The relation between thoracic paraspinal tissues and pressure sensitivity measured by a digital algometer

The relationship between palpation of thoracic paraspinal tissues and pressure measured by a digital algometer

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ABSTRACT

Segmental paraspinal tissue texture change has been proposed to be an important diagnostic sign of intervertebral somatic dysfunction. The nature and existence of these regions is speculative. The aim of this study was to examine whether deep, medial, paraspinal regions identified as having abnormal texture by palpation are confirmed as being more sensitive to pressure measured by a digital algometer. An osteopath examined the thoracic regions of 32 subjects (26 asymptomatic, six with mild thoracic symptoms) to detect an abnormal to palpation and tender (AbPT) site in each individual. Three non-tender and normal to palpation (NT) regions (immediately above, below and opposite the AbPT site) were also located. A digital pressure

algometer, also known as a Palpometer, consisting of a 0.86cm force-sensing resistor (polymer film) attached to the palpating fingertip, recorded the pressure applied during palpation. Pressure pain threshold (PPT) measurements were recorded for all sites, with both researcher and subject blinded to the reading on the algometer. The AbPT regions had a lower mean PPT than the three NT regions, and a one-way ANOVA determined these differences to be significant ($p < 0.01$). A Tukey post-hoc analysis revealed the significant differences to be between PPT scores for the AbPT location and all NT locations, but scores for the NT locations were not significantly different from each other. This study demonstrated that medial, paraspinal sites identified as having abnormal tissue texture and tenderness by palpation were significantly more tender than sites immediately above, below, and on the opposite side to the abnormal region. Further investigation of the nature of these AbPT sites is recommended.

Keywords: Palpation, algometry, somatic dysfunction, paraspinal, osteopathy

INTRODUCTION

Authors in the field of manual therapy have claimed that intervertebral somatic dysfunction (known also as segmental dysfunction in osteopathy, and analogous to the chiropractic subluxation and joint blockage or fixation described by other manipulating professions[1-7]) can be detected by skilled manual palpation.[1-4] In osteopathy, the diagnostic indicators of segmental dysfunction are said to be segmental asymmetry of bony landmarks, range of motion abnormality (increased, decreased or a change in quality), tissue texture change, and tenderness.[1, 2, 8] The acronym “TART” is sometimes used as a memory aid for the features of tissue texture change, asymmetry, range of motion abnormality and tenderness.[2, 8, 9]

Osteopaths commonly palpate for altered tissue texture in three distinct paraspinal regions: the medial paraspinal groove or “gutter”, which lies close to the spine between the vertebral spinous process in the midline and the erector spinae muscle group; the bulk of the erector spinae muscle group; and, more laterally, the iliocostalis muscle fibres overlying the angles of the ribs. Authors in the field of osteopathy have

reported that segmental tissue texture changes may include abnormal hardness, bogginess or ropiness of the underlying paraspinal muscles.[1, 2, 10] Many authors have claimed that hypertonicity of the deep paraspinal muscles, particularly rotatores and multifidus,[1, 2, 10-12] is a cardinal sign of intervertebral dysfunction, and can be palpated in the medial paraspinal groove.[1, 2] Greenman[1] stated that this tissue change is usually found unilaterally and reported as being tender by the patient. More laterally, palpable hypertonicity of the iliocostalis muscle at the rib angle is thought to be indicative of rib dysfunction.[1]

The reliability of the detection of intervertebral somatic dysfunction by palpation has not been established. Palpation for paraspinal tenderness has been demonstrated to be reliable,[13-16] whereas the other aspects of the TART criteria – palpation for static asymmetry and segmental motion – have so far proved to be unreliable.[17-21] The reliability for the detection of paraspinal tissue texture change (without reports of tenderness) has received little attention from researchers. Jull *et al.*[22] reported good concordance between examiners detecting symptomatic cervical joints (which included the assessment of abnormal tissue stiffness), when no verbal report of pain was allowed. Researchers who have investigated the reliability of detecting myofascial trigger points (taut bands of skeletal muscle that are tender on palpation and refer characteristic pain[23]) have reported varying results for the reliability of palpation of the taut band.[24-27]

The nature of any paraspinal tissue texture changes remains unknown. Osteopathic researchers and authors have speculated that these palpable changes may be due to sustained contraction of the deep paraspinal muscles,[28-31] but the evidence for this is weak.[32] Fryer[33, 34] and Fryer *et al.* [32, 35] have previously suggested that tissue changes detected with palpation could possibly be produced by sprain and inflammation of the underlying zygapophyseal joint. Alternatively, localised deep muscle atrophy (as seen in back pain patients)[36-38] may leave the underlying bony architecture more exposed to probing palpation.[35] Furthermore, these regions may be tender due to regional hyperalgesia associated with central sensitisation,[39, 40] and the texture change perceived by the osteopath may be due to examiner expectation and palpatory illusion.[41]

Paraspinal regions detected as abnormal to palpation and reported as tender (AbPT) may be examined by pressure algometry to confirm that the tissues are more sensitive to manual pressure. The pressure algometer is a pressure gauge that can be placed over a muscle or bony landmark and the pressure slowly increased. The amount of pressure is usually recorded at the pressure pain threshold (PPT), which is the level where the subject reports that the pressure changes to discomfort. The use and reliability of pressure gauges to determine PPTs on bony and muscle landmarks are well established.[42-45] Normal PPT values in the thoracic spine have also been determined.[46] Pressure algometry has been reported to have higher inter-examiner reliability than manual palpation in detecting tender sites in the neck and shoulder region.[47] Bendsten *et al.*[48, 49] described the use of a digital pressure algometer, which they named the "Palpometer". This device consisted of a force-sensing resistor (polymer film) attached to the palpating fingertip and connected to a meter that recorded the pressure applied to the instrument. The Palpometer was demonstrated to be a reliable instrument for measuring pressure during palpation.[48, 49]

In preliminary trials using a conventional electronic algometer (Somedic Algometer II, Sweden), the authors of the present study have been unable to establish reliable PPT measurements in the medial paraspinal groove. These tissues are deep, and palpation involved probing and searching for abnormal and tender regions. Examining these structures with the conventional algometer has not proved to be successful, because it has been difficult to guide the 1cm rubber tip to the precise deep location that was palpated (subjects reported that the tip of the algometer did not feel to be on the same spot that was palpated with the fingertips and repeated measures of PPTs have not been consistent). There are several potential advantages of the digital algometer. The algometer is attached to the palpating finger, so the pressure measured must refer to the area that is palpated. This measure is taken concurrently with palpation, so there is no risk of transitory variations in tissue texture affected reliability.

The aim of this study was to examine whether deep, medial, paraspinal regions, identified as having abnormal tissue texture by palpation and reported as tender by the subject, are confirmed as being more sensitive to pressure by pressure algometry. The study aimed to determine if paraspinal regions identified as AbPT with palpation had

a lower PPT than areas identified as normal and non-tender (NT). It was predicted that the mean pressure for AbPT regions would be significantly lower (i.e., less pressure to reach PPT) than the means for the NT regions. If it can be established that an examiner can identify AbPT regions that are determined to be tender by a technique (algometry) that is independent of the examiner, future studies can determine if these AbPT paraspinal regions demonstrate physiological or pathological features that distinguish them from otherwise equivalent NT regions.

METHODS

Subjects

Thirty-eight subjects (25 females, 13 males, age range: 19 - 37) were recruited from the student and staff population at Victoria University (VU). Thirty-two subjects were asymptomatic, whereas six reported mild thoracic pain or stiffness. Twenty-seven subjects reported having an episode of thoracic pain in the past. The procedures for this study were approved by the VU Human Research Ethics Committee and all subjects signed a standard consent form. Subjects were excluded from the study if the osteopath was unable to locate any AbPT regions, or if the subject was unable to lie comfortably in the prone position for 20 minutes. Six individuals (16%) were excluded because no AbPT regions could be located in their thoracic regions, leaving 32 to participate in the study.

Measures and Instruments

Manual palpation: Subjects were requested to lie prone on a treatment table, while an osteopath examined their medial thoracic paraspinal regions with palpation, using the first and second fingertips. Anecdotal evidence suggested there will often be one or two AbPT sites in the thoracic paraspinal region, even in asymptomatic subjects, and these regions may be small, specific spots most easily located using palpation. The osteopath attempted to locate the most marked region of tissue texture change (where the deep tissues appeared hard, lumpy or boggy).[1, 2, 10] Once the region was identified, the subject was asked if the site was tender on palpation, as would commonly be done in normal practice. To be designated as a AbPT site, the region

had to *both* appear abnormal to palpation and be reported as tender. When the osteopath located an AbPT region it was marked with a skin pencil, and three NT regions were then located and marked one segment above (NT1) and below (NT2) on the ipsilateral side, and on the opposite side at the same level (NT3) (Figure 1). If the ipsilateral NT regions were found to also be tender, a site one more segment above or below was chosen, although the researchers found they did not need to move to distal sites very often.

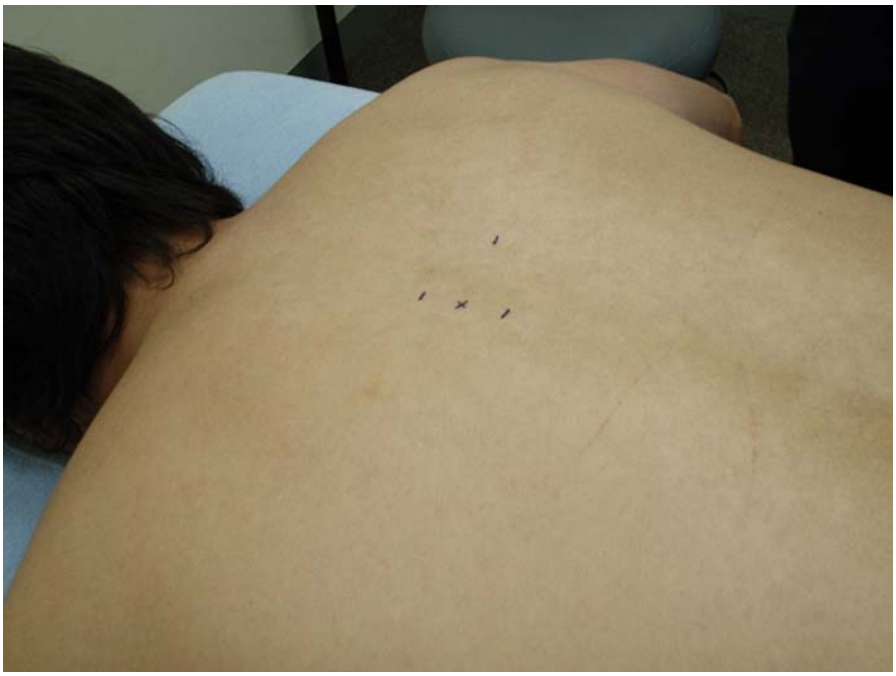

Figure 1: Thoracic medial paraspinal sites: AbPT (cross), NT above, below, opposite

Pressure pain threshold measurement: The digital algometer used in this study was modelled on the Palpometer algometer.[48, 49] A round, 0.86cm pliance® (novel, Munich) pressure sensor was attached to the pad of the osteopath's index finger (Figure 2). The sensor was connected to pedar® (novel, Munich) data collection hardware (Figure 3) and displayed on a computer monitor that was not in view of the osteopath. The pressure sensor was calibrated according to the manufacturer's specifications before data collection commenced.

Once the sites were identified with palpation, the osteopath, blinded to the algometer display, determined the PPT of each region three times. The PPT was the amount of

pressure where the subject reported that pressure changed to discomfort or pain (Figure 4). PPTs were later calculated using pliance® Cable Expert Online software.

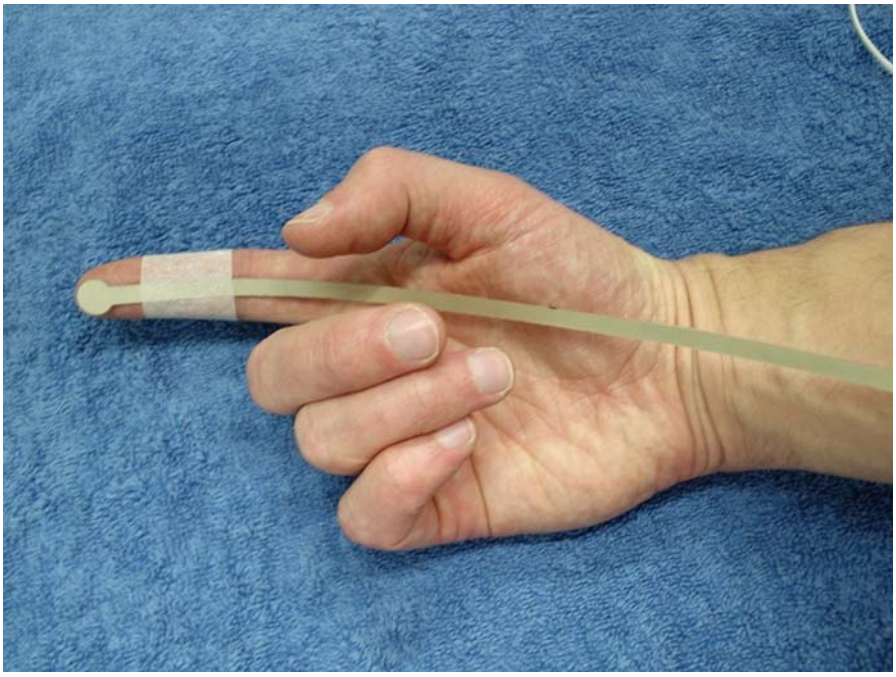

Figure 2: Digital algometer (pliance® sensor)

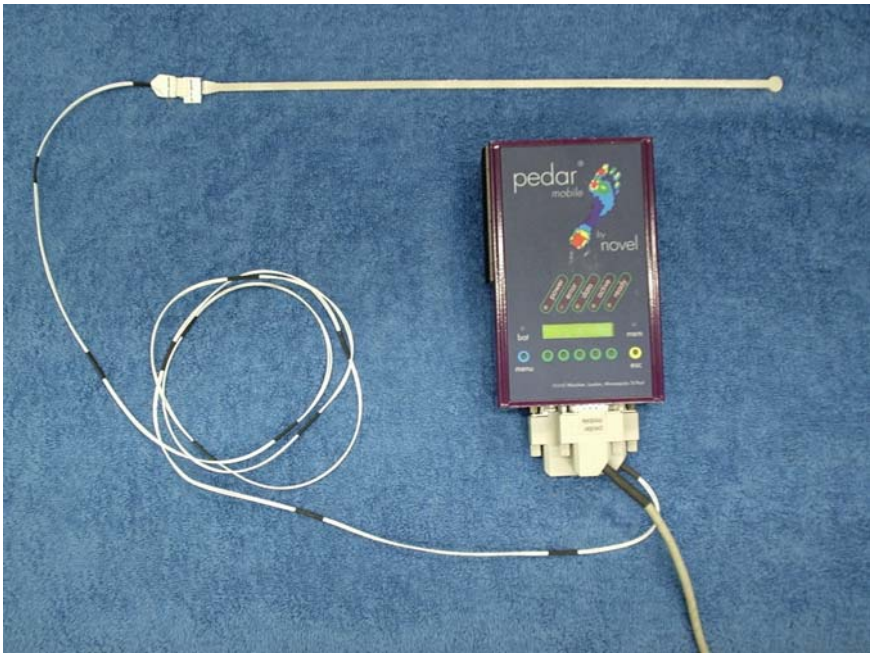

Figure 3: Digital algometer (pliance® sensor) and pedar® mobile (novel) unit

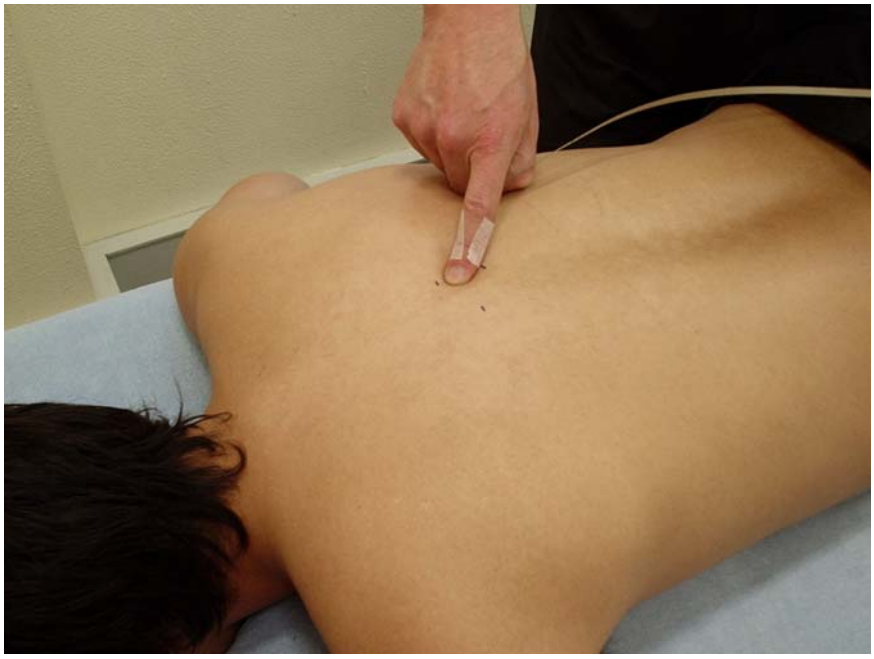

Figure 4: Pressure pain threshold measurement

Procedure

Thirty-two subjects, who were identified as having at least one AbPT site, were recruited from the student and staff population at VU. Subjects were requested to lie prone on a treatment couch for approximately 15 minutes, while thoracic palpation and PPT measurement were performed. The medial paraspinal thoracic regions of all subjects were examined by an experienced osteopath to detect and mark one AbPT and three NT regions. The examining osteopath was blinded to the readout of the digital algometer (which was recorded on a computer), and three PPTs for each region were measured and recorded using pliance® software. Debriefing followed the examination. Subjects' experiences and comments concerning the examination were recorded.

RESULTS

Reliability of Pressure Pain Threshold measurements

The Intra-class Correlation Coefficient (ICC, based on a one-way ANOVA) was calculated between algometer PPT readings 1, 2 and 3 to examine the reliability of the mechanical pain pressure threshold indicator. The Average Measure ICC = 0.952 (95% C.I.: 0.94 – 0.97; $F = 20.91$, $p < 0.01$) which indicated a high reliability for the three readings.

Comparison of Pressure Pain Threshold measurements for AbPT and NT sites

Descriptive statistics, including the means and standard deviations of algometer readings for all AbPT and NT sites, are presented in Table 1. The mean PPT for the AbPT location (7.80 N/cm2) was much lower than all the NT locations (11.68 – 12.98 N/cm2), and the standard deviations are not large in relation to the means. The differences in mean PPT between the AbPT and the NT1-3 sites were analysed using a one-way repeated measures ANOVA. The repeated measures factor had four levels, AbPT, NT1, NT2 and NT3. The ANOVA was found to be significant ($df = 3$, $F = 10.90$, $p < 0.01$), with a large effect size ($f = 0.58$). Cohen's conventions for effect sizes with ANOVA (Cohen's *f*) are 0.10 for a small effect, 0.25 for a medium effect, and 0.40 for a large effect size.[50] A Tukey post-hoc analysis revealed the significant differences to be between the AbPT site and all other sites. The NT sites were not significantly different from each other (Table 2).

Most subjects reported that the transition from pressure to pain during the measurement of PPT was obvious, and several commented that it was easier to determine this on the AbPT sites. A number of subjects commented that the AbPT region only appeared tender while the palpating fingertip was moving or rolling over the tissue, and did not appear tender on sustained pressure. The AbPT spots often proved to be very local and specific, and if the fingertip moved off the region slightly it did not feel the same to researcher or subject.

Table 1: Descriptive data for PPT means

	N	Mean	Std. Deviation
AbPT	32	7.79	2.879
NT above	32	12.98	4.569
NT below	32	11.68	4.182
NT opposite	32	12.66	4.515

Table 2: Post Hoc (Tukey) analysis of differences between groups

		Mean Difference	**Sig.**
REGION	REGION		
AbPT	NT above	-5.19*	.01
	NT below	-3.89*	.01
	NT opposite	-4.87*	.01
NT above	NT below	1.30	.58
	NT opposite	.33	.99
NT below	NT opposite	-.98	.78

* The mean difference is significant at the .01 level.

DISCUSSION

Authors in the field of osteopathy have proposed that segmental tissue texture change is an important diagnostic sign for intervertebral dysfunction, particularly when it is detected in the medial, paraspinal gutter.[1-4] Until now, there has been no investigation of whether these abnormal paraspinal sites have objective characteristics that differ from NT sites, or if the proposed tissue texture change is simply a result of palpatory illusion.[41] This study demonstrated that AbPT medial paraspinal sites – specific sites detected as abnormal based on palpation by the osteopath and reported as tender by the subject – were more tender than NT sites immediately above, below, and at the

same level on the opposite side to the abnormal region, as indicated by independent, mechanical pressure measurement.

In each subject, three PPT measurements were recorded for each site, and the means of the three readings were used for greater reliability, as recommended by other researchers.[42-46] Calculation of the ICC for these three readings demonstrated that they were strongly correlated, so it was concluded that the PPT measurement procedure was reliable. The AbPT sites had a lower mean PPT (less pressure was required to produce the first experience of pain), and analysis with a one-way ANOVA revealed the mean PPT readings to be significantly different from all other NT sites ($p < 0.01$), whereas the NT sites were not significantly different from each other.

The findings of this study are consistent with those of other studies that have demonstrated the reliability of palpation for tenderness.[13-16] The difference between those studies and the present one is that the report of tenderness in this study was secondary to the detection of tissue texture change. The osteopath located the abnormal tissue texture with palpation and then requested a confirmation of tenderness from the subject, before determining it to be an AbPT site. This reflected clinical practice, where anecdotal evidence has suggested that practitioners identify AbPT sites with little need for reports of tenderness.

A potential weakness of this study was that the researcher performed both the palpation and measurement of PPT, and was not blinded to the designation of the site to be measured. This was necessary given the difficulty a second researcher, blinded to the AbPT site, would have to re-locate and measure the exact AbPT site. Preliminary research indicated that AbPT sites were small discrete spots that required probing palpation, and re-location and measurement using a conventional algometer often failed to locate the same discrete region. For the purpose of measuring these precise locations, the digital algometer, which measured the pressure applied by the fingertip during the process of palpation, proved to be ideal.

This study examined the practice of palpation by one osteopath, and did not examine the inter-examiner reliability for detection of AbPT sites. Six volunteers (16%) were excluded because no AbPT sites could be located in their thoracic paraspinal regions.

During this study, it was noted that there were often multiple AbPT sites, which varied from being slightly apparent to very obvious. There was an attempt to locate the most obvious AbPT site for this study, providing that the regions immediately above and below did not also feel abnormal. Numerous AbPT sites of varying severity in an individual may confound any investigation of the inter-examiner reliability for palpation of these sites. For this reason, it was decided to examine whether a detected AbPT site was different from adjacent NT regions, rather than examine the reliability of palpation between examiners.

Of the 38 subjects that participated in this study, the majority were asymptomatic with only six subjects reporting mild thoracic pain or stiffness. Only six volunteers were excluded because the examiner could not locate an AbPT site. It is possible that if individuals were suffering from moderate to severe thoracic musculoskeletal pain (as is commonly seen in osteopathic practice), the differences between AbPT and NT sites would have been even more pronounced, and this warrants further investigation.

Because this study has demonstrated that deep paraspinal AbPT sites display some differences from NT sites, including sensitivity to pressure, and are not likely to be a result of practitioner imagination, the anatomical and pathological characteristics of these abnormal regions should be explored. Osteopathic authors and researchers have proposed these sites are a result of deep paraspinal muscle contraction,[1, 2, 10-12] but there is little evidence to support this.[32, 34] Denslow and Korr provided some evidence of paraspinal contraction associated with palpable paraspinal tissue change,[28, 29, 51-54] but their studies are over 50 years old and were, by today's standards, poorly described, with insufficient data reported and no statistical analysis. The pathological characteristics of paraspinal AbPT regions need re-investigation with electromyography. Such regions could be examined at rest, during quiet sitting and standing, and during dynamic movements to determine whether the muscles in these regions display higher or lower electrical activity compared to normal regions.

Several studies have demonstrated deep paraspinal (multifidus) muscle wasting associated with LBP. Hides *et al*.[36] used diagnostic ultrasound to study the cross-sectional area (CSA) of the lumbar multifidus muscles of 26 volunteers suffering from their first episode of unilateral acute/subacute LBP and 51 pain-free control subjects.

The symptomatic spinal level was determined on the basis of reproduction of the subject's pain on direct springing in conjunction with abnormal quality or quantity of tissue resistance to segmental motion. Hides *et al.* found marked wasting of multifidus on the symptomatic side, isolated to one vertebral level. They proposed that the wasting was not likely to be due to disuse atrophy because of the rapidity of onset and localised distribution. Multifidus atrophy has also been observed in patients with chronic LBP using MRI[37] and computer tomography.[38] It is feasible that deep muscle wasting could account for abnormal texture to palpation by exposing the underlying bony architecture to probing palpation. Future studies could investigate the cross-sectional area of paraspinal muscles in these regions using diagnostic imaging.[35]

Fryer[33, 34] has proposed that minor trauma could produce zygapophysial joint sprain, effusion, and associated peri-articular inflammation that may present as AbPT spots in the medial paraspinal gutter, particularly when the injury is acute. The only study that has examined zygapophysial joint effusion associated with cervical and lumbar pain found no evidence of inflammation, but these researchers did not examine acute patients.[55] The involvement of joint effusion and peri-articular inflammation in acute intervertebral dysfunction requires further investigation.

CONCLUSION

This study demonstrated that deep, medial, paraspinal regions identified with manual palpation to have abnormal texture and reported tenderness were more sensitive to pressure than surrounding regions. These abnormal and tender regions had a significantly lower mean pressure pain threshold than regions immediately above, below, and at the same level on the opposite side. The anatomical and pathological characteristics of these regions require further investigation.

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