Title       A survey and analysis of evidence for advanced soft tissue techniques in UK sports therapy curricula

Name        Emma Langham

This is a digitised version of a dissertation submitted to the University of Bedfordshire.

It is available to view only.

This item is subject to copyright.
A Survey and Analysis of Evidence for Advanced Soft Tissue Techniques in UK Sports Therapy Curricula

By

Emma Langham

A thesis submitted to the University of Bedfordshire, in fulfilment of the requirements for the degree of Msc by Research.

December 2009
Abstract

Introduction

In many instances, research in the area of manual therapy has been based on collections of anecdotal evidence, opinion editorials by practitioners, and poorly structured case studies/case series. Therefore, the purpose of this project was to identify areas within the current research for Neuromuscular Techniques where scientific evidence is lacking, and to propose a strategy for the establishment of a research driven evidence base. Where some research evidence is present, the objective will be to provide a systematically assessed evidence base to underpin the technique.

Methods

An e-mail survey of UK Universities was carried out to determine the type of techniques being taught. An inclusion criterion was created by adapting the methodology established by the Cochrane Collaboration and PEDro. Once the relevant articles were identified, a systematic review was carried out and a meta-analysis was applied to the literature to determine the ‘quality’ of the papers retrieved in each area.

Results

The results of the study showed that even though there is a wealth of literature available within this area, the quality of the papers available is not sufficient to determine an effective treatment protocol.

Conclusion

In conclusion, the research that is available within the field of Neuromuscular Techniques is currently inconsistent and lacking clarity, therefore more research is needed in the area in order to ‘fill in’ the gaps in the literature. Without a fully complete and methodologically sound evidence base, Universities within the UK are not able to effectively adopt an evidence based teaching practice. The proposals and templates highlighted above are recommended to be put into place to go some way to fill these areas where research is lacking so that Sports Therapy researchers are able to drive our understanding of NMT forward.
List of Contents

Abstract .................................................................................................................. II
List of Tables ........................................................................................................ V
List of Figures ....................................................................................................... VI
Acknowledgements .............................................................................................. VII
Declaration ........................................................................................................... VIII
List of Abbreviations ........................................................................................... VIX

Page

Chapter 1 – Introduction ...................................................................................... 1

  1.1 – Neuromuscular Techniques ........................................................................ 2

    1.1.1 Aetiology of Trigger Points .................................................................... 3

    1.1.2 Condition to Treat ................................................................................ 7

    1.1.3 Rationale ............................................................................................... 8

    1.1.4 Application of Technique .................................................................... 8

  1.2 – Objectives of this Research ....................................................................... 11

Chapter 2 – Methodology .................................................................................... 14

  2.1 – Data Collection and Collation .................................................................. 14

  2.2 – Literature Collection ............................................................................... 15

    2.2.1 Data Sources ........................................................................................ 16

    2.2.2 Study Selection ..................................................................................... 16

    2.2.3 Quality Assessment ............................................................................. 17

    2.2.4 Systematic Review .............................................................................. 18

    2.2.5 Meta-Analysis ...................................................................................... 19
Chapter 3 – Results........................................................................ 22
  3.1 – Description of Studies............................................... 26
  3.2 – Meta-analysis............................................................... 46
Chapter 4 – Discussion................................................................ 51
  4.1 Summary of Results...................................................... 51
    4.1.1 Systematic Review.................................................. 51
    4.1.2 Meta-Analysis........................................................... 52
  4.2 Pedagogical Implications............................................... 57
  4.3 Suggestions for Maintaining Methodological Rigour..... 64
Chapter 5 – Conclusion............................................................ 67
  5.1 Guidelines for Future Research.................................... 67
  5.2 Summary........................................................................... 75

6.0 – Appendices....................................................................... 77

7.0 - Reference list.................................................................... 108
List of Tables

Table 1, Page 23; A table to show the outcome of the PEDro criteria assessment, in rank order of highest to lowest scores.

Table 2, Page 62; A table to show the application of NMT and the research to support it.
List of Figures

Figure 1, Page 17; Table to show selection of studies for review.

Figure 2, Page 18; Pedro Scale Items.

Figure 3, Page 47; Effect size and 95% confidence intervals (CI) for pressure pain threshold of NMT-type therapies compared to controls, each other and other manual therapies.

Figure 4, Page 49; Effect size and 95% confidence intervals (CI) for visual analogue scale (VAS) of NMT-type therapies compared to controls, each other and other manual therapies.
Acknowledgements

I would like to formally thank Mr Peter Sheard and Mr Tim Paine of the University of Bedfordshire for their guidance, support and motivation in the production of this thesis.
Declaration

I declare that this thesis is my own unaided work. It is being submitted for the degree of (name award) at the University of Bedfordshire.

It has not been submitted before for any degree or examination in any other University.

Name of candidate:  

Signature:  

Date:
List of Abbreviations

NMT – Neuromuscular Technique
ACh – Acetylcholine
ATP – Adenosine triphosphate
SEA – Spontaneous Electrical Activity
PNF – Proprioceptive Neuromuscular Facilitation
PEDro – Physiotherapy Evidence Database
ASTT – Advanced Soft Tissue Techniques
NAGs – Natural Apophyseal Glides
SNAGS – Sustained Natural Apophyseal Glides
RCT – Randomised Controlled Trials
ES – Effect Size
DOMS – Delayed Onset Muscle Soreness
VAS – Visual Analogue Scale
PPT – Pressure Pain Threshold
PA – Pressure Algometer
MPR – Manual Pressure Release
AECC – Anglo-European College of Chiropractic
AAI – Activator-Adjusting Instrument
LF – Lateral Flexion
CROM – Cervical Range of Motion
MTrPts – Myofascial Trigger Points
Chapter 1 - Introduction

In many instances, research in the area of manual therapy has been based on collections of anecdotal evidence, opinion editorials by practitioners, and poorly structured case studies/case series. For example, in a publication in 2003 by Heuguenin, it is stated that ‘... much of the early literature on trigger points are based on anecdotal reports and the clinical experience of those using this form of treatment...much of the fundamental understanding remains in the theories of early clinicians and still requires experimental verification’ (page 2).

In a further example, a search for ‘neuromuscular technique’ (a widely accepted technique) on MedLine indicated no peer reviewed literature in this area. A ‘Google’ search of the same term returns ~3,579 hits. This suggests that although this technique is widely used, there is little scientific research to support it.

This disparity between available information and peer reviewed literature is consistent with many other advanced techniques. Of those few techniques where a recognized research ethic has been adopted, there have been inconsistencies between their results. The purpose of this project is therefore, to identify areas where research-derived evidence is absent, and to propose a strategy for the establishment of a research driven evidence base. Where research is present, the objective will be to systematically assess the evidence base used to underpin the techniques, and carry out a meta-analysis in order to establish the quality of the papers available.
This research originally proposed to carry out a review of four techniques; however, during the initial research phase it became apparent that there was a lack of supporting literature and a substantial lack of clarity within the literature that was available. Therefore, the decision was made with supervisors to concentrate on one technique in order to be able to produce a more thorough analysis, and to establish viability of procedures for analysis of other techniques, should the volume and quality of papers increase in those areas. From here, the technique chosen for this research was Neuromuscular Technique (NMT).

The technique that will be investigated within this project will be Neuromuscular Technique. The main focus of the project will concentrate on the following areas within the technique:

- Efficacy of the manual therapy
- Physiological, (bio)mechanical and/or neurological evidence
- 'Physical' outcome(s)
- Quantification of protocol parameters
- Dose:Response relationships

1.1 Neuromuscular Techniques

Neuromuscular Techniques have emerged over the last several decades as an effective means of assessing, treating and preventing soft tissue injuries and chronic pain (Delany, 2007). Despite the application of NMT evolving over several decades, the lack of clarity described above begins with the language that is used to identify this technique within the current research.
Neuromuscular techniques have also been referred to as Trigger Point Therapy, Myofascial Trigger Point Release Therapy, Manual Pressure Release, and Ischemic Compression; thus adding to the difficulties in reviewing the research which may underpin this technique. Throughout this study we will refer to these techniques collectively as Neuromuscular Technique (NMT) for clarity.

According to Delany (2007) the aim of the NMT is to remove/reduce the occurrence of trigger points within the target muscle. Travell and Simmons (1992) define trigger points as having 3 possible components either separately or in combination: 1) localised areas of deep tenderness within a taut band of muscle; 2) they exhibit a local twitch response (muscle fasciculation) or jump sign (whole body movement) in response to digital pressure; 3) trigger points are able to produce referred pain upon digital compression, upon which the sensations will be recognised as familiar to the client. It is this final descriptor that distinguishes Latent Trigger Points from Active Trigger Points.

1.1.1 Aetiology of Trigger Points
The development of trigger points can be observed following either occupational or athletic trauma and may be due to muscle imbalances, postural deficiencies or secondary to underlying pathologies (Huguenin, 2003). Examples of this are when trigger points are found in the Quadratus lumborum muscle in association with and following an irritated lumbar disc, or in the case of a desk worker presenting with headaches that are reproducible
with pressure over trigger points found within the trapezius muscle; each thought to be due to prolonged muscle contraction and inappropriate postures. Further to this, Simons (2004) suggests that the activation of a myofascial trigger point is associated with either acute or chronic muscle overload. The chronic muscle overload is associated with maintaining the muscle under contraction for long periods of time, or repetitive movements. Simons (2004) then goes on to conclude that myofascial trigger points are a likely source of musculoskeletal disorders, especially in the workplace, and are commonly overlooked as a cause of this type of disorder. Whether these symptoms are a cause or effect of trigger points is not always clear, although the history of the individual client may help to clarify this for the practitioner.

Despite the limited research of NMT being contradictory in many areas, one area where researchers seem to be concentrating is the research that has been carried out to further our understanding of the mechanisms that cause trigger point formation. The aetiology of trigger points is still not clear and the theories that have been developed are based a great deal on supposition. There are, however, two theories that are most widely accepted: 1) the first is known as the ‘motor end plate hypothesis’ which purports that increased action potential motor end plate dysfunction has been attributed to an excessive release of acetylcholine (ACh) from the presynaptic motor nerve terminal. To bring about a muscle contraction, ACh is released into the synaptic cleft, which rapidly activates ACh receptors to create an action potential and a resultant muscle contraction (McPartland, 2004); 2) the second is known as ‘energy crisis theory’ where, according to Huguenin
The earliest explanation of trigger point formation is founded. This theory postulates that an increased demand on a muscle via increased neural output, macrotrauma, or recent microtrauma, can all lead to an increased calcium release in the sarcolemma. This leads to prolonged shortening of the sarcomeres compromising circulation, and consequently, the reducing oxygen supply leaving the cells unable to produce enough ATP to initiate the active process of relaxation. Ischemic by-products of metabolism accumulate being, in part, responsible for some of the pain produced (Simons, 1996). These two theories working in combination provide the most credible and complete aetiology of trigger points.

In 1999, Travell and Simons proposed such an integrated hypothesis regarding the aetiology of trigger points. It was discovered that during a biopsy of local myofascial tissue in the vicinity of trigger points that the tissue contained 'contraction knots' which were described as "large, rounded, darkly staining muscle fibres, it was also found that during this biopsy there was a statistically significant increase in the average diameter of muscle fibres" (McPartland, 2004, p244). In addition, within the vicinity of trigger points there was evidence of spontaneous electrical activity (SEA) in trigger points while adjacent tissues were electrically silent. These interesting discoveries led Travell and Simons to implicate dysfunctional motor end plates as the underlying aetiology for trigger points (McPartland, 2004).

When a motor end plate becomes dysfunctional, there are several mechanisms that cause it to persist as a trigger point, primarily where
excessive muscle contraction compress local sensory nerves, thus reducing axoplasmic transport of molecules that normally inhibit acetylcholine release. The sustained muscle contraction also compresses local blood vessels reducing the local supply of oxygen (ischemia). It is this information that caused Travell and Simons to adapt their views on the treatment of trigger points.

Twenty years ago, Travell and Simons (1999) advocated treating trigger points with ‘ischemic compression’ by applying heavy thumb pressure on the trigger points, which was then later changed to ‘light digital pressure’. McPartland (2004) states that this fundamental change from heavy to light pressure is anchored in the theory that there is local hypoxia in the region of trigger points and therefore deep digital pressure producing further ischemia will not be beneficial. However, disputing this Hou, et al. (2002), in a comparison of treatment pressures and differing timings, found that the higher the pressure and longer timings created the most significant results. From these findings, Hou et al., suggest that the ischemia imposed upon the tissues during the NMT causes a ‘reactive hyperaemia’ due to a counter irritant effect or a reflex relaxation of the target muscle brought about by a spinal mechanism and, therefore, a resultant pain reduction. Once again, this has produced contradictory rationale and is an area that needs to be investigated further in order to establish the correct treatment protocol for the most effective treatment of trigger points.
1.1.2 Condition to treat

Another area of ambiguity and uncertainty within the research of NMT is the type of conditions that NMT can be used to treat. Current research provides us with unclear or vague guidelines as to what this technique should or can be used to treat. The most recognised rationale for carrying out an NMT on a client is to reduce the size or occurrence of trigger points within a target muscle. Trigger points that develop within a muscle have been associated with symptoms including loss/decrease in muscular function, increase in pain/sensitivity within the muscle, decrease in range of motion, musculo-skeletal imbalance, and the production of hypertonic muscles (Chaitow, 1988). Therefore, it can be proposed that by reducing the size or occurrence of trigger points we can bring about a positive effect on the above symptoms.

Reliable diagnosis and location of trigger points is essential for successful treatment. Despite routine claims of the clinical prevalence of trigger points, there are many concerns related to the subjective nature in which these clinical entities are diagnosed (Sciotti et al, 2001). As well as the concerns over correct diagnosis, Sciotti et al also highlight the lack of adequately controlled studies that have examined the ability of the clinician to reliably identify trigger points. Where research has been carried out in this area, they produce equivocal and inconsistent results. However, during their study, Sciotti et al demonstrated that in a comparison, two trained examiners can reliably localize latent trigger points with some precision. In addition to this, during a review of literature, Simons and Dommerholt (2006) state 'it cannot be emphasised enough that the identification of trigger points requires
training' (page 125) and further state that ‘...training in the identification of trigger points should be included more thoroughly within the training of clinicians...’ (page 125). As well as the correct diagnosis and location of trigger points, Huguenin (2003), comments that another important aspect to the treatment of trigger points is the assessment and reduction of any precipitating or perpetuating factors in the presence of trigger points in order to maximise the chance of long-term response to any treatment approaches. In essence, as well as the correct identification of trigger points in the first instance, along with treating the cause of the trigger points (which could be anything from athletic injury to poor postural habits) and not just continually treating symptoms, is key to a successful treatment plan.

1.3 Rationale for Efficacy

Based on the theoretical background above, the rationale behind the efficacy of NMT relies upon the integrated hypothesis adapted from Travell and Simons (1999). Evidence suggests that the palpable trigger point and nodules are areas of local bulging and shortening of the sarcomeres in a muscle fibre producing ‘contraction knots’ (McPartland, 2004). Manual pressure applied to these ‘contraction knots’ have been proposed to reduce the height of the sarcomeres in the involved muscle fibres, and causes concomitant lengthening of the muscle fibres (Fryer, 2005).

1.4 Application of Neuromuscular Technique

Within the literature there are varying methods for carrying out NMT with the following protocol being the most comprehensive. It is found in the lecture
notes of the University of Bedfordshire, and, where noted below, some aspects are referenced in other texts such as: Ward (2004).

1) **Prepare target area with massage and other preparatory techniques.** Although this is not explicitly stated within any other literature it is possible that because NMT is an integrated technique, authors of the research assume this is being carried out to prepare the area to be targeted.

2) **Locate trigger point (‘knot’).** Although this is not explicitly referenced within the current literature, it is inferred that the trigger point must be located before the application of the technique can be carried out.

3) **Apply tolerably painful persistent manual pressure; usually with the thumb or fingertip, against the tissue barrier of the trigger point up to 7/10 on a 1-10 pain scale, where 1 = no pain and 10 = severe pain.** Fryer and Hodgson (2005) relate that this part of the technique is one of the few areas that are relatively consistent within the literature.

4) **Hold this pressure for 7 seconds with direct pressure to the ‘knot’ whilst communicating with the client to determine if either:**
   
   a. pain increases and therefore assume there is a ‘strain’ or inflammation present and treatment must cease immediately.

   b. pain decreases, the area is safe to proceed.
DeLany (2006) states this is a safety/diagnosis procedure that will determine if the technique is safe to use or whether it will cause any adverse effects. The need for a safety/diagnosis test is recognised within the literature; however, the timing of this safety procedure is not specified. The University of Bedfordshire advocates 7 seconds as sufficient time to complete the test.

5) Reapply pressure to 7/10 on pain scale and maintain until pain dissipates to 3 or 4/10 (or maximum 60 seconds). Although the reapplication of pressure is agreed by Fryer and Hodgson (2005) and DeLany (2006), it is not clear, from these authors, when this re-application of the pressure should occur. Hanten (2002) states that the re-application of the pressure should occur after the clinician feels a ‘release’ of the tissues, other researchers such as Fryer and Hodgson (2005) and de-las-Peñas et al. (2006) state that the pain should only be re-applied once the clients’ perceived sensations of pain/discomfort had reduced. However, only two researchers (Fryer and Hodgson, 2005; Delany, 2006) specify the use of a 1-10 scale therefore, the application of pressure is another area for further research for clarification.

6) Ask client to inhale deeply; upon exhalation reapply pressure to 7/10. Although this is not referenced within the literature the University of Bedfordshire advocate this method just before the re-application of pressure. It is not believed to have any added benefit to the results produced by this technique, but it does give the client a focus and an added means of coping with the discomfort or pain.
7) **Complete three cycles of 4→5.** Another area of little research is the number of times to repeat the technique to attain maximal beneficial effects on the target tissue. Lederman (2005) states three repetitions of Proprioceptive Neuromuscular Facilitation (PNF) technique creates the optimal range of motion gains, with any more repetitions producing diminished returns; it may be that the same rationale applies with NMT.

### 1.2 Objectives of this Research

Based on the search highlighted above, the aim of this research project will be to contribute to the understanding of Neuromuscular Technique (NMT) which is a technique taught within the Sports Therapy Degree Programs in the UK. The research will endeavor to evaluate the protocol parameters of this chosen technique, and hopes to give a better understanding of the procedures for the NMT. Secondly, as a result of the clarification of protocol parameters, the efficacy and quality of teaching and learning within Sports Therapy programs will be enhanced as clear guidelines and rationale for the application can be clearly underpinned as empirical evidence supports the practice of manual therapy. The final aim of this research will be to aid and guide the direction of future research in this area.

In order to achieve the above, a comprehensive analysis of current literature will be conducted in the form of a systematic review. By carrying out a systematic review the author hopes to increase awareness of inconsistencies among available research evidence. This can then be enhanced, and by
quantitatively combining the results of several studies, meta-analyses can create more precise, powerful and convincing conclusions (Cook et al., 1997). The term meta-analysis is used to describe the statistical integration of separate studies, whereas ‘systematic review’ is most appropriate for denoting any review of a body of data that uses clearly defined methods and criteria; systematic reviews can include meta-analyses and other sources of evidence (Egger, 1997).

Whether a systematic review or meta-analysis is chosen to be applied to a collection of literature will be determined by the ‘quality’ of the papers retrieved in each area. The method of inclusion for the literature should be created by adapting the methodology established by the Cochrane Collaboration and PEDro. The Cochrane Collaboration is an international and independent organization, dedicated to making up-to-date, accurate information about the effects of healthcare readily available worldwide. It produces and disseminates systematic reviews of healthcare interventions and promotes the search for evidence in the form of clinical trials and other studies of interventions. The major product of the Collaboration is the Cochrane Database of Systematic Reviews which is published quarterly as part of The Cochrane Library.

Cochrane Reviews explore the evidence for and against the effectiveness and appropriateness of treatments (medications, surgery, education, etc.) in specific circumstances, designed to inform the choices that doctors, patients, policy makers and others face in health care. Cochrane Reviews are based on
randomized controlled trials, but other types of evidence may also be taken into account, if appropriate.

The Cochrane Collaboration have set rigorous quality standards to which the Cochrane reviews must adhere to, in order to maintain consistency; this is the format to which this project will attempt to conform. Full details of the process are available at: http://www.cochrane.org/resources/handbook.

The PEDro scale will be used to determine the credibility of the literature to be included within the systematic review. PEDro was initially developed to rate quality of Randomized Controlled Trials (RCT) on PEDro, the Physiotherapy Evidence Database (www.pedro.fhs.usyd.edu.au). The PEDro scale is an 11-item scale designed for rating methodological quality of RCT.
Chapter 2 – Methodology

2.1 - Data Collection and Collation

The data collection for this study was carried out as follows:

1) An e-mail survey of current UK Sports Therapy programs was carried out in order to determine the primary techniques taught throughout the UK, and the core texts used to support them.

The eligibility of the universities that were chosen was based on whether the institutions were teaching Advanced Soft Tissue Techniques within the course in question. In the correspondence with the institutions, Advanced Soft Tissue Techniques (ASST) were classified as ‘manual techniques which are considered beyond the basic massage skills (such as Neuromuscular and Muscle Energy techniques, etc)’ (Appendix 1; a copy of the letter sent to institutions). Based on the above criteria 16 Universities were contacted via e-mail.

Out of the 16 Universities that were contacted, 13 institutions replied. Two of these stated they were unable to participate in the current study; one due to only teaching massage at a basic (Year 1) level, and the other not teaching any manual therapy as they deemed the evidence base to support such techniques as ‘contentious’. From the remaining 11, 9 institutions supplied a comprehensive reading list and all 11 provided a list of techniques taught.

2) Once the information from the institutions was received, it was collated two tables: techniques taught (Appendix 2) and reading material (Appendices 3 and 4).
From these tables, the four primary ASTT used within Sports Therapy Programs throughout the UK were identified as being:

i. Neuromuscular Techniques/Tender and Trigger Point Therapy;

ii. Muscle Energy Techniques (Post Isometric Relaxation and Reciprocal Inhibition);

iii. Positional Release/Strain Counter Strain, and;


From the initial list of techniques (Appendix 2), it emerged that mobilisation techniques such as Mulligans (NAGS and SNAGS) and Maitland Mobilisations were amongst the most commonly taught techniques. However, as these techniques are not classified treating solely soft tissues, they have not been included in the present analysis. Thus, the four primary techniques identified were selected as they were the most commonly taught ASST techniques throughout the UK Sports Therapy curriculum.

3) A review of the 9 main texts was then carried out to understand the types of ASTT the students were being exposed to, the common language/terminology used, the condition that the techniques are purported to treat, and to examine any scientific rationale supporting the techniques.

2.2 Literature Collection

The second phase of the methodology looks at literature collection. Once the techniques and the core texts were established, a literature search was
carried out, concentrating on finding empirical evidence to support the rationale for using the chosen techniques as highlighted in 3) above.

2.2.1 Data Sources
This review was restricted to published research articles and abstracts that compared the effects of the manual therapy technique Neuromuscular Technique or any other form of this technique (as indicated below), and its effects on pain/sensitivity. These studies were identified in three ways: 1) the on-line database Pubmed and Highwire were used. The words ‘Neuromuscular Techniques’, ‘Trigger Point Release Therapy’, ‘Myofascial Trigger Point Release’ were used to gather the relevant studies; 2) reference lists of the identified publications were searched; 3) personal/departmental library collections were also used to identify the peer reviewed literature.

2.2.2 Study Selection
Studies were initially excluded if there were no manual therapy interventions or if the manual therapy intervention was compared to invasive techniques such as Dry Needling and/or Acupuncture techniques. Based on the set criteria above, the citations were filtered and used for the Systematic Review and Meta-analysis. Figure 1, below, schematically presents the study selection process. A total of 31 studies were identified from the searches via ‘Pubmed’, ‘Highwire’ and the personal and departmental libraries of the University of Bedfordshire. A total of 7 articles remained after the selection criteria were applied. The PEDro scale was then used to assess the quality of the remaining articles. See Appendix 5 for full details of excluded studies.
15 articles were excluded from the study at this stage because they were reviews of current literature, case reports or commentaries

3 articles were excluded: 2 because they were studying the reliability of diagnosis of trigger points as opposed to the treatment of trigger points and 1 as it was a pilot study only

3 further articles were excluded: 2 based on the clinical importance of pain scale ratings and 1 due to the purpose of the research being to measure muscle activation after trigger point therapy

3 articles were excluded as they investigated the effects of exercise as a treatment of trigger points

7 Articles remained after the filtering process. The PEDro criterion was then applied to the remaining articles in order to determine which studies would be used within the systematic review.

Figure 1 – Table to show selection of studies for review

2.2.3 Quality Assessment

The PEDro scale was used to determine the credibility of the literature to be included within the systematic review. PEDro was initially developed to rate quality of Randomized Controlled Trials (RCT) on PEDro, the Physiotherapy Evidence Database (www.pedro.fhs.usyd.edu.au). The PEDro scale is an 11-item scale designed for rating methodological quality of RCT; refer to figure 1 below, for the selection criteria used.
1. Eligibility Criteria were specified
2. Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)
3. Allocation was concealed
4. The groups were similar at baseline regarding the most important prognostic indicators
5. There was blinding of all subjects
6. There was blinding of all therapists who administered the therapy
7. There was blinding of all assessors who measured at least one key outcome
8. Measurements of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups
9. All subjects for whom outcome measurements were available received the treatment or control condition as allocated, or where this was not the case, data for at least one key outcome were analyzed by “intention to treat”
10. The results of between-group statistical comparisons are reported for at least one key outcome.
11. The study provides both point measurements and measurements of variability

Figure 2. Pedro Scale Items. Each satisfied item (except the first item) contributes 1 point to the total of PEDro score (range =0-10 points). Maher et al (2003)

During a reliability study, Maher et al. (2003) determined the precision of the PEDro scale to be sufficiently reliable to be used in systematic reviews of Physical Therapy Randomised Control Trials (RCT). Intraclass correlation coefficients was $r = 0.56$ (95% confidence interval = 0.47 – 0.65).

2.2.4 Systematic Review

Once the articles were assessed for quality, a systematic review was carried out on the remaining literature. The systematic review is where further critical analysis was carried out on each paper to ascertain the clinical value of the paper in educating practitioners. In essence, the systematic review explored in more detail the level of compliance to the PEDro criteria and how the compliance/non-compliance affected the value of the paper as a rigorous
source of information for practitioners to retrieve information from. These explorations are highlighted in the Results section.

2.2.5 Meta-analysis

A meta-analysis was carried out to check the cumulative effect of the outcome measures of the journals identified as being of sufficient rigour to include in the analysis. These were identified as those with a PEDro score of 6 or more as these papers demonstrated valid outcome measures from acceptable methodology. The exceptions to this were Gam et al. (1998), which was excluded as the data was not readily transferrable to the meta-analysis, and Fernandez-de-las-Penas et al. (2006), which was previously omitted from the systematic review due to its presentation as a pilot study rather than a full research document. In light of the sample size (n = 40) being similar to other included studies, and the thorough presentation of results, Fernandez-de-las-Penas et al. (2006) was deemed suitable for inclusion within the meta-analysis.

The determination of an appropriate outcome measure to investigate via meta-analysis was confounded by the lack of agreement with regards to what conditions NMT can treat. Practitioners such as Chaitow (1988) state that NMT can be used to treat postural deviations, improve function and reduce energy loss, however, very few others, i.e. Hugenen (2000), note an improvement in posture after the application of a NMT. Within the systematic review of literature, it was noted that one area where researchers agree is that NMT can restore normal function of the muscle that houses the tender or
trigger point. Despite this interest, the area has not been widely empirically tested. One area that has been relatively widely researched, however, is the effect of NMT on pain sensitivity; for this reason change in pain levels is the outcome measure which was identified as the appropriate target for the meta-analysis. (Appendix 6, Tables of Literature, presents the outcome measures of the studies). Two dependent variables were present across a number of papers allowing for two meta-analysis to be undertaken: the first on the variable pain pressure threshold (PPT; kg/cm²) and the second, on the visual analogue scale (VAS; 0 - 100mm.)

The meta-analysis was carried out in accordance to the methodology taken from Doherty and Smith (2005). Initially the Effect Size was calculated for each paper:

\[ \text{ES} = (\text{mean}_{\text{intervention}} - \text{mean}_{\text{control}})/\text{SD}_{\text{control}}. \]

The control was not, in all cases, 'no treatment' but an 'alternative treatment'. This would effectively lessen the NMT effect size if there was any efficacy in the alternative treatment. It was determined that this would decrease the chance of 'false positives' in the efficacy of NMT and was acceptable for the purpose of the investigation. For the two dependent variables assessed, PPT and VAS, the effect size and details of the individual studies were then analysed in two groups (all results pooled to create one 'meta-project' of NMT vs. No Treatment and a second meta-project of NMT vs. Alternative Treatment) to determine the cumulative effect size and direction. Effect sizes were described by magnitude of effect, following Cohen (1977), as < 0.2 = trivial, ~0.2 = small, ~0.5 = moderate, and ~0.8 = large. Ninety-five per cent
confidence intervals were calculated around the effect sizes for PPT and VAS at each of the intervention comparisons. Where the 95% CI effect size interval included zero the effect was deemed to be non-significant as direction of trend could not be predicted; where the 95% CI effect size interval did not cross zero, a significant influence could be predicted. Note that an increase in PPT was a beneficial effect, whereas a decrease in VAS was indicative of a beneficial effect.

As the number of papers included in the meta-analysis was limited (n = 4), no attempt was made to undertake tests for significant difference between the effect sizes of the independent variables No Treatment and Alternative Treatment. When pooling data by No Treatment and Alternative Treatment, a simple weighting of effect size was undertaken to account for sample size of each included data set; each paper adding its representative 'weight' as percentage of total pooled sample size.

All relevant comparisons of interventions within papers and pooled results for No Treatment vs. Alternative Treatment across papers were graphed to illustrate effect size, 95% CI of effect size interval, and relative weight of sample size.
Chapter 3 – Results

This project originally proposed to carry out a review of the four techniques that were subsequently highlighted as the most commonly used techniques from the initial survey of the UK Sports Therapy Curricula. However, during the literature research phase it became apparent that there was a lack of supporting literature for positional release/strain-counter-strain and soft tissue release. As such, only superficial review/analysis would have been possible for these two techniques. The substantial body of literature that was available for muscle energy techniques (when extended to cover the linear applications of proprioceptive neuromuscular facilitation stretch techniques) exposed a gross lack of clarity within the literature that was available. As this topic is under examination by one of the supervisors of the current project it was determined that it was inappropriate to duplicate the in-house work on this topic. Therefore, it was agreed with both supervisors to concentrate on the one remaining technique, NMT, and to produce a thorough analysis, both textual/qualitative (systematic review) and statistical/quantitative (meta-analysis), on that technique. The model used in the exploration of NMT would then act to establish viability of the procedures for analysis of other techniques, should the volume and quality of papers increase in those areas.

After the study selection process (Figure 1), seven articles remained. A PEDro criteria assessment (Figure 2) was applied to these remaining articles in order to determine which studies were to be used for inclusion into the systematic review. The PEDro criteria were put into place as a methodological guideline
for experimental studies to refer to, in order to protect the research design or statistics of the chosen study.

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>Total PEDro Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gemmell</td>
<td>2008</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Blickstad</td>
<td>2008</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Gam</td>
<td>1998</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Fryer</td>
<td>2005</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Hanten</td>
<td>2000</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Bron</td>
<td>2007</td>
<td>Y</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Fernandes-de-las-panas</td>
<td>2006</td>
<td>Y</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 1 – Exhibits the outcome of the PEDro criteria assessment, in rank order of highest to lowest scores.

After the PEDro criteria assessment it was determined that a total of five studies met the inclusion criteria for incorporation within the current study. As such, 26 of the original 31 papers were excluded from the current study. The reason for the exclusion of these studies was mainly that the studies consisted of reviews of literature regarding the purported rationale(s) off/for NMT. It may be suggested that in light of the number of previous reviews of NMT this current study would be redundant. However, the previous ‘reviews of literature’ based a large proportion of their findings on anecdotal evidence and the suppositions of previous authors. It is exactly this perpetuation of tradition versus evidence that the present study is designed to query. The PEDro scores for the excluded journals were based at 5/10 or below

The exclusion of the two studies that did not reach the 5/10 score from the PEDro assessment, were excluded based on the lack of fulfilling the criteria from sections 3 and 5 (highlighted within table 1) and 8 – 11. Number 3 in the
PEDro criteria assesses the concealment of the random allocation of the subjects. If allocation was not concealed, it may be possible to (consciously or unconsciously) influence the group to which a participant is allocated. This could occur from either changing the order in which the participants are enrolled, or the order in which the treatments are provided. A study that did not fulfil this criterion could produce a systematic bias in an otherwise random allocation. Criterion number 5 in the PEDro scale looks at the blinding of the subjects taking part within the study. The subjects cannot be blind to the intervention per se, as they are experiencing the intervention and will be feeling the effects. They can, however, be blind to the research question and the expected outcomes, and, therefore will be less likely to give a result according to what they think the examiner wants to hear, which means the reader can be confident that the effects of the treatment are due to intervention or placebo, and not bias influenced by ‘desire to please.’

Criteria 8-11, ensure that the key outcomes were measured in more than 85% of subjects. It is important that this level of follow up is maintained as participants who are lost to follow-up differ greatly from those that remain in the study. These criteria look to decrease the level of bias with regards the loss to follow up and ‘intention to treat’.

The five relevant papers were included into the systematic review below. Details of each study have been tabulated and the textual analysis that follows each article echoes the table headings for consistency. This presentation of the details of the papers reflects, to a large degree that preferred in the
Cochrane Reviews. The textual analysis also reflects a degree of merging between the Results and Discussion sections of the traditional presentation of experimental research papers that is implicit in the systematic review process.
3.1 Details of Included Studies

Hanten et al. 2000

Characteristics of Included Studies

| Methods | Methods of Randomisation: Using a table of random numbers.  
|         | Assessor Blinding: Yes  
|         | Participant Blinding: Yes |
| Participants | School of Physical Therapy, Texas Woman's University  
|             | Participants: Total - 40; 17 Male, 23 Female  
|             | Age: Mean – 30.6, range 23-58 years  
|             | Inclusion: Palpable tender spot in the neck of upper back, reproduction of the subject's pain upon palpation and a 'jump sign' characterised by patients vocalisation or withdrawal.  
|             | Exclusion: History of orthopaedic surgery to the neck or back, cardiovascular or neurological conditions, and treatment of myofascial pain or trigger points at the time of study. |
| Interventions | Measurements were obtained before the subjects' received the home program and on the third day after they discontinued treatment. A 5-day home program of either ischemic pressure followed by general, sustained stretching of the neck and upper back musculature or a control treatment of active range of motion. |
| Outcomes | Differences were found between the treatment and control groups for Visual Analogue Scores (VAS) and Pressure Pain Threshold (PPT). No difference was found between groups for percentage of time in pain. |

Within the critical analysis of the research papers, the areas where the PEDro scores were awarded will be highlighted. The quality of the above paper was sufficient enough to be included within the scope of the current study. This was based upon the article being awarded a PEDro score of 7.
Methods

The subjects were randomly assigned to the intervention groups, and the allocation of the assignation was concealed. It was also clearly stated within the methodological procedures that there was blinding of the subjects within the study. However, the PEDro analysis highlighted the study's possible lack of validity due to the lack of evidence to suggest the assessors of the study were suitably blinded towards the intervention therefore the study can be said to have assessor bias.

Participants

There were 40 subjects who volunteered for this study; however the authors did not highlight where this population came from; whether they were from the staff or student body or whether they were part of any particular sporting team or background. The inclusion criteria for the study included criteria that discounted subjects who had received recent surgery to neck or back, but it did not highlight whether any of the subjects had or recently suffered with any other types of injury. Further to this the exclusion criteria, they should also have looked to the screening of the subjects for type and frequency of sport as the pain/tenderness felt around the trigger point area could be as a result of Delayed Onset Muscle Soreness (DOMS) from sport and not actually as a result of the trigger points, therefore making the results less accurate and reliable.
**Interventions**

In this study, Hanten et al (2000) tested the effectiveness of a home program of ischemic pressure followed by sustained stretch for the treatment of myofascial trigger points. The unit of measure used to test the effectiveness of this treatment was the Visual Analogue Scale (VAS). The VAS is used to measure the intensity of the subjects’ pain. The scale is a 10cm line, marked at the extremes with ‘no pain’ and ‘worst pain ever’. The reliability of the VAS has been set at $r = 0.99$ (Hanten et al, 2000). Before and after treatment the subjects were asked to record their VAS scores to compare the effects of the intervention on their perceived pain. The second unit of measure was the Pressure Pain Threshold (PPT) which is the minimal amount of pressure applied until the feelings of pressure turns to that of pain. The PPT was measured with a digital Pressure Algometer (PA). The PA consists of a gauge that is attached to a hard rubber tip of 1cm in diameter; this is used to apply pressure to the trigger point area and the gauge records the amount of pressure ($\text{kg/cm}^2$) applied until the pressure turns into sensations of pain. This point is known as the Pressure Pain Threshold. The reliability of the PPT for intratester reliability has been set at $r = 0.69 - 0.97$ and intertester reliability has been set at $r = 0.71 - 0.89$ in a study by Reeves et al. (1986). Both of the units of measure chosen have high reliability which helps to maintain the validity of the results.

The subjects in group 1 of this study were given a home program of ischemic compression and stretching and compared against group 2 who were given a home program of stretching only. Group 1 were given the instructions for
carrying out the ischemic compression in one session and in a subsequent session an assessor verified the application of the ischemic compression and offered a chance to ask any questions for clarification. The application of the technique is one that takes therapists a lot of training and practice, not only to become confident in applying the technique but also to develop the experience and palpatory skills that are required to be able to identify trigger points effectively. Therefore it has to be questioned as to whether the subjects were given enough time and instruction to carry out the ischemic compression accurately enough and reliably enough to gain true effects from the technique.

Upon further critical analysis of the interventions used, it was noted, that the subjects were given a Theracane to apply the ischemic compression to the trigger point and told to ‘apply gradually increasing pressure over the area and to hold that pressure until a release was felt’ (page1000). These instructions do not include such details as how much pressure to apply and when to know when to stop applying pressure. This can lead to inconsistencies of application between subjects. Also, by using a Theracane to apply the technique the subject is loosing the palpatory sensations that a therapist would gain from applying the technique with their thumb or fingertips and will be solely relying on the release of pain as an indicator to move on with the technique. The ‘release’ in this case could possibly be as a result of the subject inadvertently releasing the pressure from the area and not as a result of the tissues ‘releasing’ in response to the technique.
In order for the results to be a true reflection of the efficacy of the interventions, the interventions used within the study ought to be more carefully selected, regulated and monitored. One suggestion that the authors themselves make is that there should be three groups: ischemic compression only, stretch only, and ischemic compression and stretch combined. By doing this it allows the authors to state whether the greater effects are gained from either ischemic compression, stretch or the two techniques combined.

**Outcomes**

The results of this study show a decrease in both the VAS and the PPT scores which demonstrates that this method of treatment was effective at decreasing the perceived pain and sensitivity of the myofascial trigger points. No difference was found between the groups for percentage of time in pain, this however was put down to the subjects finding it difficult to recall and quantify this measurement.

The short term effect of this type of treatment was highlighted within this study, however, the authors state that for an effective treatment protocol, not only do the symptoms have to be managed, but also the perpetuating factors need to be managed or eliminated in order to create an effective treatment plan which is also highlighted in other research in the area such as Huguenin (2003).
**Fryer and Hodgson 2005**

---

**Characteristics of Included Study**

<table>
<thead>
<tr>
<th>Methods</th>
<th>Methods of randomisation: Randomly allocated via lottery draw to either treatment or control group. Assessor Blinding: Yes Participant blinding: Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Participants</td>
<td>Student Population at Victoria University, Melbourne Participants: Total - 37: Male 12, Female 23 Age: Mean – 23.1, Range, 20-33yrs Inclusion – The presence of Myofascial trigger points within the upper trapezius muscle. Exclusion – if presented with primary fibromyalgia syndrome, had taken analgesic medication in the past 24 hours, or had no identifiable myofascial trigger points in the upper trapezius muscle.</td>
</tr>
<tr>
<td>Interventions</td>
<td>All subjects underwent a screening procedure to establish the presence of Myofascial Trigger Points within the upper trapezius muscle. Each subject was then randomly assigned to either the treatment (Manual Pressure Release – MPR) or the control group (Sham Myofascial Release). The Pressure Pain Threshold (PPT) was recorded, pre and post intervention.</td>
</tr>
<tr>
<td>Outcomes</td>
<td>There was a significant decrease in PPT of the Myofascial Trigger Points in the Upper Trapezius following MPR (P &lt; 0.001), but not following the sham treatment.</td>
</tr>
</tbody>
</table>

Fryer and Hodgson (2005) investigated the effect of manual pressure release on myofascial trigger points in the upper trapezius muscle. This paper met the eligibility criteria as set out in the methodology and scored 6 on the PEDro scale.
Methods

The subjects within this study were randomly allocated via a lottery draw to either a Manual Pressure Release (MPR) group or a Sham (control) group. The blinding of the subjects and examiners was clearly stated within the methodology.

Participants

To do this they used 37 subjects, who were volunteers from the population at Victoria University, Melbourne. There is no mention as to whether the subjects chosen from this location were of a specific population or just a random assortment of subjects.

As mentioned within the critical analysis of the previous study, the inclusion criteria for this study does not include those who suffered with conditions such as fibromyalgia syndrome but did not highlight if any of the subjects had or recently suffered with any other types of injury. Further, as in the previous study, the exclusion criteria should also look to the screening of the subjects for type and frequency of sport as the pain/tenderness felt around the trigger point area could be as a result of Delayed Onset Muscle Soreness (DOMS) from sport and not actually as a result of the trigger points, therefore making the results less accurate and reliable.

Interventions

The results of this study were measured using Pressure Pain Threshold (PPT) measurements as with the previous study, but did not include the Visual
Analogue Scale (VAS) to further quantify these results. It is preferable, if suitable, that studies use both VAS and PPT measurements as each one can support or contradict the other, therefore provides us with a more balanced measure of effects. The subjects were randomly allocated to either The Manual Pressure Release (MPR) group or the Sham/control group. Within the MPR intervention, the subjects were encouraged to relax as much as possible while pressure was applied by examiner 1 until the subject reported a 'moderate but easily tolerable' (page 251) pain value of 7/10 (where 0 = no pain and 10 = severe pain) and examiner 2 recorded the pressure value from the PA.

The MPR pressure was sustained for 60 seconds while examiner 2 monitored the pressure reading and prompted examiner 1 to maintain constant pressure. If the subject reported that the pain decreased to a value of 3 or 4/10, examiner 1 increased the pressure to restore the original value of 7/10 examiner 2 recorded the pressure score at the end of the 60 second treatment.

This application of the manual pressure release technique, in comparison with the previous studies methodology seems a lot more explicit with the application of pressure up to a set pain scale of 7/10 as opposed to the previous study where simply 'apply pressure until pain is felt' was instructed. The pressure being applied by examiner 1 was monitored by examiner 2 to ensure the decrease of pressure/pain was not due to the unconscious release
of pressure by the examiner, which again demonstrates greater methodological rigour than Hanten et al (2000).

The second group were subject to a sham myofascial release technique, this was carried out in the same way as the first group but without the application of deep pressure, and a trigger point was not directly located to render the sham treatment inert. The subjects were blind to this and were informed that they were receiving an ‘indirect osteopathic myofascial release technique.’(Page 252)

Outcomes

The results of this study found that the subjects' mean pressure pain threshold increased after a treatment of manual pressure release therapy. They further state that this change in tolerance of pressure/pain was caused by a change in the tissue sensitivity rather than an unintentional reduction of pressure by the examiner, as this was monitored by a digital algometer; this ensured the pressure applied was measured and maintained throughout the treatment and due to the second examiner monitoring this pressure to ensure it is at a constant pressure this can be assumed to be an accurate and valid account of the tissues' response to the treatment.

This study seems to support the findings and rationale proposed by Simons (2002) where it was stated that manual pressure to the trigger point will lengthen the sarcomeres that have shortened to form a 'contraction knot' which consequently will decrease the size of the palpable 'knot' and pain.
Fryer and Hodgson also state that another possible proposal to the mechanisms of this technique, as suggested by Hou et al (2002), is that the pain reduction in the trigger point is due to a reactive hyperaemia in the local area, due to a counter-irritant effect or a spinal mechanism that may produce a reflex relaxation of the involved muscle.

This said, the authors go on to state that these proposed rationales for the effectiveness of treatment are purely speculative and that further research is required to establish the true therapeutic mechanisms. The authors also suggest that future research includes symptomatic patients with a longer treatment period of at least 4 weeks in order to assess the effect of treatment duration on the efficacy of treatment. They also recommend the use of a VAS to further quantify the results obtained.
Blikstad and Gemmell 2008

Characteristics of Included Study

Methods
Method of Randomisation: Computer Randomisation,
Assessor Blinding: Yes
Participant Blinding: Yes

Participants
Recruited from the Student Body of the Anglo-European
College of Chiropractic (AECC)
Participants: total - 45, 20 male, 25 female
Age: Range: 18-55yrs
Inclusion: Subjects were admitted to the study if they met the
following criteria - Male or Female between ages 18-55,
Unilateral or Bilateral neck pain that lasted for at least 4 weeks,
but no longer than 12 weeks. Neck pain of at least 4 on an 11
point numerical scale rating. The presence of an activator
trigger point in the upper trapezius muscle or decreased lateral
cervical flexion to the opposite side of the active trigger point.
Exclusion: Subjects with any of the following were excluded -
Specific neck pain, blood coagulation disorder, currently taking
anticoagulants e.g. warfarin or any long term steroid use.

Interventions
Neck pain level was determined by using a numerical scale,
degrees of lateral flexion were measured using a goniometer,
and pain pressure thresholds (PPT) were measured with a
pain pressure algometer. All subjects attended one treatment
session and outcome measures were repeated 5 minutes after
treatment. Subjects were either allocated to one of three
treatment groups – Activator Trigger Point Therapy, Myofascial
Band Therapy or Sham Ultrasound (control group).

Outcomes
For the primary measure of pain reduction, the odds of a
patient improving with activator trigger point therapy was 7
times higher than a patient treated with Myofascial band
therapy or Sham ultrasound (95% CI: 1.23 - 45.03).

Within this research, Blikstad and Gemmell (2008) compared the immediate
effects of activator trigger point therapy and myofascial band therapy with a
control group of sham ultrasound. The aims of this study were to measure the
effects of each intervention on non-specific neck pain in patients with upper
trapezius trigger points. This study scored 8 on the PEDro rating scale.
Methods

The subjects were randomised with concealed allocation via sealed opaque envelopes. Based on this method of randomisation, it can be assumed that the subjects were blind to their original allocation but aware of the treatments as applied. However, within the study there is reference to the fact that the therapists carrying out the interventions were not blind to the treatment given, however the examiners recording the scores were blinded.

Participants

Forty-five subjects were recruited from student body of the Anglo-European College of Chiropractic (AECC) in the UK. The authors of this research did not state whether these students were from a particular sporting back ground, which could have an effect on the formation of trigger points. The exclusion criterion was stated as follows; the subjects with any of the following were excluded: specific neck pain (radiculopathy, systemic disease etc...), a blood coagulation disorder, or long term steroid use. The Inclusion criterion is as highlighted in the table above.

Interventions

The first intervention for this study consisted of activator trigger point therapy which is a technique that uses activator-adjusting instrument (AAI) which is a hand held device that delivers controlled and reproducible forces to the trigger point. The AAI features force settings ranging from 1-4. The AAI was placed perpendicular to the trigger point, and used at a setting of 3 (170 N) and the trigger point was treated with 10 thrusts at the rate of 1 thrust per second. The
second intervention was Myofascial Band Therapy which consisted of firm thumb pressure in a slow stroking motion from the lateral shoulder to the mastoid process along the upper trapezius and through the active trigger point, for 1 minute. The control intervention consisted of Sham Ultrasound consisting of the ultrasound gel being applied to the skin around the area of the trigger point and the ultrasound head was moved slowly over the upper trapezius in the region of the trigger point for 2 minutes without the machine being activated. The primary outcome measure used was an 11 point numerical scale, similar to the VAS that Hanten et al (2000) utilized in their study as highlighted above. PPT was also measured in the same way as the previous studies by way of a pressure algometer (PA). As well as this, the degree of Lateral Flexion (LF) was also measured using a Cervical Range of Motion Goniometer (CROM).

Outcomes
The results of this study show that activator trigger point therapy, while non-significant, is more effective in treating patients with non-specific neck pain than myofascial band release compared with the control group. This was underlined by an odds ratio of 7.4 which suggests that a patient treated with activator trigger point therapy are 7 times more likely to improve after one treatment than a patient treated with myofascial band therapy or sham ultrasound.

The proposed rationale for these results in effect is suggesting the same as Fryer and Hodgson (2005) where they state that is the equalisation of the
sarcomere length and the resultant decrease in energy needed to maintain
the 'contraction knot' are responsible for the decrease in pain and disability.
Method of Randomisation: Computer randomisation.
Assessor Blinding: not indicated
Participant Blinding: Yes

Recruited from the Student Body of the Anglo-European College of Chiropractic (AECC) Bournemouth.
Participants: total - 45
Age: 18-55yrs
Inclusion: Subjects were admitted to the study if they met the following criteria: Male or Female between ages 18-55, had an activator trigger point in the upper trapezius muscle, pain of at least 30mm on the Visual Analogue Scale (VAS) or decreased lateral cervical flexion to the opposite side of the active trigger point.
Exclusion: Subjects with any of the following were excluded: Specific causes for neck pain, those currently taking anticoagulants e.g. warfarin or any long term corticosteroid therapy.

Neck pain level was determined by using a numerical scale, degrees of lateral flexion were measured using a goniometer, and pain pressure thresholds (PPT) were measured with a pain pressure algometer. All subjects attended one treatment session and outcome measures were repeated 5 minutes after treatment. Subjects were randomly allocated to one of three treatment groups - Trigger Point Pressure Release, Ischemic Compression or Sham Ultrasound (control group).

Ischemic compression is superior to sham ultrasound in immediately reducing pain in patients with non-specific neck pain and upper trapezius trigger points, with an odds ratio of 5.01 (95% CI 1.19 - 21.06).

Gemmell, Miller and Nordstrom (2008) investigated the effects of ischaemic compression versus trigger point release therapy on neck pain and upper trapezius trigger points.
Methods

All subjects were randomly assigned to the group by means of sealed opaque envelopes containing the assigned treatment and number, consecutively. The subjects were allocated the next available envelope number. It was clearly stated within the methodological procedures that this is a single-blind methodology where the subjects were blinded due to the nature of the allocation (but not to the intervention as received) therefore the assessors and therapists were not blind to the intervention given.

Interventions

The interventions for this study consisted of Ischemic compression, sustained deep pressure with the thumb to the upper trapezius trigger point for 30 s to 1 minute. Pressure was released when there was decreased tension within the trigger point or when the trigger point was no longer tender, or 60 s had elapsed, whichever occurred first. The second intervention was Trigger point pressure release technique; this was applied to the trigger point with non-painful slowly increasing pressure with the thumb until a tissue resistance is felt by the clinician. This level of pressure was maintained until a release of the tissue barrier was felt, at which time pressure was increased until a new barrier was reached. This process was repeated until there was no tension/tenderness within the trigger point or 90 s had elapsed, whichever occurred first. And finally, sham ultrasound. The Sham Ultrasound (control) consists of the ultrasound gel being applied to the skin around the area of the trigger point and the ultrasound head was moved slowly over the upper trapezius in the region of the trigger point for 2 minutes without the machine being
activated. The results of this study were measured by using a pressure algometer (PA) to measure the subjects PPT which was recorded before and after the intervention. CROM was also measured pre and post intervention. Also the VAS was used to further measure the effects of the interventions.

Outcomes

The findings of the study showed that there were no significant differences between the experimental groups, however, there was a clinical significance between Ischaemic compression group and the control, stating that a patient treated with IC is five times more likely to improve compared to the control.
Gam et al 1998

Characteristics of Included Study

| Methods                      | Method of Randomisation: Computer randomisation.  
|                             | Assessor Blinding: Yes  
|                             | Participant Blinding: Yes  
|                             | Loss to follow up: Yes (n = 9/67)  

| Participants               | Patients of Bispebjerg Hospital Out-patients clinics  
|                            | Participants: total 58  
|                            | Age: 18 -60yrs  
|                            | Inclusion: Subjects would be included if they met the following criteria: Aged between 18 and 60, Trigger-points in the neck and shoulder region and have a duration more than 3 months with an intensity disturbing normal daily activity, reproduction of the patients pain complaints by palpation of the trigger points, number of trigger points = less than 10, the patients should be capable of following the demands inherent in the trial and correct daily recorded Visual Analogue Scales (VAS) for pain at rest and on normal daily function a week before entrance into study.  
|                            | Exclusion: Subjects were excluded if any of the following were met: Signs of cervical disc prolapse, systemic disorder or migraine, changes in medication or other treatments 3 weeks prior to entrance or pregnancy.  

| Interventions              | The patients were randomised into three groups. The first was treated with Ultrasound, massage, and exercise. The second was treated with sham ultrasound, massage and exercise and the third was a control group. The duration of the study was 6 weeks. Treatment was given twice a week from the second to the fifth week. The numbers of trigger points were recorded at each treatment session for groups 1 and 2. Six months after the study, subjects were sent a questionnaire  

| Outcomes                   | It was concluded that Ultrasound gave no pain reduction, but massage and exercise reduces the number and intensity of trigger points.  

Gam (1998) compared the effect of treatment with ultrasound, massage and exercise on Myofascial Trigger Points (MTrPts) in the neck and shoulders in a Randomised Controlled Trial.
Methods

The subjects within this study were all randomly allocated to the intervention groups (a), (b) or (c) by the envelope method to ensure that randomisation was concealed. This study also took particular care over the blinding of the subjects, clinicians and assessors that took part within the study which is the main difference between this and other papers reviewed in this article. This increased methodological attention helped to give this study's findings an increased validity and accuracy.

Participants

Sixty-seven subjects started out included within the study, with 9 subject dropping out, 58 patients were included within the final analysis. Of those completing the trial, 20 patients were allocated to group (A) and were administered ultrasound, massage and exercise; 18 subjects were allocated to group (B) and were treated with sham-ultrasound, massage and exercise; and, 18 subjects were allocated to group (C) which was the control group. The subjects were recruited from the out-patients department of Rheumatology at Bispebjerg Hospital. Inclusion a criterion was set as stated in the table above. And an exclusion criterion was also established (also highlighted within the table above).

Interventions

The interventions consisted of ultrasound, which was administered at a frequency of 100 Hz, pulse = 2:8 and the intensity was 3 W/cm². The treatment time was 3 min per ultrasound head. The treatment time varied...
depending on how many trigger points were found, with a maximum treatment time of 10 minutes. The massage intervention consisted of transverse frictions and myofascial technique being applied to the five most tender trigger points. This was then followed by a standardised exercise programme which the subjects also used for home treatment also. The control group recorded pain levels (VAS) and analgesic usage throughout the 6 weeks. At the final consultation the control group were offered treatment, only data from those that accepted treatment was included in the final analysis.

The massage group were administered massage in the form of transverse frictions and myofascial technique also. The authors of this study did not highlight the exact methodology for the myofascial technique therefore critical analysis of this technique cannot be carried out, nor can the experiment be repeated by other investigators violating one of the underlying principles of the scientific method. However, it can be suggested that for future research the administering of massage and any form of myofascial release techniques should be separated in order to clarify a most effective method for treating trigger points. By doing this it can help to distinguish where the greatest beneficial effects upon the trigger points originate from. The interventions were carried out by experienced Physiotherapists who had experience in palpating and treating trigger points. The treating clinicians were also briefed thoroughly about the study and tested at the end to assess the effectiveness of the blinding efforts. The fact that the clinicians used within this study were experienced in treating this kind of condition is more beneficial than a non-trained person carrying out the procedure. Studies such and Simons and
Dommerholt (2006), state that the identification of trigger points requires extensive training. And that the correct diagnosis of a trigger point is essential to the success of the treatment. Therefore, by utilising trained professionals to carry out this procedure, the authors are ensuring the accuracy and efficacy of the treatment.

The outcome measures for this study were pain at rest and on daily function, tested by Visual Analogue Scale (VAS). Analgesic usage was recorded as number of tablets per day before during and after the interventions.

**Outcomes**

The results of the study showed that there was a significant reduction in the number and intensity of the trigger points from the massage and exercise interventions, but the Ultrasound had no effect on the treatment of trigger points within this study.

**3.2 Meta Analysis**

The four papers that presented their results in a fashion that were readily adaptable to effect size (ES) analysis were Hanten et al. (2000), Blikstad and Gemmell (2008), Gemmell, Miller and Nordstrom (2008) and Fernandez de-las-Penas et al. (2006).

All effect size comparisons were calculated, where possible, from derived data (Appendix 8) and shown in Figures 3 and 4 below. Only PPT and VAS scores from the included articles have enough overlap across papers to be worth assessing via meta-analysis.
For the meta-analysis, the pooled outcomes use N from the contributing papers as weighting factor to adjust for group size discrepancy.

<table>
<thead>
<tr>
<th>Intervention Comparison</th>
<th>Effect Size (pain pressure threshold)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanten IC vs. Stretch</td>
<td></td>
</tr>
<tr>
<td>Fernandez IC vs TFM</td>
<td></td>
</tr>
<tr>
<td>Gemmell IC vs TPPR</td>
<td></td>
</tr>
<tr>
<td>Gemmell IC vs Con</td>
<td></td>
</tr>
<tr>
<td>Gemmell TPPR vs Con</td>
<td></td>
</tr>
<tr>
<td>Blikstad ACT vs MFB</td>
<td></td>
</tr>
<tr>
<td>Blikstad ACT vs Con</td>
<td></td>
</tr>
<tr>
<td>Pooled 'NMT' vs 'Con'</td>
<td></td>
</tr>
<tr>
<td>Pooled 'NMT' vs 'other'</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 3** - Effect size and 95% confidence intervals (CI) for pressure pain threshold of NMT-type therapies compared to controls, each other and other manual therapies, as indicated.

Figure 3 shows the effect sizes for the PPT (post-minus pre-intervention) between the independent variable interventions of the four papers included in the analysis. Where the ‘diamond’ symbol is left of the zero line, this indicates that the NMT-type intervention was less effective in decreasing PPT than its comparator intervention; where symbol is to the right of zero line this indicates that NMT is more effective than the techniques it is compared to. Where x-error bars cross zero the effect is non-significant regardless of effect size. The midpoint of the symbol represents the effect size. The size of the symbol in the centre of the error bars roughly equates to number of subjects in each comparison. The graph shows that nearly all of the NMT ‘type’ techniques are shown to be more effective at increasing pressure pain threshold than the techniques they are compared to. The least effective study with regards to the
PPT is Blikstad and Gemmell (2008) in a comparison of Activator Trigger Point Therapy and a Control of Sham Ultrasound; the results show a negative effect size. Therefore, it may be suggested that the activator trigger point therapy is not effective at increasing the pressure pain threshold compared to a control of sham ultrasound. Figure 1 shows that Hanten (2000) has largest ES but this effect size is not significant. Gemmell on the other hand in a comparison of IC vs Control shows as the next highest ES, and is significant so therefore produces the better results; Fernandez et al shows as the next best ES but shows less variability in its effect on subject than the intervention used by Gemmell. Therefore figure 3 demonstrates that in a study by Gemmell a comparison of ischemic compression (IC) and control shows that IC is more effective at increasing the threshold at which pressure turns to pain compared to the control group of sham ultrasound.
Figure 4 shows the effect size for the Visual Analogue Scale scores for the included studies within the current analysis. A symbol to left of the zero point means the VAS was lower post-intervention, therefore the trigger point 'hurt less'. A symbol to right of the zero point means the VAS increased post-intervention, therefore after the NMT the trigger point 'hurt more'. The pooled data for 'NMT' vs control shows a positive effect size (but negative beneficial effect) with significance, whereas the pooled 'NMT' vs 'other' shows a negative effect size with no significance.

The only study that displays a significant effect is Hanten et al (2000); this study shows that the VAS scores decreased post-intervention, therefore decreased the subjects' perceived tenderness of the trigger point. Gemmell et al (2008) also demonstrated a decrease in scores in a comparison of effects.
size between ischemic compression and trigger point pressure release. The Fernandez-de-las-Penas et al. (2006) study showed an increased VAS post-intervention but with less variability in its effects than other studies.
Chapter 4 Discussion

Neuromuscular Technique (NMT) is a widely used and, therefore, accepted manual technique. However, there is insufficient empirical research with adequate methodological rigour to move our understanding of the technique and its rationale forward from the more traditionally-based anecdotal evidence to a more evidence-based rationale. The purpose of this project was consequently to assess the quality of current literature informing NMT via a systematic review and meta-analysis, and where scientific evidence is absent, to establish the direction for a research driven evidence base to be developed from.

4.1 Summary of Results

4.1.1 Systematic Review

During the literature search for this study it became apparent that the research that was available was limited, and lacking in consistency. The number of good quality experimental studies are minimal considering how widely accepted the technique is. The results of this study echoed this with the original search revealing only 31 articles, and then after applying the selection criteria for this project, only 5 articles being eligible for inclusion in the systematic review.

The review of literature highlights that the inconsistencies within the research mainly stem from the lack of methodological rigour applied to the studies. The main inconsistency with regards the methodology was the lack of blinding of
the subjects and assessors, where possible. The blinding of the subjects is not possible per se but the subjects can be blind to the research question and therefore more likely to give less biased results.

Not all NMT protocols are identical; as is highlighted within the systematic review is that the interventions used within the studies are not comparable, when designing a study, the experimenter should look to compare a ‘like for like’ in order to determine true effects for example, things to keep in mind to enhance consistency would be to compare the same technique with different timings, or differing degrees of pressure and not to compare techniques that differ in both of these areas as how is the researcher able to determine where the true effects lie?

The same considerations should to be applied to the control group that the interventions are being compared to – the most effective and consistent control, seems to be the sham ultrasound as it had no clinical effects but provides a placebo comparison.

4.1.2 Meta – analysis

The data for the meta-analysis was taken from the studies that presented their results in such a way that the effect sizes could be calculated. These were were Hanten et al (2000), Blikstad and Gemmell (2008), Gemmell, Miller and Nordstrom (2008) and Fernandez de-las-Penas et al (2006).
Pressure Pain Threshold

The results of the meta-analysis were placed into graphical format to represent effect sizes for each of the interventions. Based on the effect sizes displayed in Figure 3 the least effective study with regards to the increase in PPT is Blikstad and Gemmell (2008) in a comparison of activator trigger point therapy and a control of sham ultrasound. The results show a negative effect size with no significance. Activator Trigger Point Therapy is a technique where an Activator-adjusting instrument, (AAI) a hand held device delivers controlled and reproducible forces to the trigger point area. The AAI is used to administer 10 thrusts at 1 per minute to the trigger point. As this intervention is applied via a device, it may be classified as a non-manual therapy. As this technique comprises 10 thrusts at 1 per second, based on this the rationale for efficacy used for the NMT type techniques cannot be applied to this technique, as the rationale refers to a sustained pressure being applied to the trigger point therefore the rationale as to why this technique may work needs to be established, and compared to another non– manual technique for the treatment of trigger points to determine efficacy.

Based on the same graph, the most effective study is Fernandes de-las-penas et al (2006) where there was a comparison of Ischemic Compression and Transverse Friction Massage, this shows that ischemic compression is more effective at increasing the PPT of the trigger point post intervention. This is in concurrence with the findings of Fryer, (2005), and supports the theory that manual pressure applied to these trigger points or ‘contraction knots’ within the muscle reduces the height of the sarcomeres in the involved muscle
fibres, and causes concomitant lengthening of the muscle fibres and in turn increasing the PPT and physiologically breaking the cycle of sustained muscle contraction which caused the trigger point to persist.

The pooled data for PPT scores shows that the 'pooled NMT vs con' is small positive effect size and not significant, which suggests that the NMT 'type' techniques are more effective at increasing PPT than the control, however these effects are non-significant. And the 'Pooled NMT vs other' is moderate positive effect size and significant which again suggests that NMT 'type' techniques are more effective than 'other' types of treatment at increasing the PPT of trigger points post treatment. However, even though the results are showing an increase in effect size compared to control, it has to be highlighted, that the control groups that the NMT techniques were compared against are not 'identical'. This underscores the validity concerns within each study regarding these results; a 'gold standard' reference treatment has not yet been identified and the use of sham ultrasound as a control has not been universally adopted, but perhaps should be. Perhaps most confounding, the validity of comparing the results, (as we have done in the pooled comparisons) requires cautious acceptance – at best it represents a flawed approach and an agreed acceptance of the assumption that IC + stretch, IC, TPPR and ACT all represent legitimate NMT-type therapies; at worst it is an exercise underlining the paucity of evidence-based literature yet still using non-equivalent interventions, both experimental and control, to explore the viability of the systematic review and meta-analysis to explore tradition-based ASTT in Sports Therapy.
Visual Analogue Scores

Within Figure 4 the only study that displays a significant effect is Hanten et al (2000). This study shows that the VAS scores decreased post-intervention thereby implying a decrease in the subjects' perceived tenderness of the trigger point. After the application of IC compared to stretch. Gemmell et al (2008) also demonstrated a decrease in scores in a comparison of effects size between ischemic compression and trigger point pressure release. Fernandes de-las-penas et al (2006) study showed an increased VAS post interventions with a comparisson of IC and transverse friction massage. However the study effect size shows less variability than the other studies that it is compared to.

The pooled data for ‘NMT’ vs control shows a increase in VAS scores post–intervention, with significance, whereas the pooled ‘NMT’ vs ‘other’ shows a decrease in VAS score post–intervention, with no significance. However, the controls that the NMT techniques were compared against are not identical so validity concerns regarding the differences between controls are diminished. Also, the ‘other’ techniques that the NMT was compared to are not identical either therefore any direct comparisons cannot be made.

Taking the results of both graphs into consideration, it seems to be suggested that the VAS score for the ‘treatments’ appears to ‘hurt more’ than ‘no treatment’ but shows lower PPT as presented in Figure 3. This may suggest that the trigger point itself hurts less post intervention (as measured via PPT), but the ‘treatment’ aggravates the tissue in general area, therefore increasing the VAS scores post intervention. As such, the measurement of the
Immediate effects of this type of manual therapy intervention may not be the most effective measurement of efficacy of technique as this shows that immediately after the intervention; the tissues are potentially in an aggravated state. A possible alternative could be to measure the 'rate of decay' of the post-NMT discomfort and use the results of the study into the 'rate of decay' to design another that measures the effects of the NMT within the window between the time the initial irritation of the tissues wears off but before the effects of the technique start to diminish. This said, even though there is some residual tenderness in the area after a trigger point treatment, NMT is less uncomfortable than the alternate treatments such as dry needling.

In a critical analysis of the studies by Gemmell et al (2008) and Blikstad and Gemmell (2008), both studies were comparing differing interventions and the effects these interventions have on treating trigger points in the upper trapezius muscle. One of the outcome measures for this was to assess lateral cervical flexion via a goniometer. However, the muscles that are primarily responsible for lateral cervical flexion are the anterior and medial scalenes and sternocleidomastoid. Therefore by treating upper trapezius and primarily measuring the ROM as produced by Scalenes and Sternoceleidomastoid, this suggests that the dependent measure was not a valid outcome measure for the independent variable intervention. A suggestion to ensure the reliability of the results could be to either use a pressure algometer to record the effects of the treatment on pressure over the trigger points in the upper trapezius, or if the ROM is a key dependant variable, the appropriate ROM needs to be measured.
4.2 Pedagogical Implications

Increasingly, the teaching of manual therapy is becoming increasingly centred around 'evidence-based practice'. This project has served to highlight the inconsistent quality of the publications on various aspects of NMT-type techniques. This re-emphasizes the need for further, well-conceived, research in the area.

With institutions advocating the teaching of manual therapy from a background of evidence-based practice, the current research underpinning the use of NMT is not sufficiently consistent nor agreed in its outcomes. For a more comprehensive evidence base to support NMT to exist, the criteria below should be considered as critical for inclusion. For this technique to be taught with the emphasis on evidence-based practice we recommend presenting the following areas as a template:

1) Background
2) Condition to Treat
3) Theory
4) Evidence
5) Diagnosis
6) Application
7) References

The following will expand on this template and, together with the findings of the systematic review and meta-analysis, will offer a template for the teaching of NMT. It will also highlight the areas where future research is needed; the conclusion to follow will offer a number of tentative project proposals for future
research, designed to ‘fill in the ‘gaps’ around the research reported within the current study.

1. Background

Terminology within this therapeutic intervention, history of development of this therapeutic intervention etc.

The background of NMT, as highlighted in Chapter 1, aims to give the reader a sense of the technique and an idea of the journey the technique has taken up until this point.

2. Condition to Treat

What disease, discomfort and/or dysfunction is this therapeutic intervention meant to help control, ameliorate and or alleviate?

The scope of treatment for NMT is not well supported by scientific research with no clear guidelines as to what conditions can be treated. It is clear however, that NMT can aid with the reduction in size and pain of trigger points. It is also known that trigger points within a muscle can affect muscle activation and efficiency (Lucas, 2004), cause musculoskeletal imbalances Chaitow (1998) cause pain etc. Based on this, it can be assumed that by treating the trigger point with NMT we are decreasing the effects that the trigger point have on the conditions highlighted above. Therefore, it can be inferred that NMT, via the treatment of trigger points, can treat a variety of symptoms from muscle movement deficiencies to correcting musculoskeletal imbalances.
3. Theory

What is/are the current/traditional rationale for the efficacy of this therapeutic intervention

Aetiology of Trigger Points

As researchers such as Hanten et al (2000) and Delany (2007) to name a few, seem to agree on the definition of Trigger Points, they also appear to share common views surrounding the aetiology of trigger points being an integrated theory, incorporating motor end plate hypothesis and the energy crisis theory. However, the proposed theories into the aetiology of trigger points are again, mainly based on supposition. The integrated hypothesis created by Simons (2002) is the most commonly accepted theory for the formation of trigger points. Briefly, this integrated theory states that there is normally equilibrium between the release of ACh, the breakdown of ACh and the removal of ACh. In an injured muscle, there is a release of substances that activate muscle nociceptors and cause pain and this elicits a facilitation of ACh release, an inhibition of ACh breakdown, leading to the development of persistent muscle contraction as is a characteristic of the myofascial trigger points. Although this integrated hypothesis is widely accepted, it is based on supposition; therefore, a formulated methodology should be put into place in order to quantify these theories.

4. Evidence

What evidence is there in the scientific/sports medicine peer-reviewed research literature to support/refute/redefine efficacy and/or application of this therapeutic intervention?
Evidence suggests that the palpable trigger point and nodules are areas of local bulging and shortening of the sarcomeres in a muscle fibre producing 'contraction knots' (McPartland, 2004). Manual pressure applied to these 'contraction knots' have been proposed to reduce the height of the sarcomeres in the involved muscle fibres, and causes concomitant lengthening of the muscle fibres (Fryer, 2005) and therefore reducing the size of the trigger points in series.

5. Diagnosis

There needs to be a formulated methodology in place, in order to quantify these theories.

The area that was most consistent within the research was the diagnosis of the trigger points. As highlighted by Travell and Simons (1992) there are set guidelines for the correct diagnosis of either active or latent trigger points:

1) Localised areas of deep tenderness within a taut band of muscle

2) They exhibit a local twitch response (Muscle fasciculation) or jump sign (whole body movement) in response to digital pressure

3) Trigger points are able to produce referred pain upon digital compression causing sensations that may be familiar to the client.

It is this final descriptor that distinguishes Latent Trigger Points from Active Trigger Points. There is a common consensus of opinion for this, although there is still the need for further research to test these descriptors empirically.
6. Application

In light of the above evidence, what is the (proposed) accepted method of application for the (newly) defined therapeutic intervention?

There are a variety of accepted methods that are all considered to be consistent with the application of the Neuromuscular Techniques.

The application of the technique as highlighted in Chapter 1, is taken from various sources that have carried out experiments with valid methodologies. This amalgamation of the various techniques hopes to go some way to clarifying the way the technique should be carried out, based on empirical evidence. However, further testing may be carried out to determine and compare effectiveness for the different styles and timings of the NMT. This would help define which methods are most appropriate for application in different circumstances.

Table 2 below shows the method of application for NMT as discussed in Chapter 1. The table also highlights the areas where research is absent and Chapter 5, Conclusion, will define the proposed plan for the development of research to fill these areas.
<table>
<thead>
<tr>
<th>Application of Technique</th>
<th>Dialogue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare Area for treatment</td>
<td>This is not referenced within the literature. However, this is an integrated technique therefore it can be assumed that this is carried out before the NMT is applied.</td>
</tr>
<tr>
<td>Locate trigger point (‘knot’).</td>
<td>Although this is not explicitly referenced within the current. The Travell &amp; Simons ‘diagnosis’ provides the basis for locating the trigger point prior to the technique being applied. See ‘diagnosis’ above.</td>
</tr>
<tr>
<td>Apply tolerably painful persistent manual pressure; usually with the thumb or fingertip, against the tissue barrier of the trigger point up to 7/10 on a 1-10 pain scale, where 1 = no pain and 10 = severe pain.</td>
<td>Fryer and Hodgson (2005) relate that this part of the technique is one of the few areas that are relatively consistent within the literature. However, the amount of pressure needed is another area for future research. Hanter (2002) states that the re-application of the pressure should occur after the clinician feels a ‘release’ of the tissues, other researchers such as Fryer and Hodgson (2005) and Fernandez-de-las-Peñas et al. (2006) state that the pain should only be re-applied once the clients’ perceived sensations of pain/discomfort had reduced.</td>
</tr>
<tr>
<td>Hold this pressure for 7 seconds with direct pressure to the ‘knot’ whilst communicating with the client to determine if either:</td>
<td>DeLany (2006) states this is a safety/diagnosis procedure that will determine if the technique is safe to use or whether it will cause any adverse effects. The need for a safety/diagnosis test is recognised within the literature; however, the timing of this safety procedure is not specified. The University of Bedfordshire advocates 7 seconds as sufficient time to complete the test.</td>
</tr>
<tr>
<td>a) pain increases and therefore assume there is a ‘strain’ or inflammation present and treatment must cease immediately.</td>
<td></td>
</tr>
<tr>
<td>b) pain decreases, the area is safe to proceed.</td>
<td></td>
</tr>
<tr>
<td>Reapply pressure to 7/10 on pain scale and maintain until pain dissipates to 3 or 4/10 (or maximum 60 seconds).</td>
<td>Although the reapplication of pressure is agreed by Fryer and Hodgson (2005) and DeLany (2006), it is not clear, in these authors, when this re-application of the pressure should occur.</td>
</tr>
<tr>
<td>Ask client to inhale deeply; upon exhalation reapply pressure to 7/10.</td>
<td>Although this is not referenced within the literature, the University of Bedfordshire advocate this method just before the re-application of pressure. It is not believed to have any added benefit to the results produced by this technique, but it does give the client a focus and an added means of coping with the discomfort or pain.</td>
</tr>
<tr>
<td>Complete three cycles of 4→5.</td>
<td>Another area of little research is the number of times to repeat the technique to attain maximal beneficial effects on the target tissue. Lederman (2001) states three repetitions of Proprioceptive Neuromuscular Facilitation (PNF) technique creates the optimal range of motion gains, with any more repetitions producing diminished returns; it may be that the same rationale applies with NMT.</td>
</tr>
</tbody>
</table>

Table 2 - A table to show the application of NMT and the research to support it.

1 More research regarding the most effective method of re-application of pressure – barrier release or client controlled
2 Research into the use 7 second test and the efficacy of such test
3 Barrier release or client modulated re-application of pressure needs to be researched in order to determine the most effective application of NMT technique
4 The effects of breathing on pain control related to the increase in pressure during NMT
5 Duration of technique – research needed to investigate the optimal duration of NMT
The area with the most ambiguity within the application of this technique is the amount of pressure needed to gain maximum effects. Travel and Simons (1992) state that deep pressure was to be applied to the trigger point enough to make the skin blanch. In 1999, Travel and Simons then changed this deep digital pressure to light digital pressure as it was thought that if a trigger point is already causing the tissue to be in a hypoxic state then applying heavy pressure will create an ischaemic effect, further exacerbating the problem. More recently this has again been adjusted to include deeper pressure again as research from Hou et al, (2002) states that the ischemia imposed upon the tissues during the NMT causes a reactive hyperaemia afterwards, due to a counter irritant effect or a reflex relaxation of the target muscle brought about by a spinal mechanism and therefore, a resultant pain reduction. In addition to the amount of pressure needed, there is also uncertainty about how long to hold the pressure for. Studies such as Hanten (2002) state that the pressure used within the NMT should be held until the clinician feels a ‘release’ of the tissues being targeted, others state that the pressure should be held for 60 second, others 90 seconds.

In a review of treatment of myofascial trigger points, Fernandez-de-las-Peñas (2005) concluded that few studies demonstrated reduced pain scores and pressure pain threshold following manual therapy. Fernandez-de-las-Peñas (2005) then went on to state, that there was a lack rigorous evidence to show that some manual therapy techniques have any effects beyond placebo in the treatment of myofascial pain. The methodological quality of future studies
need to ensure that any effects are true intervention effects rather than placebo effects.

4.3 Suggestions for Maintaining Methodological Rigour

In light of the inconsistencies highlighted above with regards the research surrounding NMT, and the findings of the systematic review, the following section will look at, and offer guidelines regarding, the structure and design of any future research that may be carried out within the areas that have been highlighted above. There is a need for such consistency in order to maintain the validity of any future research that may be carried out.

Methodologies

The methodology of the research carried out in the field of neuromuscular technique research, as with any research, needs to have clear guidelines with regards to the methodology in order to increase the validity of the outcomes. This should include where possible, the random allocation of all subjects and this randomisation should be concealed. Other areas of consideration should be the blinding of the subjects and assessors where possible. This also increases the validity of the findings by minimising the any assessor or subject bias that could compromise the results. Acceptance of an area-specific, adapted version of the CONSORT (Consolidated Standards of Reporting Trials) Guidelines (Altman et al. 2001) may be a starting point from which Sports Therapy researchers could consider working.
Participants

When researchers are considering the target population of their research, consideration should be made with regards to the participants that are chosen to take part in the research. One consideration is whether the subjects are presenting as symptomatic, Fryer and Hodgson (2005) state in their research, any future research within this technique should be carried out on symptomatic individuals as opposed to a group of volunteers. If Symptomatic individuals are not required within a study, the sample population should also be chosen comparing ‘like for like’. It is advisable to carry out the research on a similar population as to whom the results are to be applied to. For example, to choose a population from the same sporting team or from the same occupation type will go some way to controlling the inter-subject differences.

As Simons (2004) states that the production of trigger points are caused by muscle overload and by maintaining muscle contraction for long periods of time therefore by specifying what type of subject is taking part in the study the validity and reliability are enhanced. An example of this: if you are comparing an office worker with someone with a more manual occupation, then the predispositions for trigger points will differ greatly, whereas if you compare like-for-like then these differences could be minimised.

Interventions

The interventions used within future research should be carefully considered, the interventions should look to establish ‘primary’ technique in area then compare with others to establish ‘reference’ or ‘best practice’ technique.
Standardise 'control' as either 'primary' technique and/or sham ultrasound.

Dependent variables/outcome measures also need to be considered as previous measures have either been quantifications of subjective pain perception or poorly planned functional outcome measures ie. measuring the ROM of the wrong muscles. Functional performance measures such as strain gauge and/or algometer measured Active, Passive or Strength tests or sport-specific trials should be considered. The important consideration regarding interventions is that the interventions reflect the outcomes of the study and for those outcomes to be functional in order for the results of the study to be applied to the general population rather than a specific sample.

Outcomes

The outcome of the research should be considered before any research is carried out – the researchers should think about what they are hoping to add to the current research pool that already exists. Care should be taken when deciding on the research title to be undertaken, to ensure that experimenters strive to build upon the current knowledge in the area by filling in the gaps in the research as highlighted above, rather than revisiting areas of research that already has established results which would not help to drive the research forward in this area.
Chapter 5 – Conclusion

In summary, the findings of the current project show that the empirical evidence that is available to support the teachings of Neuromuscular Technique lacks both quality and consistency. The main areas of inconsistency lie within the application of the technique and the conditions that this technique can be used to treat. Future research in this area should concentrate on identifying the most effective application of NMT, to establish the amount of pressure needed to gain the greatest results and the optimal timings needed for the greatest effects. Another area of inconsistency is the quality of the research that is available. Future research needs to focus on the methodological rigour of the research in order to produce valid and reliable studies. To do this, the ‘suggestions for maintaining methodological rigour’ as highlighted in Chapter 4 should be adhered to. The PEDro criteria that have been used within the systematic review of this study, or the CONSORT Guidelines mentioned in the discussion, should be used when designing the procedures for the future research. By doing this it will allow researchers to be rigorous and systematic with regards the methodology of any future research. It will also create a body of literature that is consistent in its formulation allowing for ease of comparison across studies and for more comprehensive meta-analysis in the future.

5.1 Guidelines for Future Research

The areas that were exposed as lacking in research were highlighted in the Chapter 4 include:
1. the amount of pressure needed to gain the most benefits from the application of NMT;
2. research into the use of the 7 second test and the validity/efficacy of such a test;
3. research regarding the most effective method of re-application of pressure – barrier release or client controlled;
4. the effects of breathing on pain control related to the increase in pressure during NMT;
5. research is needed to investigate the optimal duration of NMT.

The remainder of this chapter will outline a research proposal for the implementation of research to fill these gaps within the research. The following research proposals will be included below:

1) A Project Proposal – A Study to assess the Efficacy and Effectiveness of 'Barrier Release' NMT and 'Client – Modulated' NMT in the treatment of trigger points within the Upper Trapezius Muscle.

2) A Project Proposal to Compare the Effects of Ischaemic Compression, Trigger Point Therapy, Activator Trigger Point Therapy Techniques to Determine the most effective technique in the treatment of Trigger Points.
Project Proposal

A study to assess the efficacy and effectiveness of 'Barrier Release' NMT and 'Client Modulated' NMT in the treatment of trigger points within the upper trapezius muscle.

Methodology

Participants

The participants chosen would be a group of symptomatic individuals, all with similar occupations either all office workers or those with a manual occupation, not a combination of both due to the different demands placed on the body from a variety of occupations.

Interventions

The interventions used will be designed to assess the effectiveness of either 'barrier controlled' NMT or 'client controlled' NMT.

Barrier Controlled NMT

This intervention will apply the following intervention -

1) Prepare area for treatment,
2) Locate trigger point ('knot').
3) Apply tolerably painful persistent manual pressure; usually with the thumb or fingertip, against the tissue barrier until the client reports the sensation of pressure turning to that of pain.
4) Hold this pressure until the clinician feels a 'release' of the tissue barrier.
5) Reapply pressure to the area until the tissue barrier is again felt or the client reports feelings of pressure turning to pain.

6) Complete until all resistance is eliminated.

Client Controlled NMT

1) Prepare area for treatment

2) Locate trigger point ('knot')

3) Apply a tolerably painful persistent manual pressure until the client reports the discomfort turns to that of pain - pain being 7/10 on a client's pain scale - 1 = no pain and 10 = Worst pain.

4) Hold this pressure until the client reports the pain has decreased to a 2 or 3/10 on the same pain scale.

5) Re-apply the pressure until the client again reports 7/10 on the same pain scale.

6) Repeat x3

Sham Ultrasound

The subject will be informed that a pulsed ultrasound will be used: that they should not feel any sensation of pain or heat and that, if this was felt, to let the clinician know and the machine would be turned down. Since this is a sham procedure, such an adjustment made no actual difference. Ultrasound lotion was applied to over the located trigger point and the ultrasound head was moved slowly over the trigger point for 2 minutes. The machines integrated timer was used to alert the clinician when 2 minutes had elapsed. (Blikstad and Gemmell, 2008)
**Outcome Measures**

The outcome measures will be the clients VAS and PPT as measured with a PA. This will be measured pre- and post-intervention to see if the clients’ pressure pain threshold increased post-intervention and the VAS scores decrease post-intervention. These measures will allow comparison to previous literature. Further functional outcome measures as mentioned in discussion will be added so that the previous subjective measures can be compared to objective and performance measures. Functional performance measures such as strain gauge and/or algometer measured Active, Passive or Strength tests or sport-specific trials should be considered.

**Procedure**

On day 1 the subject will enter the treatment room, and the examiner will locate an active trigger point in the upper trapezuis muscle. This trigger point will then be palpated by the examining researcher and with a PA, pressure will be applied to the trigger point and the score will be recorded once the client states that the feelings of pressure have turned into that of pain. The location of the examined trigger points will be marked on the skin so that the treatment research treats the points examined, and so that the examining researcher re-assesses the identical location. This is recorded as their baseline PPT. The client will also record their baseline VAS and this will be recorded for comparison. Also functional/performance baselines The examining researcher will randomly select a sealed envelope with the intervention to be applied enclosed and the subject will then be treated as per one of the three interventions (Barrier/Client/Sham) as indicated by the enclosed instruction.
Treatment will be applied the treatment researcher so that the examining researcher is blind to the treatment imposed. Post-intervention scores will then be recorded for comparison, by the examining researcher.

**Project Proposal**

A study to Compare the Effects of Ischaemic Compression, Trigger Point Therapy, Activator Trigger Point Therapy Techniques to Determine the most effective technique in the treatment of Trigger Points

**Background**

Within the introduction to this study, it was stated that 'the lack of clarity described above begins with the language that is used to identify this technique within the current research. Neuromuscular techniques have also been referred to as Trigger Point Therapy, Myofascial Trigger Point Release Therapy, Manual Pressure Release, and Ischemic Compression; thus adding to the difficulties in reviewing the research which may underpin this technique. Throughout this study we will refer to these techniques collectively as Neuromuscular Technique (NMT) for clarity'. In order for these techniques to be compared a study will need to be carried out in order to assess the effects of such techniques beyond placebo. In order to address whether these techniques are comparable, a study needs to be carried out in order to determine this.
Methodology

Design of the Study

A repeated measures design leading to a 2-way (intervention x time of measure), 4 x 2 (3 NMT-type techniques + sham x pre/post), factorial (within x within) ANOVA will be used to compare the effects of: Ischemic Compression, Trigger Point Pressure Release and Activator Trigger Point therapy against a control session will be added so that the previous subjective measures can be compared to objective and performance measures of sham ultrasound.

Interventions

Sham Ultrasound

See Sham Ultrasound Intervention above.

Ischemic Compression

Location of the trigger point is determined; the therapist then gradually increases pressure to the trigger point until the sensations of pressure became that of pressure and pain. At that moment, the pressure was maintained until the discomfort and/or pain eased by around 50%, perceived by the own patient, at which time pressure was increased until discomfort appeared again. This process was repeated for 90s, (Fernandez-de-las-Penas et al, 2006).

Trigger Point Pressure Release

Trigger point therapy will be administered by a activator-adjusting instrument (AAI) this is a hand held device that delivers controlled and reproducible
forces over the trigger point area. The trigger point will be treated with the AAI using 10 thrusts at a rate of one thrust per second.

*Outcome measures*

The outcome measures for this proposal will be as per proposal above.

*Procedure*

The Procedure will be replicated as above.

*Further proposed studies*

The studies proposed below also draw upon the areas highlighted in the results section of this study as areas where more research is needed for clarification. The design principles from above will be replicated with the major changes being in the independent variables as will be highlighted below – primary NMT intervention used below will be determined by outcomes of the projects above.

*Rate of Decay*

The study will be carried out replicating the above procedure, however the independent variables will differ to the study highlighted above, and in this instance should include: differing times when dependent variables (outcome measures) are re-recorded such as 2, 5, 10 and 20 minutes post intervention to assess the rate of decay for the NMT technique used which will be determined by outcomes of the projects above.
Effects of breathing

The study will be carried out as above – with the independent variables being - the techniques used with and without the use of breathing to control the pain/discomfort from the re-application of pressure. This will help to determine whether the final 'gold – standard' NMT technique should include this type of breathing control.

7 second test

The study will be carried out as above – with the independent variables being - the inclusion of the 7 second test to the protocol, compared with that of a protocol with out the use of the 7 second test.

5.2 Summary

In conclusion, the research that is available within the field of Neuromuscular Techniques is currently inconsistent and lacking clarity, therefore more research is needed in the area in order to ‘fill in’ the gaps in the literature. Without a fully complete and methodologically sound evidence base, Universities within the UK are not able to effectively adopt an evidence based teaching practice. The proposals and templates highlighted above are recommended to be put into place to go some way to fill these areas where research is lacking so that Sports Therapy researchers are able to drive our understanding of NMT forward.

Research in the field of Neuromuscular Techniques needs to maintain methodological rigour in order to produce valid and reliable results. The
template created within this research can provide a platform, not only for Neuromuscular technique research to be developed but can also be adapted for other manual therapy techniques such as Positional Release and Soft Tissue Release Techniques – that are also lacking in a sound evidence base to give a structured research plan to drive the evidence base that surrounds these manual therapy techniques forward. This will also help clinicians to determine which technique is the most effective for the greatest clinical improvements and will also provide teachers in manual therapy techniques a sound evidence base from which to draw information and to adopt an evidence based practice approach to teaching.
Appendix 1 – Letter to institutions

This is a copy of the letter that was sent in e-mail format to the institutions that met the criteria:

My name is Emma Langham and I am currently undertaking a MSc by Research at the University of Bedfordshire. The aims of my research project will be to survey the provision of manual therapy techniques taught within UK University sports therapy programmes and secondly to examine the current evidence supporting the use of a selection of these techniques. By embarking on this project I hope to record the range and in addition, review the scientific evidence that underpins the techniques taught within sports therapy programmes.

Accordingly, I am writing to ask if you will provide a list of those manual techniques which are considered beyond the basic massage skills (such as neuromuscular and muscle energy techniques, etc), and a second list of the current core texts that you are using to support the delivery of these techniques.

May I assure you that my aim is not to audit or to 'borrow' curriculum content from any institution - my interests are purely research driven and the results of my investigation will be made available to all contributing institutions at their request. Further to this, a bound copy of the dissertation will be registered with the British Library as per normal procedures.

If you have any enquiries about the above request please feel free to contact myself on emma.langham@beds.ac.uk, my Director of Studies – Mr Peter Sheard on peter.sheard@beds.ac.uk 01234 400 400 ext 2637, or my project supervisor Mr Tim Paine on tim.paine@beds.ac.uk

I would like to take this opportunity to thank you in advance for your co-operation and please see the attached proposal for your information.

Please let me know if you would like to receive the final copy of this project for your records.

Respectfully

Emma Langham
<table>
<thead>
<tr>
<th>University</th>
<th>MET PIR</th>
<th>MET RI</th>
<th>NMT</th>
<th>Mulligans(SNAGS ETC)</th>
<th>Maitland</th>
<th>SCS</th>
<th>STR</th>
<th>McKenzie</th>
<th>Trigger point therapy</th>
<th>CTM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edgehill University</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Leeds Metropolitan University</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St Marys University</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Bedfordshire</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University College Birmingham</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Bolton</td>
<td>x</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>x</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Central Lancashire</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Chichester</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Hull</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Middlesex</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Salford</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Teeside</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of the West of England</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Winchester</td>
<td>x</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UWIC</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Appendix 2 – Table of Techniques

The results of the initial e-mail survey were placed into a table to demonstrate the range of techniques taught within the UK Sports Therapy Curricula:
|                               | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|-------------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Edgehill University           |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Leeds Metropolitan University | n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a|
| London Metropolitan University | x |   |   |   |   |   |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| St Marys University           |   |   |   |   |   |   |   |   |   | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  |
| University of Bedfordshire    |   |   |   |   |   |   |   |   |   | x  | x  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| University College Birmingham | n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a|
| University of Bolton          |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| University of Central         | x | x | x | x | x | x | x | x | x | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  |
| Lancashire                    |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| University of Chichester      | n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a|
| University of Hull            | n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a|
| University of Middlesex       |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| University of Salford         |   | x |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| University of Teeside         | n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a|
| University of the West of      |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| England                       |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| University of Westminster     | x | x | x |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| UWIC                          | n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a| n/a|

**Appendix 3** – Table of Reading Material used within Sports Therapy UK Curricula
### Appendix 3 – Table of Reading Material used within Sports Therapy UK Curricula Continued....
<table>
<thead>
<tr>
<th></th>
<th>49</th>
<th>50</th>
<th>51</th>
<th>52</th>
<th>53</th>
<th>54</th>
<th>55</th>
<th>56</th>
<th>57</th>
<th>58</th>
<th>59</th>
<th>60</th>
<th>61</th>
<th>62</th>
<th>63</th>
<th>64</th>
<th>65</th>
<th>66</th>
<th>67</th>
<th>68</th>
<th>69</th>
<th>70</th>
<th>71</th>
<th>72</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edgehill University</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leeds Metropolitan</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>London Metropolitan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University College</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Bedford</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Chiche</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>University of Hull</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Middle</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Salford</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Teeside</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>University of the W</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Westmi</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UWIC</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Appendix 3** – Table of Reading Material used within Sports Therapy UK Curricula Continued....
<table>
<thead>
<tr>
<th>University</th>
<th>73</th>
<th>74</th>
<th>75</th>
<th>76</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edgehill University</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leeds Metropolitan</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>London Metropolitan University</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St Marys University</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>University of Bedfordshire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University College Birmingham</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>University of Bolton</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Central Lancashire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Chichester</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>University of Hull</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Middlesex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Salford</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Teeside</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>University of the West of England</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Westminster</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UWIC</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

**Appendix 3** – Table of Reading Material used within Sports Therapy UK Curricula Continued....
Appendix 4 – Reading Material References


84


85


43. Shultz, (2005) Examination of Musculoskeletal Injuries Human Kinetics

46. NASM Kinetic Chain Assessment Video. NASM
47. NASM Neuromuscular Stretching Video
50. Jennings Myofascial Release: Complete Study Guide Package
51. Myers Anatomy Trains Churchill Livingstone


### Appendix 5 - Characteristics of Excluded Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simons &amp; Dommerholt (2006)</td>
<td>This study was excluded on the grounds that it was a review of current research, and the scope of this research was to review studies of an experimental nature.</td>
</tr>
<tr>
<td>Simons (2008)</td>
<td>This study was excluded on the grounds that it was a review of current research, adding commentary and highlighting new views on the etiology and diagnosis of Trigger points. The scope of this research highlights the use of only studies with an experimental design</td>
</tr>
<tr>
<td>Shah et al (2008)</td>
<td>Biochemicals associated with pain and inflammation are elevated in sites near to and remote from active myofascial trigger points. This is a review article and not within the scope of this research</td>
</tr>
<tr>
<td>De-las-Peñas (2005)</td>
<td>This study was excluded on the grounds that it was a review of current research, and the scope of this research was to review studies of an experimental nature.</td>
</tr>
<tr>
<td>Simons (2004)</td>
<td>A review of enigmatic MTrPS as a common cause of enigmatic musculoskeletal pain and dysfunction - This study was excluded on the grounds that it was a review of current research, and the scope of this research was to review studies of an experimental nature.</td>
</tr>
<tr>
<td>McPartland (2004)</td>
<td>This study was excluded on the grounds that it was a review of current research, and the scope of this research was to review studies of an experimental nature.</td>
</tr>
<tr>
<td>Study</td>
<td>Reason for Exclusion</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Huguenin (2004)</td>
<td>Review of Current Evidence - This study was excluded on the grounds that it was a review of current research, and the scope of this research was to review studies of an experimental nature.</td>
</tr>
<tr>
<td>DeLany (2007)</td>
<td>This Study was rejected due to the lack of experimental design of this paper</td>
</tr>
<tr>
<td>Gross et al (2002)</td>
<td>A Systematic Review – manual therapy for mechanical neck disorders. This Study was rejected due to the lack of experimental design of this paper</td>
</tr>
<tr>
<td>Study</td>
<td>Reason for Exclusion</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tough et al (2007)</td>
<td>Variability of criteria used to diagnose myofascial trigger point pain syndrome – evidence from a review of the literature</td>
</tr>
<tr>
<td>Baldry (2002)</td>
<td>Management of Myofascial Trigger point pain – Based on a lecture given at the BMAS spring scientific meeting, Bournemouth.</td>
</tr>
<tr>
<td>De-las-Peñas (2006)</td>
<td>Rejected on the grounds that this paper is a pilot Study.</td>
</tr>
<tr>
<td>Sciotti (2001)</td>
<td>A Study into the clinical precision of identifying trigger points – not in the scope of this research.</td>
</tr>
<tr>
<td>Farrar et al (2001)</td>
<td>A study into the clinical importance of changes in chronic pain intensity measured on an 11 point numerical rating scale – not in the scope of this research.</td>
</tr>
<tr>
<td>Salaffi et al (2004)</td>
<td>A study into the clinical importance of changes in chronic pain intensity measured on a numerical rating scale – not in the scope of this research.</td>
</tr>
<tr>
<td>Study</td>
<td>Reason for Exclusion</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Simons (2004)</td>
<td>A review of MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction – not in the scope of this research.</td>
</tr>
</tbody>
</table>
Studies Excluded after PEDro Criteria was applied

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for Exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brön 2007</td>
<td>Randomised study comparing treatment of myofascial trigger points in common shoulder disorders. Excluded based on PEDro score of 5.</td>
</tr>
<tr>
<td>De-las-Peñas 2006</td>
<td>Excluded based on a PEDro score of 3.</td>
</tr>
<tr>
<td>Study</td>
<td>Improved ROM</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Bron, et al. (2007)</td>
<td></td>
</tr>
<tr>
<td>Bilkstad &amp; Gemmell (2008)</td>
<td></td>
</tr>
</tbody>
</table>

**Appendix 6.1 – Condition to Treat**

94
<table>
<thead>
<tr>
<th>Study</th>
<th>Improved ROM</th>
<th>Improved Posture</th>
<th>Restore Function</th>
<th>Normal Decrease Sensitivity</th>
<th>Pain/ Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* aims of treatment -</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>restore normal function</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>reduce pain</td>
<td></td>
</tr>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td></td>
<td></td>
<td></td>
<td>* application of technique can decrease sensitivity in the area</td>
<td></td>
</tr>
<tr>
<td>Chaitow (1988)</td>
<td></td>
<td></td>
<td></td>
<td>* application of technique can decrease sensitivity in the area</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The use of NMT can improve posture</td>
<td>The aims of NMT are to restore/improve function</td>
</tr>
<tr>
<td>Fernandes De-la-penas (2007)</td>
<td></td>
<td></td>
<td></td>
<td>* aims of treatment -</td>
<td>* Sensitivity reduced from ischemic compression</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>restore normal function</td>
<td></td>
</tr>
</tbody>
</table>

Pilot Study- effects of ischemic compression on MTrPs, testing pressure pain threshold (PPT), and a visual analogue scale. Findings - significant improvement in the PPT (P=0.03) and a sig. decrease in visual analogue scores (P=0.04). Ischemic compression and transverse frictions were equally effective in reducing tenderness in MTrPs.

The Effect of manual pressure release on MTrPs in upper traps. Measurements of perceived pain thresholds (PPT) were taken pre and post intervention. A significant reduction in PPT and significant increase in tolerance to pressure (P=<0.001) caused by change in tissue sensitivity.

A blinded, controlled study - Active trigger points are more frequent in neck pain patients than in healthy subjects (P=<0.001). The prevalence of latent MTrPs are similar in neck pain and healthy subjects. No sig (P=>0.05)

Appendix 6.1 - Condition to treat - continued
<table>
<thead>
<tr>
<th>Study</th>
<th>Improved ROM</th>
<th>Improved Posture</th>
<th>Restore Normal Function</th>
<th>Normal Decrease Sensitivity Pain/</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fernandes De-la-penas (2005)</td>
<td></td>
<td></td>
<td>*Restore normal function</td>
<td>* aims of treatment – reduce pain</td>
<td>A systematic review of manual therapy in MTrP treatment – no rigorous evidence that some manual therapies have an effect beyond placebo, some studies reviewed confirmed that MTrP treatment is effective in reducing pressure pain threshold. More randomised controlled trials needed.</td>
</tr>
<tr>
<td>Ward (2004)</td>
<td>Trigger points cause restriction in ROM around joints – CAUSE/EFFECT</td>
<td></td>
<td></td>
<td></td>
<td>Latent myofascial trigger points and their effects on muscle activation and movement efficiency. Treatment to remove trigger points normalized muscle activation patterns – Surface EMG was used.</td>
</tr>
</tbody>
</table>

Appendix 6.1 - Condition to treat - continued
<table>
<thead>
<tr>
<th>Study</th>
<th>Treatment of Tender/trigger points</th>
<th>Reduction of Hypertonic Muscles</th>
<th>Restoration of M/S Balance</th>
<th>Reduction Of Ischemia</th>
<th>Restoration of flexibility</th>
<th>Measured outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bron, et al.(2007)</td>
<td>MTrPs may be inactivated by manual techniques such as compression on the trigger point.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Treatment of Myofascial trigger points in common shoulder disorders by physical therapy – Randomised Controlled Trial - No results, only a project proposal</td>
</tr>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td>* Manual Pressure release is one of a number of advocated therapies for the treatment of Trigger points.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The Effect of manual pressure release on MTrPs in upper traps. Measurements of perceived pain thresholds (PPT) were taken pre and post intervention. A significant reduction in PPT and significant increase in tolerance to pressure (P=\textless0.001) caused by change in tissue sensitivity.</td>
</tr>
</tbody>
</table>

Appendix 6.1 - Condition to treat continued
<table>
<thead>
<tr>
<th>Study</th>
<th>7 (5/10) Second Test Responses</th>
<th>Apply Pressure to MTrP</th>
<th>Pressure to 7/10</th>
<th>Re-apply pressure 7/10?</th>
<th>Pressure maintained until pain decreases by 50%</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td>* Applying tolerable but painful (how much?) persistent manual pressure (with the thumb or fingertip) against the tissue housing MTrP</td>
<td>* Use of pain scale – 7/10 reduced to 3/10...</td>
<td>...then re-apply to 7/10</td>
<td>* Pressure maintained until pain eased by 50% perceived by patient.</td>
<td>Pilot Study- effects of ischemic compression on MTrP, testing pressure pain threshold (PPT), and a visual analogue scale. Findings – significant improvement in the PPT(P=0.03) and a sig. decrease in visual analogue scores (P=0.04) Ischemic compression and transverse frictions were equally effective in reducing tenderness in MTrPs.</td>
<td></td>
</tr>
<tr>
<td>Fernandes De-las-Penas et al (2006)</td>
<td>* Gradual increase in pressure over MTrP until pressure/pain is felt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ward (2004)</td>
<td>Pressure that Increases Pain should be abandoned</td>
<td>* Direct, continuous or intermittent pressure (ischemic compression) over associated muscle may reduce symptoms</td>
<td>Pressure increased gradually as pain dissipates</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Appendix 6.2 - Application of Technique

98
<table>
<thead>
<tr>
<th>Study</th>
<th>7 (5/10) Second Test and Responses</th>
<th>Apply Pressure to MTrP</th>
<th>Pressure to 7/10</th>
<th>Re-apply pressure 7/10?</th>
<th>Pressure maintained until pain decreases by 50%</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>DeLany (2007)</td>
<td>Once Tender/trigger point is located, pressure is applied for a brief period of time. The patient should then be asked to report on his/her sensations - local tenderness decreases (positive response) - the local and referred pain are unchanged (positive) - local and referred pain increase (negative)</td>
<td>Pressure is gradually applied to the point, during this time the client should experience 'significant' discomfort/pain at trigger point site and/or referred areas.</td>
<td>Apply pressure to 7/10 on clients perceived pain scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Simons (2002)</td>
<td>Compression and release allows sarcomeres to return to shortened position where little can be gained. However, if gentle constant pressure is applied this would help sarcomeres return to new lengths</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Understanding effective treatment of myofascial trigger points - A review of literature?</td>
</tr>
<tr>
<td>Gemmel et al (2007)</td>
<td>Apply non-painful slowly increasing pressure with the thumb over the TrPt until tissue barrier felt</td>
<td>Pressure then increased until new barrier was reached</td>
<td></td>
<td></td>
<td>A randomised control trial – Immediate effect of ischemic compression and TrPt release on neck pain – Clinical improvement – a 20mm or more reduction on the visual analogue scale. Subjective feeling, ischemic compression is superior to sham ultrasound but more investigation into ischemic compression vs trigger point pressure release.</td>
<td></td>
</tr>
</tbody>
</table>

99
Appendix 6.2 Application of Technique – continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Repeat for 90's</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td>Pressure sustained for 60 seconds</td>
<td>The Effect of manual pressure release on MTrPs in upper traps. Measurements of perceived pain thresholds (PPT) were taken pre and post intervention. A significant reduction in PPT and significant increase in tolerance to pressure (P= &lt;0.001) caused by change in tissue sensitivity.</td>
</tr>
<tr>
<td>Fernandes De-las-Penas et al (2006)</td>
<td>*Repeat for 90's</td>
<td>Pilot Study- effects of ischemic compression on MTrP, testing pressure pain threshold (PPT), and a visual analogue scale. Findings – significant improvement in the PPT(P=0.03) and a sig. decrease in visual analogue scores (P=0.04) Ischemic compression and transverse frictions were equally effective in reducing tenderness in MTrPs.</td>
</tr>
<tr>
<td>Gemmel et al (2007)</td>
<td>Repeat until no tension remains or 90’s whichever 1st</td>
<td>A randomised control trial – Immediate effect of ischemic compression and trp release on neck pain – Clinical improvement – a 20mm or more reduction on the visual analogue scale. Subjective feeling. Ischemic compression is superior to sham ultrasound but more investigation into ischemic compression vs trigger point pressure release.</td>
</tr>
</tbody>
</table>

Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction – review of literature??
<table>
<thead>
<tr>
<th>Study</th>
<th>Ischemic Compression</th>
<th>GTO</th>
<th>Sarcomere Equalization</th>
<th>Endorphin Release</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>De-las-penas et al (2006)</td>
<td>Reactive hyperaemia for relief of muscle spasm??</td>
<td>...Or spinal reflex mechanism</td>
<td>* Local pressure may equalize sarcomere length and in return reduce sensitivity. - Referenced from Simons (1999)</td>
<td></td>
<td>Pilot Study- effects of ischemic compression on MTrP, testing pressure pain threshold (PPT), and a visual analogue scale. Findings – significant improvement in the PPT(P=0.03) and a sig. decrease in visual analogue scores (P=0.04) Ischemic compression and transverse frictions were equally effective in reducing tenderness in MTrPs.</td>
</tr>
<tr>
<td>Simons.D. (1999)</td>
<td><strong>Contradictory</strong> – Seems no need to apply excessive force provoking additional ischemia in a point already suffering with severe hypoxemia.</td>
<td></td>
<td>*Local pressure may equalize sarcomere length and in return reduce sensitivity.</td>
<td></td>
<td>Understanding effective treatment of myofascial trigger points - A review of literature??</td>
</tr>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td>Pain reduction in MTrP following manual pressure release may result from reactive hyperaemia due to counter irritant effects...</td>
<td>...Or a spinal reflex mechanism that may produce reflex relaxation of involved muscle</td>
<td>* There is evidence that the palpable TrP bands and nodules are a result of local bulging and shortening of sarcomeres in muscle fibres to produce 'contraction knots'. (SIMONS 1999) Mense et al (2003) - manual pressure to the 'knot' has been proposed to reduce the height of sarcomeres ad causes concomitant lengthening of the sarcomeres in muscle fibres</td>
<td></td>
<td>The Effect of manual pressure release on MTrPs in upper traps. Measurements of perceived pain thresholds (PPT) were taken pre and post intervention. A significant reduction in PPT and significant increase in tolerance to pressure (P=&lt;0.001) caused by change in tissue sensitivity.</td>
</tr>
<tr>
<td>Gemmel, Miller &amp; Nordstrom (2007)</td>
<td>Ischemic compression over TrP with thumb for 30s-1min decreased tension</td>
<td>Sarcomere normalisation – and balance between hyper-contracted and overstretched sarcomeres is restored.</td>
<td></td>
<td></td>
<td>No statistical difference – clinical significance, Patients treated with Ischemic compression were 5x more likely to improve that those with sham Ultrasound</td>
</tr>
<tr>
<td>Bron et al (2007)</td>
<td>MTrPs may be inactivated by manual techniques such as compression on the trigger point</td>
<td></td>
<td></td>
<td></td>
<td>Treatment of Myofascial trigger points in common shoulder disorders by physical therapy – Randomised Controlled Trial - No results, only a project proposal</td>
</tr>
<tr>
<td>Delany (2007)</td>
<td>Ischemia may lead to trigger point production</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Appendix 6.3 – Rationale**

101
<table>
<thead>
<tr>
<th>Study</th>
<th>Alterations In Consistency</th>
<th>Local Tenderness</th>
<th>Local Response</th>
<th>Twitch</th>
<th>Jump Sign</th>
<th>Taut Band of Tissue</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bron et al (2007)</td>
<td></td>
<td>* Defined as exquisitely tender spots</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>* tender spots in taut band of hardened muscle tissue</td>
</tr>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td></td>
<td>* Inclusion criteria for MTrPs include a palpable tender spot in the neck or upper back</td>
<td>* Local twitch response provoked by snapping palpation of the taut band</td>
<td></td>
<td></td>
<td></td>
<td>The Effect of manual pressure release on MTrPs in upper traps. Measures of perceived pain thresholds (PPT) were taken pre and post intervention. A significant reduction in PPT and significant increase in tolerance to pressure (P=&lt;0.001) caused by change in tissue sensitivity.</td>
</tr>
<tr>
<td>Hanten (2000)</td>
<td></td>
<td>* Inclusion criteria for MTrPs include a palpable tender spot in the neck or upper back</td>
<td>* Jump present</td>
<td></td>
<td>* and a jump sign characterised by patient vocalisation or withdrawal</td>
<td>Trigger point within a taut band of tissue</td>
<td>Subjects in treatment group were found to have significantly decreased perceived pain and pressure pain threshold in comparison to the control.</td>
</tr>
<tr>
<td>Delany (2007)</td>
<td></td>
<td>Trigger points are localized areas within muscle belliesot myotendinous attachments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pilot Study - effects of ischemic compression on MTrP, testing pressure pain threshold (PPT), and a visual analogue scale. Findings - significant improvement in the PPT (P=0.03) and a sig. decrease in visual analogue scores (P=0.04) Ischemic compression and transverse frictions were equally effective in reducing tenderness in MTrPs.</td>
</tr>
</tbody>
</table>

**Appendix 6.3 - Rationale**

102
### Study

<table>
<thead>
<tr>
<th>Study</th>
<th>Alterations In Consistency</th>
<th>Local Tenderness</th>
<th>Local Response</th>
<th>Twitch</th>
<th>Jump Sign</th>
<th>Taut Band of Tissue</th>
<th>Measured Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gerwin (2005)</td>
<td></td>
<td>Local tenderness over taut band</td>
<td></td>
<td></td>
<td></td>
<td>The usual description is that of a taut band</td>
<td>A review of myofascial pain and fibromyalgia – factors that promote their existence.</td>
</tr>
<tr>
<td>Tough et al (2007)</td>
<td></td>
<td>MTrPs are Hyper irritable points...</td>
<td>Local twitch response as one of 4 most commonly applied criteria for MTrp diagnosis</td>
<td></td>
<td></td>
<td>...within a taut band of skeletal muscle</td>
<td>Review of literature – Variability of criteria used to diagnose myofascial trigger point pain syndrome – Limited consensus, further research needed for reliability and validity of diagnostic criteria</td>
</tr>
<tr>
<td>Simons (2004)</td>
<td></td>
<td>Focal spot of muscle tenderness</td>
<td></td>
<td></td>
<td></td>
<td>Taut band</td>
<td>Review of enigmatic MTrPs as a common cause of enigmatic musculoskeletal pain and dysfunction – review of literature??</td>
</tr>
</tbody>
</table>

**Appendix 6.3 - Rationale**
<table>
<thead>
<tr>
<th>Study</th>
<th>Alterations In Consistency</th>
<th>Local Twitch Response</th>
<th>Jump Sign</th>
<th>Taut Band of Tissue</th>
<th>Local Tenderness only on palpation</th>
<th>Produced Pain but non-recognisable</th>
<th>Measured outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bron et al (2007)</td>
<td>*tender spots in taut band of hardened muscle tissue</td>
<td>* deep tenderness within a taut band of muscle tissue</td>
<td>Latent trigger points – pain will only occur in the application of external pressure</td>
<td>Latent – pain is produced upon palpation but is not recognisable to the client</td>
<td>Treatment of Myofascial trigger points in common shoulder disorders by physical therapy – No results, only a project proposal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hugenin (2003)</td>
<td>*they exhibit a local twitch response</td>
<td>* or a jump sign in response to digital pressure</td>
<td>Trigger point within a taut band of tissue</td>
<td></td>
<td>Subjects in treatment group were found to have significantly decreased perceived pain and pressure pain threshold in comparison to the control.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hanten (2000)</td>
<td>Jump sign present</td>
<td></td>
<td></td>
<td></td>
<td>Referral pattern is unusual for that patient, one he/she does not recognise as a daily occurrence. (all other characteristics are the same)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delany (2007)</td>
<td>Tenderness in a palpable taut band of tissue</td>
<td></td>
<td></td>
<td></td>
<td>Latent myofascial trigger points and their effects on muscle activation and movement efficiency. Treatment to remove trigger points normalized muscle activation patterns – Surface EMG was used.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lucas et al (2003)</td>
<td>within a taut band of skeletal muscle</td>
<td>Tenderness in a palpable taut band of tissue</td>
<td>tender on palpation</td>
<td>but Non symptom producing</td>
<td>Review of literature – Variability of criteria used to diagnose myofascial trigger point pain syndrome – Limited consensus, further research needed for reliability and validity of diagnostic criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tough et al</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Appendix 6.4 - Latent Trigger Points Definition**

104
<table>
<thead>
<tr>
<th>Study</th>
<th>Referred pain</th>
<th>Reproduction of Muscle Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bron et al (2007)</td>
<td>* that produces familiar symptoms</td>
<td>Active trigger points – may be associated with muscle weakness</td>
</tr>
<tr>
<td>Hugenin (2003)</td>
<td>* ... active trigger points are associated with referred pain</td>
<td>Patient will recognise pain for the reproduction of patients pain on palpation</td>
</tr>
<tr>
<td>Fryer &amp; Hodgson (2005)</td>
<td>Active trigger points - Produce referred pain</td>
<td>Reproduction of patients pain on palpation</td>
</tr>
<tr>
<td>Hanten (2002)</td>
<td>Active trigger points - Produce referred pain</td>
<td>An 'active ' trigger point is one whose referral pattern the patient recognises as his/her common pain/sensation.</td>
</tr>
<tr>
<td>Delany (2007)</td>
<td>...when sufficiently provoked the trigger point will produce a referral pattern.</td>
<td>Reproduction of the typical referred pain pattern of the MTTrP in response to compression</td>
</tr>
<tr>
<td>Tough et al (2007)</td>
<td>Active- producing the clinical pain complaint</td>
<td></td>
</tr>
<tr>
<td>Simons (2004)</td>
<td>Pressure-elicited referred pain pattern</td>
<td>Active – pressure elicits symptoms recognised as familiar</td>
</tr>
</tbody>
</table>

Appendix 6.5 - Active Trigger Points Definition

Also to include All Latent trigger point characteristics.
### Appendix 7 – Results of the PEDro Ratings

<table>
<thead>
<tr>
<th>Study</th>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>Total PEDro Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gemmell</td>
<td>2008</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Blikstad</td>
<td>2008</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Gam</td>
<td>1998</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Fryer</td>
<td>2005</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Hanten</td>
<td>2000</td>
<td>Y</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Bron</td>
<td>2007</td>
<td>Y</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Fernandes-de-las-penias</td>
<td>2006</td>
<td>Y</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>

- Studies included based on a PEDro score of 6 or above.

- Studies excluded based on PEDro score of 5 or below and the absence of concealed allocation to groups and the blinding of the subjects, both of which compromises the validity of their results.
Yellow are the PPT that will be put into meta-analysis

- The following will be considered NMT
  - Hanten IC + stretch
  - Fernandez IC
  - Gemmell IC

Blue are the VS that will be put into meta-analysis

- The following will be considered NMT
  - Hanten IC + stretch
  - Fernandez IC
  - Gemmell IC
  - Gemmell TPPR
  - Blikstad ACT

<table>
<thead>
<tr>
<th>Study</th>
<th>Measure</th>
<th>Comparison</th>
<th>n</th>
<th>mean</th>
<th>SD</th>
<th>n</th>
<th>mean</th>
<th>SD</th>
<th>ES</th>
<th>95% CI</th>
<th>Sig</th>
<th>Cohen</th>
<th>Direction</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanten</td>
<td>PPT</td>
<td>IC Stretch vs Stretch</td>
<td>20</td>
<td>1.2</td>
<td>1</td>
<td>20</td>
<td>-0.3</td>
<td>1.3</td>
<td>1.15</td>
<td>1.29</td>
<td>no</td>
<td>Large</td>
<td>IC &gt;</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>VAS</td>
<td>IC Stretch vs Stretch</td>
<td>20</td>
<td>-12.5</td>
<td>20.7</td>
<td>20</td>
<td>-1.9</td>
<td>16.4</td>
<td>-0.65</td>
<td>0.57</td>
<td>yes</td>
<td>Moderate</td>
<td>IC &gt;</td>
<td>40</td>
</tr>
<tr>
<td>Gemmell</td>
<td>PPT</td>
<td>IC vs TPPR</td>
<td>15</td>
<td>3.4</td>
<td>1.2</td>
<td>15</td>
<td>2.8</td>
<td>1.2</td>
<td>0.50</td>
<td>0.50</td>
<td>yes</td>
<td>Moderate</td>
<td>IC &gt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>PPT</td>
<td>IC vs Con</td>
<td>15</td>
<td>3.4</td>
<td>1.2</td>
<td>15</td>
<td>2.6</td>
<td>0.83</td>
<td>0.96</td>
<td>0.78</td>
<td>yes</td>
<td>Large</td>
<td>IC &gt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>PPT</td>
<td>TPPR vs Con</td>
<td>15</td>
<td>2.8</td>
<td>1.2</td>
<td>15</td>
<td>2.6</td>
<td>0.83</td>
<td>0.24</td>
<td>0.19</td>
<td>yes</td>
<td>Small</td>
<td>n/a</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>VAS</td>
<td>IC vs TPPR</td>
<td>15</td>
<td>41.3</td>
<td>7.8</td>
<td>15</td>
<td>43.6</td>
<td>8.8</td>
<td>-0.26</td>
<td>0.28</td>
<td>no</td>
<td>Small</td>
<td>IC &lt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>VAS</td>
<td>IC vs Con</td>
<td>15</td>
<td>41.3</td>
<td>7.8</td>
<td>15</td>
<td>38.1</td>
<td>8.8</td>
<td>0.36</td>
<td>0.38</td>
<td>no</td>
<td>Small</td>
<td>IC &gt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>VAS</td>
<td>TPPR vs Con</td>
<td>15</td>
<td>43.6</td>
<td>8.8</td>
<td>15</td>
<td>38.1</td>
<td>8.8</td>
<td>0.63</td>
<td>0.63</td>
<td>no</td>
<td>Small</td>
<td>n/a</td>
<td>30</td>
</tr>
<tr>
<td>Fernandez</td>
<td>PPT</td>
<td>IC vs TFM</td>
<td>20</td>
<td>0.4</td>
<td>0.19</td>
<td>20</td>
<td>0.35</td>
<td>0.09</td>
<td>0.56</td>
<td>0.34</td>
<td>yes</td>
<td>Moderate</td>
<td>IC &gt;</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>VAS</td>
<td>IC vs TFM</td>
<td>20</td>
<td>0.8</td>
<td>0.3</td>
<td>20</td>
<td>0.7</td>
<td>0.4</td>
<td>0.25</td>
<td>0.28</td>
<td>no</td>
<td>Small</td>
<td>IC &gt;</td>
<td>40</td>
</tr>
<tr>
<td>Blikstad</td>
<td>PPT</td>
<td>ACT vs MFB</td>
<td>15</td>
<td>3.4</td>
<td>1.8</td>
<td>15</td>
<td>3.2</td>
<td>0.84</td>
<td>0.24</td>
<td>0.14</td>
<td>yes</td>
<td>Small</td>
<td>IC &gt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>PPT</td>
<td>ACT vs Con</td>
<td>15</td>
<td>3.4</td>
<td>1.8</td>
<td>15</td>
<td>3.8</td>
<td>1.7</td>
<td>-0.24</td>
<td>0.23</td>
<td>yes</td>
<td>Small</td>
<td>IC &lt;</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>PPT</td>
<td>MFB vs Con</td>
<td>15</td>
<td>3.2</td>
<td>0.84</td>
<td>15</td>
<td>3.8</td>
<td>1.7</td>
<td>-0.35</td>
<td>0.45</td>
<td>no</td>
<td>Small</td>
<td>n/a</td>
<td>30</td>
</tr>
</tbody>
</table>

Appendix 8 – table to show Data Used for Meta-analysis