken to place the stabilizing hand in such a way that does not interfere with elbow movement and the belt placement such as to be close to the joint line and orientated such that when end of range is reached the lateral glide through the belt is effective
- Self-treatments as in Table 1 and Figure 16 with the exception that instead of gripping the client moves the elbow through ranges of flexion and extension
- Taping techniques as seen in Figure 15 may also be of benefit
- This technique can be used when pain on pain-free grip strength test occurs in a position other than extension but without movement (i.e. grip in the provocative position)

*See Figures 17–18.

thrust manipulation seeks to gap the radio-humeral joint and restore joint play. See Table 4 and Fig. 22 for details. Once the manipulation has been applied and accessory movement of the radio-humeral joint restored, exercises are commenced and MWM once again attempted to reduce any remaining pain and dysfunction.

(b) *Pressure pain threshold deficit predominates*: An interesting by-product of some of our laboratory studies (Vicenzino et al. 1998, 2001) is the finding that the SLGWPFG treatment technique of the elbow exerts a powerful effect on pain-free grip strength and substantially less of an effect on pressure pain threshold, whereas the Elvey (1986) lateral cervical glide technique (Table 5, Fig. 23) improves pressure pain threshold greater than it improves pain-free grip strength (2001). This has lead us to speculate that in the case in which there is comparatively and substantially greater pain on direct pressure over the lateral epicondyle than there is deficit in pain-free grip strength, the cervical spine and relevant fore-

Fig. 19—A sustained posteroanterior glide of the radio-humeral joint with pair-free grip (SPAGWPFG) is performed here with full support of the trunk and upper limb. See Table 3 for further details.

Fig. 20—Self-treatment with the SPAGWPFG.

Fig. 21—Sports tape (BDF, Australia) replicates the SPAGWPFG. Apply by laying tape on the posterior surface of the radial head and then apply traction to the tape in such a way as to replicate the SPAGWPG.

Table 3. Radio-humeral joint sustained postero-anterior glide with pain-free grip (SPAWPFG)*

Indication

- Pain over lateral elbow on gripping that is relatively greater than tenderness to palpation over the lateral epicondyle
- Poor response to SLGWPFG

Positioning

Client	Supine with upper limb positioned by side
Upper limb	The position may vary but is usually in the pain provocative position
Therapist	Adjacent to the affected elbow facing across the body of the client in line with the radio-humeral joint plane
Therapist hands	*Stabilizing hand:* the hand situated over the distal humerus holds the humerus down onto the treatment table and the thumb of this hand is placed over the radial head *Movement hand:* the thumb of the hand that is placed over the forearm is placed over the thumb of the stabilising hand while the rest of this hand rests on the forearm

Application guidelines

- Determine the aggravating activity (gripping, wrist extension, etc.)
- Apply a postero-anterior glide to the radio-humeral joint
- While sustaining the glide have the client repeat the aggravating activity
- Release the aggravating activity then release the glide
- Repeat several times (6–10X) in a session

Comment

The contacting thumb pad should not produce pressure pain over the site of application

Variations

- Self-treatment should be as effective as that of the therapist's (Fig. 20)
- Taping that replicates the techniques (Fig. 21) is very useful

*See Figures 19–21.

Table 4. High-velocity thrust to the radio-humeral joint*

Indication
- Pain over lateral elbow on gripping that is relatively greater than tenderness to palpation over the lateral epicondyle
- Difficulty in achieving a consistent or substantial effect with SLGWPFG or SPAGWPFG and passive movement examination reveals hypomobility of this joint

Positioning

Client	Supine and near the side of the treatment table
Upper limb	Elbow joint is positioned just short of end of range of extension
Therapist	Standing in between the medial side of the upper limb and the trunk facing the client's axilla
Therapist hands	*Palpation hand:* the index finger of this hand gently palpates the radio-humeral joint so as to sense tension and movement of the joint. The palm of this hand also applies a force that compresses the radius and ulna together *Thrust hand:* lateral border of the second metacarpal and index finger are placed over the medial ulna just distal to the joint line. Ensure that the wrist of this hand is in a functionally neutral position and not extended

Application guidelines
- Apply compression across the superior radio-ulna joint so the forearm bones will now move as one
- Apply longitudinal compression up the humerus so that the shoulder joint is stabilized
- Check that the elbow is not fully extended
- Apply a gapping movement of the RH joint by placing a valgus stress of the elbow such that tension develops in the RH joint
- Perform a very small amplitude oscillatory mobilisation at this point of RHJ tension
- Superimpose a high-velocity transverse thrust in a lateral direction by the thrust hand at the stage that optimal tension in the RH joint is achieved

Comment
- Setting up the technique is the most important part of the technique
- Be sure not to thrust into extension, the thrust must be in a lateral direction
- Do not proceed with the thrust if the gapping oscillations are painful or engender a reactive or guarding muscle response by the client

*See Figure 22.

Fig. 22—High-velocity thrust technique for the radio-humeral joint. See Table 4 for detailed description.

quarter neural tissues should be thoroughly evaluated and any impairment in this region treated (Vicenzino et al. 2000).

Treatment of the spine in sufferers of LE may also involve other spinal manipulative therapy treatments. A single case study of a 47-yr-old male with a 6-month history of LE highlights the utility of treating the cervical and thoracic spines with high-velocity thrusts of the thoracic spine and cervicothoracic junction in addition to Elvey's lateral cervical glide (Elvey, unpublished work). Apart from having a 60% deficit in pressure pain threshold over the elbow compared to 40% deficit in pain-free grip strength test, this client also had an increased thoracic spine kyphosis with compensatory poked chin and increased mid-cervical spine lordosis. Passive intervertebral motion testing revealed marked hypomobility in the mid-thoracic spine and the cervico-thoracic junction as well as positive neural tissue provocation tests. Treatment involved exercises (described above) solely for 6 weeks after which spinal manipulative therapy was performed on five sessions over a 2.5 week period. Comparing the rate of change of data over time between spinal manual therapy and exercise showed that spinal manipulative therapy was responsible for improvements in pressure pain threshold whereas the exercise program had most impact on the pain-free grip strength test. The spinal posture exercises appeared to be easier to perform following spinal manipulation.

There is also a MWM treatment technique that may also be beneficial in treating those who experience pain when elevating the arm, for example, swinging a tennis racket (Fig. 24), reaching for shelves and working over head (Table 6). The concept with this spinal manual therapy treatment technique is to effect a transverse glide on the spinous process in a direction contralateral to the affected arm. The sustained glide on the cervical spine should allow pain-free elevation of the affected arm and when repeated several times should result in improved pain-free elevation (Mulligan 1999).

(c) *Relatively similar deficits in pain-free grip strength and pressure pain threshold:* In the case in which equal deficits are present an approach similar to that described above in (a) in which there is a predominant pain-free grip strength deficit would be the first option taken. Re-evaluation of the key

Table 5. Lateral glide of the cervical spine (Elvey 1984)*

Indication

- Pain over lateral elbow that is markedly tender to palpation compared to deficit in grip strength
- Past problems of the cervical spine
- Physical examination reveal signs of intersegmental dysfunction in the lower cervical spine (mostly C5–C/T junction) and/or positive neural tissue provocation signs

Positioning

Client	Supine
Cervical spine	The motion segment that is most restricted is placed in a neutral flexion and extension position
Upper limb	The upper limb position is determined by the degree of sensitivity elicited on neural tissue provocation testing. In cases of high sensitivity the upper limb is placed with the hand on the abdomen, scapula elevated, and the flexed elbow is raised off the table such that the shoulder is not extended In cases of low sensitivity the upper limb may be placed in the position of provocation. In no case should the distal end of the upper limb be rigidly fixed into a maximally stretch position during this technique
Therapist	Stands at the head of the bed
Therapist hands	*Movement hand:* cradles the head and neck above the motion segment to be treated. This is assisted by gently resting the head onto the therapist's abdomen. The hand used to perform the movement is the opposite one to that of the affected arm *The other hand:* the other hand is placed on the scapula and acts to sense tension developing in the scapula elevators and to maintain shoulder position. Vigorous depression of the scapula should be avoided

Application guidelines

- The movement is purely transverse and occurs to both sides of the neutral neck position in the frontal plane
- The head and joints above the treated segment are not sideflexed towards the direction of the glide
- In most cases of non-irratible tennis elbow in which there is no overt signs of irritable cervical joints or neural tissue (as opposed to a case of nerve root irritation) the oscillating frequency of the technique is reasonably high (approximately 1.3 Hz) (Vicenzino et al. 1999)

Comment

Reproduction of distal symptoms during treatment is a contra-indication

*See Figure 23.

Fig. 23—The lateral glide of the cervical spine (Elvey 1986) performed through the therapist's left hand in this photo. Note the therapist's right hand DOES NOT force the scapula into depression, it merely monitors upper limb position and any changes in tension in the underlying muscles. See Table 5 for details.

Fig. 24—A sustained transverse glide to the spinous process with Upper Limb Movement (STWULM) which in this case involves swinging a tennis racket. See Table 6 for details.

physical examination findings will either confirm this approach or indicate the need to move to more of an approach in (b), pressure pain threshold deficit predominate.

(d) *Past history of neck and upper limb pain:* This paper deals with pain over the lateral epicondyle with no overt signs of cervical radiculopathy or referred pain from the cervical spine. In the event where there is only pain over the lateral epicondyle with a past history of prior neck and upper limb pain (see (b) above) the cervical spine and forequarter neural tissues should be evaluated. If impairments are elucidated on examination then they should be treated.

(e) *Night pain*: If there is night pain present and it has not settled with the above described approaches

Table 6. Sustained contralateral transverse pressure of the cervical spine with upper limb movement (STWULM)*

Indication	
• Usually performed as an alternative to the Elvey lateral glide of the cervical spine, so similar indications to that technique, especially if neural provocation tests are negative • Movements of the upper limb reproduce some of the elbow pain • Less than optimal response to techniques applied to the elbow	
Positioning	
Client	Sitting with trunk support
Upper limb	• If a movement exacerbates the elbow pain then it should be used • Otherwise use elevation of the arm in the scapula or sagittal planes
Therapist	Standing behind the client
Therapist hands	*Stabilizing hand:* the medial side of the thumb on the hand contralateral to the clients affected arm is placed over the side of the spinous process of the superior vertebra of the motion segment to be mobilized. This thumb contact will include some of the paraspinal tissue if the glide is to be effective and non-noxious. This thumb is purely a contact point through which to apply the force, not the applicator of the force *Movement hand:* the index finger supported by the middle finger of the other hand is placed over the lateral side of the thumb that was placed on to the spinous process
Application guidelines	
• Determine the aggravating activity (e.g. shoulder elevation, horizontal flexion, etc.) • Apply a contralateral transverse glide to the spinous process by applying force to the contact point thumb with the reinforced index finger of the movement hand. (Figure 24) • While sustaining the glide have the client repeat the aggravating activity • Cease the aggravating activity before releasing the transverse glide of the spine • Repeat several times (6–10X) in a session, but only if pain and function improve	
Comment (see previous Tables also)	
• The contacting thumb pad should not produce pressure pain over the site of application • The therapist may need to apply the transverse glide to a number of spinous process before finding the most effective one (C_{5-6} are usually tried first)	

*See Figure 24.

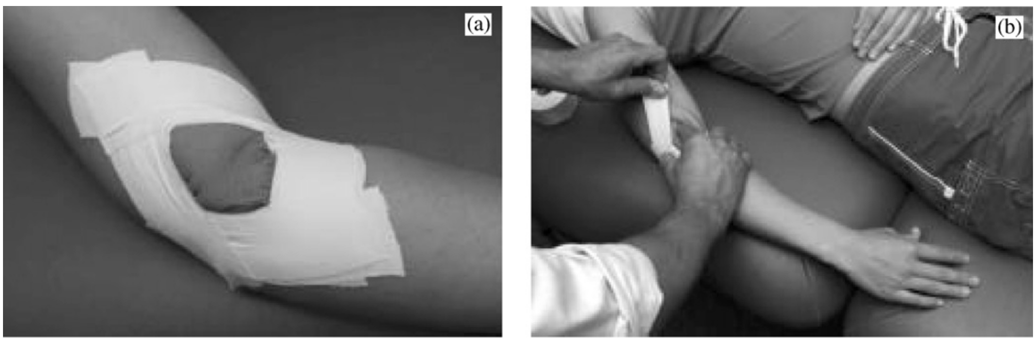

Fig. 25—The McConnell (2000) Diamond box tape (A) and a view of one of the pieces of tape that make up the technique being applied (B). For each individual piece of applied tape, an example of which is demonstrated in B, the right thumb holds the tape firmly onto the skin while the left hand applies force along the length of the tape. The right index finger moves skin and soft tissues under where the tape is to be placed in towards the lateral epicondyle (i.e. perpendicular to the line of the tape). When all pieces of tape are in place a characteristic orange peel effect should be visible as seen here. See Table 7 for details.

then there are some further treatments that may be of use. It is important to note that this type of night pain is mechanical in nature. It is associated with a position or movement of the elbow that settles with some adjustment allowing the client to resume sleep as opposed to pain that consistently occurs in the early hours of the morning not associated with any positions or movements and is relentless in its persistence once it has appeared. If the taping procedures described above do not help, then a diamond tape should be tested (Fig. 25A). This taping procedure is one of McConnell's deloading procedures (McConnell 2000) in which the soft tissues are drawn in towards the area of pain at the lateral epicondyle in a manner described in Table 7 and shown in Fig. 25B. In an unpublished study of this taping technique in 14 sufferers of chronic LE we showed that it produced substantial improvements in pain-free grip strength and to a lesser extent pressure pain threshold.

Table 7. Diamond tape of the elbow (McConnell 2000)*

Indication
- Lateral elbow pain which is present much of the time
- Particularly useful for resting pain or pain at night

Positioning

Client	Supine
Elbow	Small amount of flexion in most cases. The tape will reduce motion at end of range so if extension is especially a problem for the client then tape the elbow in more flexion and if the client has problems mostly at end of range of flexion apply the tape more in extension
Therapist	Stand by side of treatment table facing cephalad

Application guidelines
- The centre of the diamond is located over the painful region
- Start applying the tape distally anchoring it on or close to the midline of the forearm
- Run the tape on a diagonal across the longitudinal axis of the forearm
- Anchor the starting part of the tape to the client's skin with your thumb
- With the other hand apply a tensing force longitudinally along the direction of the tape
- Before laying the tape down onto the skin make sure that the underlying skin is moved in towards the painful region. Do this by using the index finger of the hand that is anchoring the tape to the skin (Fig. 25B)
- Tape will be orientated on the skin as shown in Fig. 25A

Comment
- There should be an orange peel effect present with puckering of the skin inside the diamond
- Always lay the tape down in a cephalad direction along the long axis of the arm

*See Figure 25.

Outcome measures

Pain-free grip strength has been reported to be the most sensitive outcome measure of physical impairment in tracking change in LE (Stratford et al. 1993; Stratford & Levy 1994; Abbott et al. 2001) and should be at least one of the outcome measures used in clinical practice. In addition, MacDermid's (2001) Patient-Rated Elbow Evaluation scale may also be used to track the responses to treatment. McDermid's scale is primarily a client self-rated perception of pain and function scale that is a reliable and valid measure of disability (MacDermid 2001).

CONCLUSION

Currently the recommended approach to clinical manual therapy management of LE is based on the findings from physical examination and matching the treatment approach to the deficits highlighted in the clinical examination. Essentially, therapeutic exercise forms the mainstay of the program. Manual therapy and sports tape are useful adjunctive therapies to achieve rapid pain relief that allow for effective and timely physical conditioning of the affected muscles.

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