11

Unloading and proprioceptive taping

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CHAPTER CONTENTS

Introduction

Unloading taping to reduce musculoskeletal pain, and proprioceptive taping to improve movement patterns, are useful empirical adjunctive treatment approaches. It is probable that they operate by similar mechanisms, the precise nature of which remain as yet unproven, despite an increasing evidence base. Particular attention has been paid to the effects of taping on muscle recruitment, pain scores during functional tasks and motor relearning. Relatively little progress has been made in understanding the mechanisms by which proprioceptive taping effects may be mediated. Hypotheses regarding mechanisms based on the available literature are presented in this chapter. These concepts are accompanied by clinical guidelines for the application of taping in a variety of situations with illustrative case histories.

Taping can be used in a number of ways to reduce movement-associated pain. Based on a thorough assessment of presenting movement patterns and pain mechanisms, taping can be used as a useful treatment approach in itself, or as a means of maintaining treatment effects. It can be used to provide a physical effect on the tissues that lasts for hours, or even days, supplementing the relatively brief therapist–patient contact. Taping can be used to affect pain directly by offoading irritable myofascial and/or neural tissues. Taping can also be indirectly used to alter the pain associated with identified faulty movement patterns (Table 11.1). These effects are both proprioceptively and mechanically mediated depending on the approach used. This is easily demonstrated in the shoulder girdle, with this area therefore being particularly used to demonstrate these approaches.

Other musculoskeletal dysfunctions and derangements have been the subject of increasing study since the second edition of this book. The management of patellofemoral pain by means of taping has been increasingly investigated in the literature and described elsewhere with evidence for both mechanical and motor control effects of

Table 11.1 Means of pain reduction by taping

Direct	Indirect (proprioceptively mediated)
Longitudinal offload	Inhibition of overactive movement synergists and antagonists
Transverse offload	Facilitation of underactive movement synergists
	Promotion of optimal interjoint coordination
	Direct optimization of joint alignment during static postures or movement

taping on patellofemoral movement and symptoms (Gilleard et al 1998, Hinman et al 2003a, 2003b, McConnell & Fulkerson 1996, Pfeiffer et al 2004, Salsich et al 2002, Whittingham et al 2004).

The pain symptoms of osteoarthritis of the knee have been shown to be ameliorated in the short and medium term with concomitant improvements in function (Hinman et al 2003a, 2003b). Studies aiming to quantify taping effects on foot and ankle pain and positioning have begun to reinforce clinical observations of efficacy, with positive effects of taping in reducing the pain of plantar fasciitis and adverse movement patterns of the rear foot being demonstrated (Landorf et al 2005, Wilkerson et al 2005). Conflicting evidence about the effects of tape on muscle latencies in the ankle in relation to perturbations mimicking those of inversion sprains continues to be a theme in the literature (Allison et al 1999, Hopper et al 1999, Shima et al 2005). There is still plenty of work to do in determining the optimal taping techniques to use in given circumstances, with even more work required to determine the pathophysiological mechanisms of action.

Direct methods

Longitudinal offload

Painful tissues that are held in tension either because of the unrelieved influence of gravity or because of chronically increased background muscle tone, e.g. due to habitual postures, can often be effectively helped by taping if the tissue can be passively supported in a shortened position. This is particularly useful when addressing symptoms associated with adverse neural dynamics (Fig. 11.1).

It is suggested that free nerve endings and C-fiber end-organs which intertwine with the tissues are irritated by the mechanical and chemical effects of the tissue under tension. This is reduced by holding the tissue in a shortened position therefore reducing pain fiber stimulation (Fig. 11.2).

Transverse offload

A transverse offload approach can be used particularly for myofascial tissues that may be mediated either by similar means to that described above or by a more mechanical effect. This type of technique has been shown to be effective in reducing elbow pain associated with lateral epicondylalgia (Vicenzino et al 2003) Transverse offloading of muscle structures effectively lengthens the muscle being used and may be inhibitory (Figs 11.3, 11.10) or may alter the free nerve endings' position in connective tissue (Fig. 11.2).

A number of suggested techniques mix the two approaches effectively (Fig. 11.4).

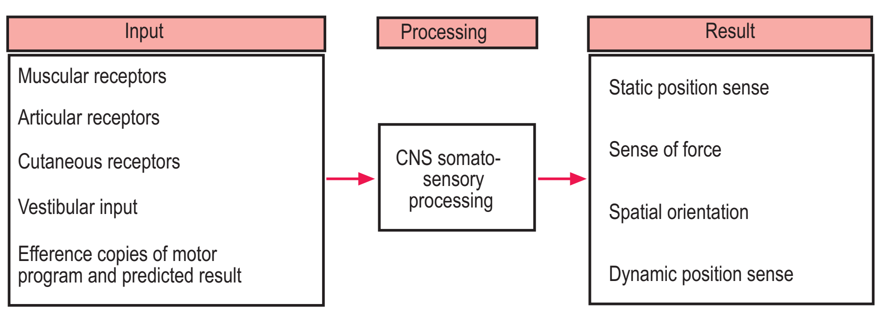

Figure 11.1 Proprioceptive summary. Input from a number of peripheral sources is integrated with expected movement patterns and the commands sent to the periphery with the result being a CNS representation of movement parameters.

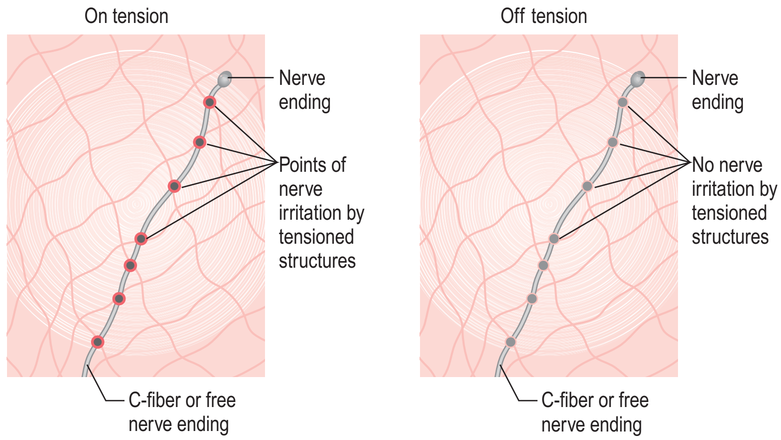

Figure 11.2 Free nerve endings piercing the multidirectional fascial planes may be irritated when there is sustained significant tension placed on the tissues. Taping that holds these tissues in a shortened position helps to reduce symptoms associated with movement.

Indirect methods: with reference to the shoulder girdle

Normal upper limb function is dependent on the ability to statically and dynamically position the shoulder girdle in an optimal coordinated fashion (Glousman et al 1988, Kibler 1998).

Movement faults, for example of the scapulothoracic 'joint', have been shown to be strongly associated with common pathologies (Hebert et al 2002, Ludewig & Cook 2000, Lukasiewicz et al 1999, Michener et al 2003).

Physiotherapy that aims to improve joint stability, optimal interjoint coordination and muscle function has been shown to be clinically effective in the management of a variety of shoulder presentations (Ginn et al 1977). Proprioception is a critical component of coordinated shoulder girdle movement, with significant deficits having been identified in pathological and fatigued shoulders (e.g. Carpenter et al 1998, Forwell & Carnahan 1996, Voight et al 1996, Warner et al 1996). It is an integral goal of rehabilitation programs to attempt to minimize or reverse these

Figure 11.3 Upper trapezius inhibition. From anterior aspect of upper trapezius just above the clavicle over the muscle belly to approximately the level of rib 7 in a vertical line. Once the tape is partially attached, a firm downward pull is applied and the tail of the tape attached.

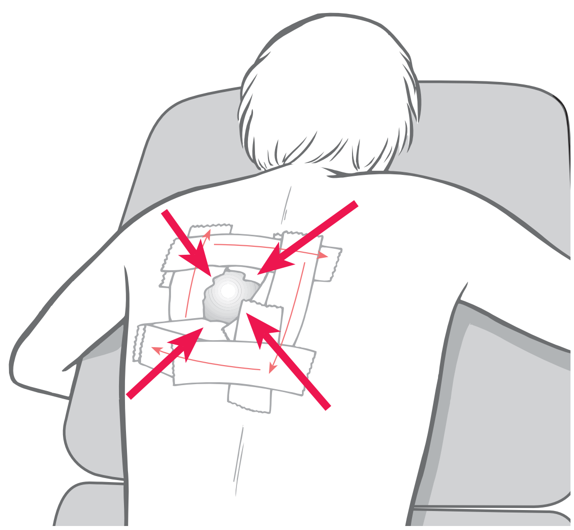

Figure 11.4 The skin over the thoracic spine is gathered centrally in the direction of the large arrows and the skin taped in the direction of the small arrows (see taping guidelines).

proprioceptive deficits (Lephart et al 1997, Magee & Reid 1996).

Taping is seen clinically to be a useful adjunct to a patient-specific integrated treatment approach aiming to restore full pain-free movement of the shoulder girdle, although the evidence for taping effects on scapular muscle recruitment patterns is mixed – suggesting that the optimal techniques to use for given presentations remain to be fully established and evaluated (Ackermann et al 2002, Alexander et al 2003, Cools et al 2002, Zanella et al 2001). It is very clear from the literature that shoulder taping must be fully integrated into the overall treatment approach so that its effects can be realized.

Initial study of the effects of taping on motor neuron pool excitability has shown physiological effects that conflict with clinical experience, but these are early days in the exploration of the pathophysiological effects of taping on musculoskeletal dysfunction, so little can be taken from this work (Alexander et al 2003).

Taping is particularly useful in addressing movement faults at the scapulothoracic, glenohumeral and acromioclavicular joints. The exact mechanisms by which shoulder taping is effective are not yet clear but the suggestion is that the effects are proprioceptive, mechanical and pain-relieving.

Possible physiological mechanisms

Proprioception is a complex process that is difficult to define (Jerosch & Prymka 1996). Essentially, information from mechanoreceptors in the skin, muscles, fascia, tendons and articular structures is integrated with visual and vestibular input at all central nervous system (CNS) levels in order to allow perception of:

- position sense (static)
- kinesthesia (dynamic)
- force detection.

Proprioception is particularly important for upper limb interjoint coordination (Sainburg et al 1993) due to the complexity of the kinetic chain, the relative lack of osseous stability and the precision of the tasks performed. The literature focuses on the role of articular and myofascial structures in contributing to shoulder girdle proprioception while cutaneous input is regarded as having a lesser role (e.g. Carpenter et al 1998, Jerosch & Prymka 1996, Lephart et al 1997, Warner et al 1996).

Proprioception has been shown to be compromised in upper limb pathologies such as sub-acromial impingement (Michner et al 2003) and glenohumeral instability (Barden et al 2004). Full return to sport is dependent on reversal of these deficits (Fremery et al 2005). These deficits can be normalized after long periods of rehabilitation and recovery following surgery (Potzl et al 2004), while immediate improvements have been shown in pathological shoulders when cutaneously mediated proprioceptive feedback is augmented by compressive bracing (Ulkar et al 2004).

Taping as a form of proprioceptive biofeedback?

A potential mechanism by means of which proprioceptive shoulder taping may be effective is via augmented cutaneous input (Figs 11.5–11.7).

Tape is applied in such a way that there is little or no tension while the body part is held or moved in the desired direction or plane. The tissues will therefore

Figure 11.5 Retraction of the shoulder. From the anterior aspect of the shoulder, 2 cm medial to the joint line, around the deltoid muscle just below acromial level to the T6 area without crossing the midline. Tape pull is into retraction.

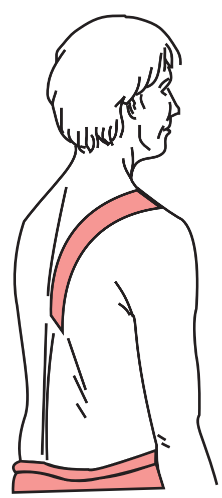

Figure 11.6 Retraction/upward rotation. From anterior shoulder just below the coracoid to low thoracic (T10) area. The initial pull on the tape is up and then back as the tape comes over the midline.

develop more tension when movement occurs outside these parameters. This tension will be sensed consciously, thus giving a stimulus to the patient to correct the movement pattern. Over time and with sufficient repetition and feedback, these patterns can become learned components of the motor engrams for given movements. This process therefore represents cutaneously mediated proprioceptive biofeedback.

Taping as a means of altering muscle function

Mechanically, if taping can be applied in such a fashion that a chronically inhibited (underactive) muscle is held in a shortened position (Fig. 11.8), there will be a shift of the length–tension curve to the left, and greater force development in the inner range through optimized actin–myosin overlap during the cross-bridge cycle (Fig 11.7).

Similarly, if taping can be applied in such a fashion that a relatively short, overactive, muscle is held in a lengthened position, there will be a shift of the length–tension curve to the right, and lesser force development through decreased actin–myosin overlap during the cross-bridge cycle at the point in joint range at which the muscle is required to work (Fig. 11.3).

The taping method used to inhibit upper trapezius activity (as in Fig. 11.3) has been investigated in a pilot study (O'Donovan 1997) and shown to have a significant inhibitory effect on the degree of upper trapezius activity in relation to lower trapezius during elevation (Morin et al 1997). Alexander et al (2003) have also shown inhibition of lower trapezius, by means of H-reflex latency and amplitude, with scapular taping albeit with a counter-intuitive procedure.

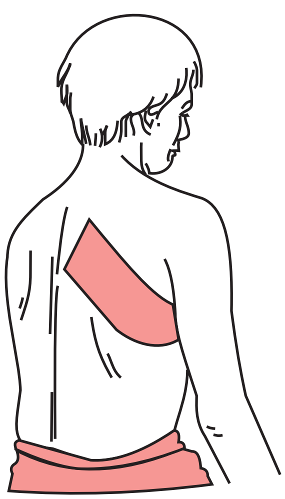

Figure 11.7 Serratus anterior facilitation and inferior angle abduction. From 2 cm medial to the scapula border, following the line of the ribs down to the mid-axillary line. Four one-third overlapping strips are applied with the origin and insertion pulled together and bunching the skin.

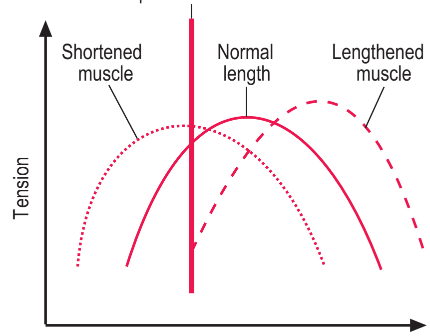

Figure 11.8 Length–tension curves. Although lengthened muscle has the capability to generate more force, postural muscles frequently need to be able to generate most force in inner range positions, in which case it is often desirable that they are relatively short.

Inhibition is demonstrated as soon as the tape is applied. Clinical effects of taping the shoulder girdle can be significant and immediate, especially in promoting altered movement patterns and allowing earlier progression of rehabilitation. Recent study has shown that the pull involved in applying the second of the two tapes is critical to the electromyographic and mechanical positional changes observed during successful taping application (Alexander et al 2003, Brown 1999). The mechanisms underlying the above study results, and the clinical effects seen during application, still merit further investigation.

Taping guidelines: shoulder as an example

It is essential to be clear about the aims of taping in order to ensure optimal results:

- In the case of the shoulder this would be assessed for its habitual resting position and for movement faults contributing to the symptom presentation.

Box 11.1 Downward rotation and tipping

Downward rotation occurs about an axis located one-third of the length of the spine of the scapula lateral to the proximal end of the spine of the scapula. Tipping is when the inferior angle protrudes from the chest wall and the coracoid is pulled down and medially as compared to winging where the entire medial border of the scapula lifts off the chest wall.

Box 11.2 Case history: direct longitudinal offload

A 34-year-old woman presented with acute discogenic low back and long leg sciatic pain, due to an exacerbation of existing low back pain caused by sleeping awkwardly on a long-haul airplane journey.

The presentation was both severe and irritable, to the extent that she had to be examined in side-lying, in order to avoid exacerbation.

A key comparable sign was a 20° straight leg raise (SLR) reproducing all her leg and back pain symptoms.

Application of longitudinal offload taping along the course of the sciatic nerve, and its common peroneal branches, reduced her symptoms on SLR and increased the pain-free range to 45° in conjunction with manual therapy techniques.

This allowed her to walk far more normally with markedly reduced pain.

The V-shaped tapes were placed at the base of the fibula, at the head of the fibula, two-thirds of the way down the posterior aspect of the thigh and at the top of the posterior aspect of the thigh. These were applied in the order stated. Interestingly, an initial attempt to apply the tape in a reverse order was not successful (Fig. 11.9).

This taping was used throughout the first 2 weeks of her management, by which time she was significantly better and able to discontinue that aspect of her treatment.

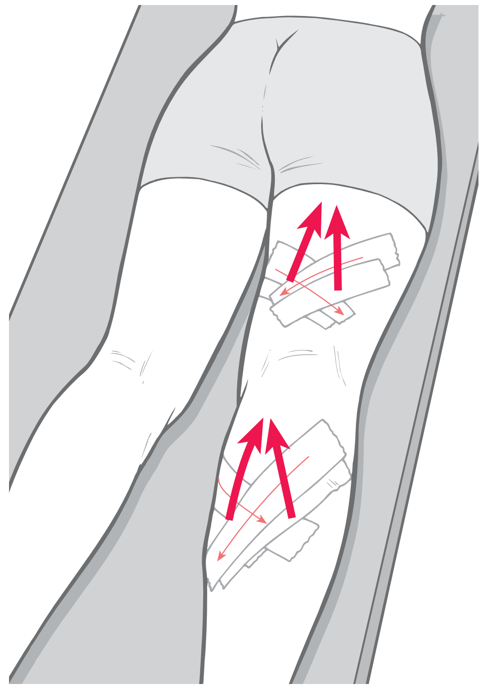

Figure 11.9 The tissues over the sciatic nerve are offloaded superiorly in the direction of the large arrows and the skin taped in the direction of the small arrows (see taping guidelines).

Box 11.3 Case history: direct transverse offload

A recreational racquet sports player presented with lateral elbow pain with clear local soft-tissue components as well as a positive radial nerve tension test and low cervical facet joint stiffness.

Static resisted contraction (SRC) of the common extensor origin muscles and extensor carpi radialis brevis in particular was comparable (Fig. 11.10).

As part of the management a transverse offload tape was applied to the common extensor origin with immediate reduction of symptoms from SRC and improved grip strength, through reduction of pain inhibition.

This remained part of her management until return to sport when it was replaced with an 'aircast' lateral epicondyle brace, which can be used to similar effect.

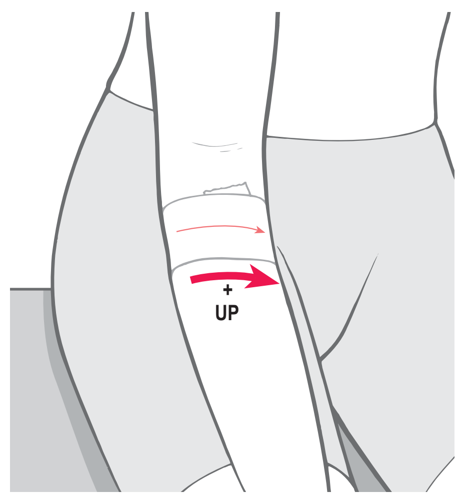

Figure 11.10 The skin and muscle tissue overlying the common extensor origin is lifted and pulled medially in the direction of the large arrows and the skin taped in the direction of the small arrows (see taping guidelines).

Box 11.4 Case history: shoulder pain

This case represents a particular example of inhibition of overactive movement synergists and antagonists and facilitation of underactive movement synergists.

A 33-year-old cricketer presented complaining of persistent and progressive shoulder pain of nonspecific onset but particularly related to bowling and throwing. He had experienced episodes of pain towards the end of the previous season, which had not interfered with participation nor persisted after the end of the season. He had experienced problems from the start of the current season which had progressed to the extent that he was no longer able to bowl or throw overarm, had pain persisting between games, while overhead activities of daily living were compromised.

Assessment showed clear impingement features including:

- localized pain to the front of the shoulder
- a painful arc on mid-range elevation that was associated with marked protraction and tipping (Norkin & Levangie 1992) of the scapula and accentuated on slow eccentric elevation
- generalized loss of thoracic extension and rotation focused at T5–T7
- a positive empty-can test (Magee & Reid 1996) (a static resisted contraction of abduction with the arm medially rotated and held at 90° of abduction in the scapular plane)
- general restriction of glenohumeral accessory joint glides
- restricted medial rotation with scapulothoracic relative flexibility on the kinetic medial rotation test (Comerford 1992, Morrissey 1998)
- painful, weak static resisted abduction and lateral rotation
- tight overactive pectoralis minor as demonstrated by the shoulder girdle not being able to lower to the supporting surface when the patient was supine and gentle pressure was applied anteroposteriorly through the coracoid process.

An initial treatment plan was formulated including: thoracic manipulation (HVLA thrust) to increase the available thoracic extension during elevation; pectoralis lengthening using trigger point treatment and specific soft-tissue mobilization to decrease the active scapula tipping; local soft-tissue deinflammation with ice; and scapula setting – initially in neutral but then incorporated into dynamic movement. It was decided to emphasize upward rotation and retraction as he demonstrated an excessively protracted, tipped scapula during elevation.

The scapula setting (Box 11.5) proved difficult for the patient to master so the shoulder was taped (Figs 11.5 and 11.6). This resulted in an immediate improvement in the patient's ability to set the scapula and an improved scapulohumeral rhythm associated with a marked decrease in the painful arc symptoms. The taping was reapplied for 3 weeks while his treatment and rehabilitation were progressed to the extent that he had achieved satisfactory control of scapula movement during functional activities and had begun to resume some of his sporting activities.

- The skin would then be prepared by removal of surface oils and body hair.
- The shoulder would be actively positioned in the desired position by the patient with the guidance of the therapist, or passively if the patient is unable to maintain the desired position.
- A hypoallergenic mesh tape would be applied without tension (e.g. Mefix, Molnlycke, Sweden).
- A robust zinc oxide tape (Strappal, Smith and Nephew, UK) would then be applied.
- Further tapes may then be applied as necessary.
- The taping is continued until the patient has learnt to actively control movement in the desired fashion, or the effects on symptoms are maintained when it is not worn.

Skin reactions

If the client develops a skin reaction this can either be due to an allergic reaction, a 'heat rash', or because the tape is concentrating too much tension in one area. Tension concentrations usually occur around the front of the shoulder.

Box 11.5 Scapula setting

Scapula setting has been defined as 'Dynamic orientation of the scapula in a position so as to optimize the position of the glenoid and so allow mobility and stability of the gleno-humeral joint' (Mottram 1997).

Box 11.6 Case history: shoulder injury

This case represents a particular example of promotion of optimal interjoint coordination as well as direct optimization of joint alignment during static postures or movement.

A 23-year-old rugby player presented 2 weeks after a shoulder pointer (fall onto the point of the shoulder causing an inferior blow to the acromion) and resultant acromioclavicular joint sprain.

Assessment showed a visible joint step with upper trapezius spasm accentuating this via its attachment to the lateral third of the clavicle (Johnson et al 1994). Range of movement was markedly reduced and the patient complained of constant pain aggravated by any movement. He was still using a sling. The scapula was noted to be in a downward rotated, depressed position thus accentuating the step and resultant acromioclavicular joint pain.

The initial treatment therefore aimed to decrease the resting joint pain using large amplitude joint mobilizations and interferential therapy, which was partially successful.

In order to further reduce the resting pain and affect the pain on movement it was necessary to improve the symmetry of the joint by decreasing upper trapezius activity and facilitating upward rotation and elevation of the scapula. This was done using tape (Figs 11.11 and 11.12) and reinforced with soft-tissue techniques (trigger point massage and specific soft-tissue mobilization) to the upper trapezius (see Figs 11.3, 11.5, 11.11 and 11.12).

An immediate improvement in symmetry was noted and a marked increase in pain-free range of motion. He was able to discard the sling. Taping remained an integral part of the treatment until he was able to actively set the scapula independently.

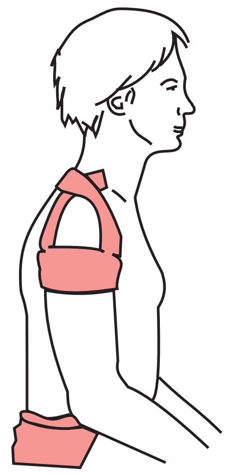

Figure 11.11 Elevation of the shoulder girdle. (1) Anchor strip applied at level of deltoid tuberosity, encircling two-thirds of the circumference of the arm; (2) elevatory strips applied from posterior arm/deltoid to the anterolateral aspect of the base of the neck; (3) elevatory strips applied from anterior arm/deltoid to the posterolateral aspect of the base of the neck; (4) locking strip over tape 1.

Figure 11.12 Acromioclavicular joint relocation; from coracoid process over the distal end of the clavicle with a downward pull applied just before the tail of the tape is attached to level of rib 6 in vertical line. Only ever applied after successful application of elevatory taping (Fig. 11.11).

Heat rashes tend to be localized to the area under the tape and settle quickly. Allergic reactions are more irritating and widespread, and must be treated with great caution as reapplication is likely to lead to a more severe reaction due to immune sensitization.

Scapulohumeral function

The scapulothoracic joint gains some stability in relation to medially directed forces from the clavicular strut via the acromioclavicular joint. This still allows a large range and amplitude of translatory and rotary movement that is primarily produced, controlled and limited by the axioscapular myofascial structures (Kibler 1998).

Compromised thoracoscapulohumeral rhythm results in the potential for impingement due to downward rotation of the glenoid associated with tipping or winging (Box 11.1) (Ludewig et al 2000, Lukasiewicz et al 1999). An anterior tilt of the glenoid, resulting from adverse scapula positioning, is regarded as being a significant occult instability risk (Kibler 1998).

The scapulohumeral joint relies heavily on the passive stability provided by the capsulo-ligamentous structures and the dynamic stability provided by the rotator cuff (Glousman et al 1988, Harryman et al

1990, 1992, Payne et al 1997, Terry et al 1991). This stability is crucially dependent on intact proprioception (Nyland 1998). Disruption by trauma or repetitive disadvantageous movement patterns is associated with impingement or instability (Barden et al 2005, Machner et al 2003).

An example of how taping can be used in the management of a patient with excessive tipping of the scapula is presented in the case history in Box 11.4. An example of how taping can be used to elevate a depressed scapula and stabilize a traumatically unstable acromioclavicular joint is presented in the case history in Box 11.6.

The case histories have been deliberately chosen to show a range of taping techniques that can be used either in conjunction with other modalities and methods, or in isolation.

Conclusion

Management of complex neuromusculoskeletal dysfunction and pathology and pain syndromes requires a multifactorial approach based on individual assessment. Strategies used to reduce pain, increase mobility, improve movement coordination and improve strength may be augmented by the use of taping to offload tissues or to improve movement patterns by proprioceptive and mechanical means.

Taping is a particularly useful treatment adjunct as it has the particular advantage of lasting well beyond the patient–therapist contact, thus extending the duration of therapeutic stimulus. Repetition and long duration experience of altered movement is essential in altering established motor engrams and overcoming the effects of established inhibition or pain presentations.

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