Masterclass

Spinal manipulative thrust technique using combined movement theory

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SUMMARY. Spinal Manipulative Thrust Technique (SMTT) is employed by all manual therapy professions using different rationales for the selection of technique. A method of rationally selecting particular SMTT’s is described with a view to integrating SMTT into the practice of manual therapists familiar with Combined Movement Theory (CMT), a corollary of the Maitland Concept. The similarities of CMT and SMTT methodologies are described and two examples of how CMT can be utilized for SMTT selection in the cervical spine are detailed. © 2001 Harcourt Publishers Ltd.

INTRODUCTION

Spinal manipulative thrust technique (SMTT) has been used by physiotherapists and other manual therapy professions for many years. Seminal authors in the field of musculoskeletal therapy including Cyriax (1941), Grieve (1991) and Maitland et al. (2001) have described spinal manipulative thrusts and recommended their consideration in the management of spinal dysfunction. SMTT continues to be taught and practiced and there appears to be no decline in the popularity of these techniques despite the scarcity of evidence to support their continued use (Bogduk & Mercer 1995).

Passive movement of the vertebral column is used commonly in the management of spinal dysfunction (Anderson et al. 1992). One of the most popular paradigms of passive movement treatment in spinal dysfunction is the Maitland Concept (Maitland et al. 2001) and the corollary of this, Combined Movement Theory (CMT) (Edwards 1987; 1992). The aims of this article are to introduce the fundamental similarities in approach between SMTT and CMT and introduce a process of SMTT selection based upon CMT. It is hoped that by adopting this rationale of SMTT selection it may provide the user with a method of applying SMTT that integrates the two concepts.

SPINAL MANIPULATIVE THRUST TECHNIQUE

Whilst the similarities and differences between particular manipulative techniques are not always clear from the literature, there seems to be agreement that SMTT involves a small-amplitude, high-velocity thrust to a spinal joint (Ottenbacher & DiFabio 1985) that extends beyond a restricted range of movement (Koes et al. 1991). The effectiveness of SMTT in the treatment of spinal pain has been investigated in numerous randomised controlled trials with these in turn being analysed in systematic reviews (Koes et al. 1991; 1996). Whilst it is beyond the scope of this article to discuss these articles in great depth, it appears that SMTT produces short-term improvement in pain, and high patient satisfaction in certain spinal dysfunctions; however, the available evidence establishes little more than this.

FUNDAMENTALS OF SPINAL MANIPULATIVE THRUST TECHNIQUE

The fundamental elements that are required for the application of localised SMTT are listed below.
Localised passive movement

SMTT aims to produce effects (local joint and paraspinal muscle effect) as a consequence of applying a passive movement towards one functional spinal unit, i.e. two spinal levels (Herzog 2000). It is essential therefore that spinal passive movement is localized to one functional spinal unit and the manipulative thrust be directed toward one zygapophyseal joint (Grieve 1991; Nyberg 1993).

Combination of movements

During SMTT the application of a high-velocity, low-amplitude thrust occurs at the end of range of movement for the joint. However, in order that the joint is not moved past its painless or ‘normal’ range of movement in any one plane, the joint is positioned in a manner that allows an end-range feel to be produced in a combination of mid-range positions. Thus the high-velocity, low-amplitude thrust is applied in a position where the joint has reached the end of its range of movement in that particular combination of plane movements but is not at the end of available range for each of the movements if they were to be applied in isolation (Nyberg 1993).

In order to produce an end-of-combined-range position amenable to SMTT, the combinations of movement used are often complex and appear to contradict the normal coupled movements of the spine. The use of these ‘irregular’ coupled movements produces the ‘lock’ position commonly referred to in osteopathic literature (Hartman 1985).

Appreciation of the end-feel

An important indicator for the suitability of a SMTT is the quality of the end-feel of the combination of movements used to produce a ‘lock’ position. Whilst this sensation is difficult to quantify, the appreciation of the difference between the feel of a ‘locked’ joint and one that has not achieved a ‘crisp or locked’ end-feel is vital in deciding if a thrust technique is to be adopted (Grieve 1991).

Local, high velocity low amplitude movement

The final movement of a SMTT involves the production of a small amplitude displacement with an acceleration over this small distance that is high. Typically the duration of cervical SMTT is between 100 and 200 ms with forces ranging from 100 to 150 Newtons (Herzog 2000).

THE EFFECTS OF SMTT

Various therapeutic effects of SMTT have been proposed in the literature, ranging from movement of the nucleus pulposus (Haldeman 1978) to reductions in paraspinal muscle hypertonicity (Herzog et al. 1999). Unfortunately, the quality of the evidence on which some of these observations have been made has been poor, ranging from personal opinion (Fraser 1976) to poorly designed trials (Rupert et al. 1985). More recent work has provided some evidence of the effects of SMTT, and whilst a considerable amount of work is still required in this area the available evidence would suggest that SMTT can cause cavitation within the synovial joint (Conway et al. 1993; Herzog et al. 1993), a temporary increase in the degree of displacement that is produced with force due to hysteresis effects (Herzog 2000) and an alteration in electromyographical (EMG) activity in local and distant spinal muscles (Herzog et al. 1999). These effects may in turn reduce the nociceptive afferent barrage to the dorsal horn (Zusman 1986) and evoke descending pain inhibitory systems (Wright 1995) resulting in analgesia.

INDICATIONS FOR SMTT

If one accepts the premise that SMTT is a modality aimed at affecting the zygapophyseal joint, then the type of clinical presentation that would suggest an amenity to SMTT would be one demonstrating signs and symptoms emanating from the zygapophyseal joint and local surrounding structures. These features would depend on the precise nature of the articular dysfunction but typically include:

- A history of onset suggestive of mechanical dysfunction.
- Local nociceptive pain, with or without somatic pain referral patterns.
- Pain that has clear mechanical aggravating and easing positions or movements.
- Spinal movement patterns that when examined actively and passively suggest a movement restriction that is local to one or two functional spinal units (Grieve 1991).

CONTRAINDICATIONS TO SMTT

The contraindications to cervical manipulation have been described in detail elsewhere (Grieve 1991, Barker et al. 2000) and whilst it is beyond the scope of this article to discuss each of these contraindications two factors are of special note.
Irritability
The ‘irritability’ of a condition is a conceptual characterization that imparts information regarding the degree of provocation required to exacerbate the condition, the degree to which it is exacerbated, and the time it takes the condition to return to previous pain levels (Maitland et al. 2001). Subjects demonstrating an irritable spinal pain syndrome rarely have spinal dysfunction amenable to SMTT (Grieve 1991). However, the presence of severe pain does not indicate an irritable condition and therefore does not preclude the use of appropriate SMTT.

Inappropriate end-feel
The practicality of producing a SMTT means that the last decision made, with regard to the suitability of performing a SMTT, is undertaken whilst assessing the quality of the end-feel (Davis 1999) or ‘lock’ immediately prior to applying the thrust. If this assessment reveals a quality of end-feel that does not match the manual therapist’s expectations of an end-feel that would lead to a successful SMTT then the SMTT is contraindicated. In other words, if when adopting the pre-manipulative starting position, the joint does not feel as if it will ‘go’ then the manipulative thrust should not be performed (Hartman 1985).

SUMMARY OF SMTT
SMTT is a passive movement treatment modality that has some evidence for its efficacy in the treatment of certain spinal dysfunctions (Anderson et al. 1992). The evidence for the exact mechanisms of effect are not fully known. The application of SMTT requires skilled assessment of active and passive movement dysfunction and the application of high-velocity, low-amplitude forces that are directed specifically at one spinal joint (Grieve 1991). In order to position the joint in a range where the movement restriction may be treated without producing excessive movement around the joint, passive movements are combined in order to produce a ‘locked position’ (Nyberg 1993). Thus, combined movements are an integral part of SMTT.

COMBINED MOVEMENT THEORY
This method of examination and treatment of spinal pain was developed by Brian Edwards (Edwards 1987) and is an important corollary of the Maitland concept. Edwards (1987;1992) has described the fundamentals of CMT as;

- The use of the analytical assessment principles described by Maitland et al. (2001).
- An expansion of the subjective examination to encourage the manual therapist to recognize patterns of presentation suggestive of specific ‘articular’ movement dysfunctions and to test these hypotheses prior to planning the physical examination.
- An expansion of the active and passive movement examination of spinal regions in order to provide more comprehensive information regarding the movement pattern of dysfunction with classification of ‘prime movements’ and ‘prime combinations’.
- An appreciation of which anatomical regions are likely to be placed on and off tension with combinations of physiological and accessory movements.
- An appreciation of regular and irregular patterns or combinations of spinal motion.
- The use of passive movements during treatment that move the joint within the range of movement in which resistance to movement is detected (typically towards the end of available passive range).
- A system of treatment progression that involves change in starting position rather than increase in the grade (Maitland et al. 2001) of the passive movement undertaken.

These fundamental elements are identical to some of the key components required for the application of SMTT. Both methodologies require skilled interpretation of signs and symptoms with a view to recognition of movement dysfunction patterns suggestive of joint dysfunction. Both methodologies require an in-depth knowledge of the effects of movement combinations on the spinal zygapophyseal joint and the structures immediately adjacent to it. Both use passive movements that are conducted towards the end of range, during which resistance to movement can be detected and both methods involve the selection and progression of treatment based on starting position rather than an increase in the grade of the passive movement applied (Table 1). With these considerable similarities in approach it seems reasonable that CMT and SMTT could form concordant methodologies.

CMT ASSESSMENT PRINCIPLES
It is beyond the scope of this article to describe in detail the assessment process. What follows represents an overview of the process.

Subjective examination
Whilst this part of the examination follows the principles described by Maitland et al. (2001) and follows a broadly hypothetico–deductive reasoning
approach (Jones 1992). The use of pattern recognition (King & Bithell 1998) is encouraged and patterns of dysfunction that could represent articular dysfunction are identified if present. The concepts of severity and irritability of the condition are established and used to structure the examination in terms of the extent of symptom provocation that is to be produced during the physical examination.

Physical examination
Following observation of static posture, observation of active movement is made. This is particularly relevant when observing the combination of movements that the patient can perform in order to most significantly change their symptoms, i.e. to reduce their pain in the case of severe pain presentation and reproduce their pain in the non-severe pain presentation. This movement combination forms an important reassessment marker and has been termed the patient’s ‘functional demonstration’ (Maitland et al. 2001).

Single-plane active movements of the spinal region are then examined. The movements requiring particular attention should be evident from the information gained from the subjective examination and the functional demonstration. Active movements are ranked in order of importance to establish the movement and combination of two movements that change symptomology most significantly. These movements are termed the ‘prime movement’ and ‘prime combination’ respectively and represent the movements that are most significant in the mechanical presentation of the condition (Fig. 1).

The prime movement and prime combination are then examined passively using both physiological and accessory movements (Edwards 1992; Maitland et al. 2001). It is during this process that the zygapophyseal joint demonstrating greatest movement dysfunction is established, quality of movement restriction felt and the relationship between range of passive movement and symptom provocation established. It is during combined passive physiological examination that the examiner will feel if the joint dysfunction has an end-feel quality that suggests a SMTT may be of use.

CMT interpretation principles
During and following the subjective and physical examination, interpretation of data should lead the examiner to form hypotheses regarding:

- Clinical diagnosis of the condition (Maitland et al. 2001).

Table 1. Fundamentals of combined movement theory and spinal manipulative thrust technique

<table>
<thead>
<tr>
<th>Combined movement theory</th>
<th>Spinal manipulative thrust technique</th>
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<tbody>
<tr>
<td>Passive movement treatment</td>
<td>Passive movement treatment</td>
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<tr>
<td>Movement induced in a range where resistance is detected</td>
<td>Movement induced in a range where resistance is detected</td>
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<tr>
<td>Movement localized to one or two functional spinal units</td>
<td>Movement localized to one functional spinal unit</td>
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<tr>
<td>Up to three physiological movements are combined to place the</td>
<td>Up to three physiological movements are combined to place the joint</td>
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<tr>
<td>joint in a starting position in which further movement can be applied</td>
<td>in a starting position in which further movement can be applied</td>
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<tr>
<td>Passive physiological and accessory movements are combined</td>
<td>Passive physiological and accessory movements are combined</td>
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<tr>
<td>Positioning of joints based on an interpretation of symptomology and of which joint structures are likely to be tensioned in combined positions</td>
<td>Positioning of joints based on an interpretation of symptomology and of which joint structures are likely to be tensioned in combined positions</td>
</tr>
<tr>
<td>Use of normal/regular coupled movements and irregular combinaisons of movement</td>
<td>Use of irregular combinations of movement</td>
</tr>
<tr>
<td>Progression of treatment by alteration of starting position rather than by alteration of grade of movement</td>
<td>Progression of treatment by alteration of starting position rather than by alteration of grade of movement</td>
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<tr>
<td>Use of low-velocity movement with low to high amplitude</td>
<td>Use of high-velocity, high-acceleration movement with low amplitude</td>
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</tbody>
</table>

Differences in methodologies are italicised.

Fig. 1—Box Diagram Illustrating Prime Movement and Prime Combination. Box diagram showing a graphical method of displaying the prime movement and combination of two movements forming the prime combination. These movements are established by examining the active physiological movements of the spinal region and ranking the movements to establish the two most significant movements in symptom reproduction. In this case, the prime movement is right lateral flexion, limited to half range, and the prime combination is right lateral flexion followed by extension, again limited to half expected range. ▪ Prime movement (Right lateral flexion). ▪ Prime combination (Right lateral flexion followed by extension).
The severity and irritability of the condition (Maitland et al. 2001).

The dysfunctional movement pattern associated with the condition (Edwards 1992).

The spinal joint that is most implicated in symptomology (Edwards 1992).

The combination of movements/positions that most influence symptomology (Edwards 1992).

The position of structures that are likely sources of symptomology, i.e. anterior or posterior joint structures (Edwards 1992).

The regularity or irregularity of the combinations of movement producing the prime combination (Edwards 1992).

The quality of the passive end-feel of the implicated joint’s prime movement and more importantly it’s prime combination.

The suitability of the implicated joint for SMTT based on the end-feel of the joint when placed in its prime combination position (Davis 1999).

Selection of SMTT using CMT

Following an interpretation of the examination, a treatment plan can be formulated. Particular SMTT’s can be selected as treatment techniques using CMT. This selection process has the advantage of providing the manual therapist with a rational reasoning process that aids the integration of SMTT into practice and enables SMTT to become a technique that may be considered earlier in the resolution of the condition rather than as a technique only used after a period of mobilization. The choice of starting position for treatment depends primarily on the willingness of the examiner to reproduce symptomology. In the first worked example, detailed below, the rationale for starting position and progression of treatment is detailed for a situation where symptom reproduction is deemed acceptable.

Symptom reproduction deemed acceptable

In a clinical presentation where the manual therapist feels it is acceptable to reproduce symptomology the dysfunctional joint is placed in a starting position from which symptoms can be reproduced with passive movements applied in this position.

Patient presentation

The patient presents with very mild right-sided neck and supra-scapular fossa pain characteristic of nociceptive and somatic referred pain. The pain is provoked with a prime movement of half-range, right-lateral flexion and a prime combination of right-lateral flexion followed by extension of the right C4/5. Passive movement examination reveals that extension-performed in right-lateral flexion reproduces symptoms most significantly. Combined movement theory suggests that the structures anterior to the joint would be tensioned in this combined position. Thus, in right-lateral flexion and extension the passive movements that could be applied that would further encourage an increase in the tension of the anterior structures would be:

- Extension
- Right-lateral flexion
- Right rotation
- Anterior glide of C5 on C4
- Posterior glide of C4 on C5
- Right-lateral flexion SMTT in extension
- Right rotation SMTT in extension
- Transverse SMTT to the left in right lateral flexion and extension

SMTT positioning

When combining the three plane movements required to produce the starting position for the right lateral flexion SMTT in right-lateral flexion and extension, the order in which the individual plane movements are combined will influence the range of movement produced and the degree to which symptomology is reproduced. As plane movements are combined passively the range of movement that can be produced is reduced as the tension in particular structures is increased. For example, the range of extension which can be produced at C4/5 in neutral is greater than when it is performed in right-lateral flexion. Thus, when producing the starting position for the right-lateral flexion SMTT, the application of the prime movement (right-lateral flexion) as the last movement to be combined reduces the range of movement required and consequently the reproduction of symptoms.

In order that an adequate ‘crisp’ locked end-feel is produced whilst in mid-range for each plane movement, the combination of movements will involve the application of an irregular pattern of movements. Thus, whilst in this example, the regular combination of movements, i.e. matching the normal coupled movements of the mid-cervical spine, are extension, right-lateral flexion and right-rotation a locked position requires an irregular movement pattern involving right-lateral flexion, extension and left rotation. As the prime movement for this example is right-lateral flexion the starting position for the application of a SMTT could be achieved by combining right-lateral flexion, extension and left rotation in that order. (Figs. 2 and 3). Right-lateral flexion followed by extension is applied first, as this is the prime movement and prime combination and symptom reproduction is acceptable in this example.
Symptom reproduction deemed unacceptable

In a clinical presentation, where the manual therapist feels it is unacceptable to reproduce symptomology, the dysfunctional joint is placed in a starting position from which symptoms are unlikely to be reproduced with passive movements applied in this position.

Patient presentation

Very severe right sided ‘nociceptive’ neck and somatic supra-scapular fossa-referred pain provoked with a prime movement of half-range right-lateral flexion and a prime combination of right-lateral flexion followed by extension of the right C4/5. Combined movement theory suggests that the structures anterior to the joint would be tensioned in this position. Thus, in left lateral flexion and flexion the following passive movements could be applied in a position where the anterior structures are not tensioned, allowing the following therapeutic passive movements to be produced whilst avoiding symptom reproduction:

- Flexion
- Left-lateral flexion
- Left rotation
- Posterior glide of C5 on C4
- Anterior glide of C4 on C5
- Left-lateral flexion SMTT in flexion
- Left rotation SMTT in flexion
- Transverse SMTT to the right in left-lateral flexion and flexion

SMTT positioning

In order to place the joint in a position where a SMTT can be applied without reproduction of symptoms the joint must be placed in a starting position that maximally reduces the tension on the anterior joint structures whilst using an irregular movement pattern to enable a mid range lock position to be produced.

Thus, in order to produce the starting position for a left-lateral flexion thrust in flexion the movements of left-lateral flexion, flexion and right rotation could be combined in that order. This order uses a combination of movements that is directionally opposite to the prime combination and ensures that (right rotation) the irregular pattern component (that moves the joint in a direction that may potentially reproduce symptoms) is combined in a position where only a small range of movement is available (Figs. 4 and 5).

SMTT selection using CMT

SMTT selection can be based on CMT and provides the manual therapist with a method of clinical reasoning that enables SMTT to be considered as a treatment option when using combined-movement treatments. Having decided that the patient’s spinal dysfunction is suitable for treatment using CMT the selection of particular SMTT can be made using information already obtained from the CMT examination. The starting position for SMTT is reasoned by analysing the combination of movements that reproduce symptomology and placing the joint into that combined position or in its directional opposite depending on the suitability of symptom reproduction.
In order that a suitable combined end-of-range ‘lock’ is produced irregular patterns of movement (not matching normal coupled movement for the spinal region) are used. The order in which movements are combined to produce starting positions for SMTT is determined by the prime movement and prime combination of the dysfunction. When symptom reproduction is deemed appropriate the prime movement can be applied first whilst when symptoms are not to be reproduced the direction opposite of the prime movement can be applied first. The choice of irregular pattern used to form the ‘lock’ and the direction of SMTT will be based on the desire of the manual therapist to move the joint into a direction that will further increase the tension on or reduce the tension on the joint structures thought to be the source of symptoms. Two examples of the positioning for cervical SMTT using CMT have been illustrated above, however the principles are identical for the thoracic and lumbar spines.

CONCLUSION

Both CMT and SMTT provide the manual therapist with methodologies for the therapeutic passive movement of spinal dysfunctions. There is considerable overlap in the fundamental components of CMT and SMTT with both methodologies using combined movements to position the dysfunctional joint and deliver movement at the end-of-range for a combination of three plane movements. This parity of methodology enables the use of CMT as a rationale for the selection of SMTT’s and it is hoped that by adopting a ‘familiar’ methodology in the selection of SMTT, manual therapists will find the selection of SMTT’s clinically relevant.

Summary points

- Spinal dysfunction amenable to treatment with CMT is amenable to treatment with SMTT
- CMT assessment provides adequate information for the selection of particular SMTTs
- Severe pain can be treated with SMTT by adopting a starting position for techniques that is directionally opposite to the prime combination of the dysfunction

Acknowledgements

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