

Original article

# The lumbar multifidus muscle and patterns of pain

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## Abstract

This paper describes the patterns of pain induced by injecting hypertonic saline into the lumbar multifidus muscle opposite the L5 spinous process in 15 healthy adult volunteers. All subjects experienced local pain while referred pain was reported by 13 subjects in one of two regions of the thigh; anterior ( $n = 5$ ) or posterior ( $n = 8$ ). These results confirm that the multifidus muscle may be a source of local and referred pain. Comparison of these maps with pain maps following stimulation of the L4 medial dorsal rami and L4-5 interspinous ligaments shows that pain arising from the band of multifidus innervated by the L4 dorsal ramus has a segmental distribution. In addition patterns of pain arising from multifidus clearly overlap those reported for other lumbar structures. These findings highlight the difficulty of using pain distribution to accurately identify specific lumbar structures as the source of pain.

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**Keywords:** Multifidus; Pain maps; Referred pain

## 1. Introduction

Establishing the source of pain is important if specific interventions for low back pain are to be developed. Sources of chronic low back pain confirmed by controlled studies include the zygapophysial joints (Schwarzer et al., 1994a, b), the intervertebral discs (Schwarzer et al., 1994a, 1995a) and the sacro-iliac joints (Schwarzer et al., 1995b; Maigne et al., 1996). For each of these structures patterns of both local and referred pain have been reported (Mooney and Robertson, 1976; McCall et al., 1979; Fortin et al., 1994a, b; Dreyfuss et al., 1996; Fukui et al., 1997; O'Neill et al., 2002). Patterns of local and referred pain have also been recorded following injection of 6% saline into the lumbar interspinous ligaments (Kellgren, 1939) and interspinous spaces (Feinstein et al., 1954).

The lumbar back muscles are another possible source of pain. Kellgren (1938) demonstrated that noxious stimulation by 0.1 to 0.3 cc of 6% saline into the lumbar

multifidus muscle in at least 3 normal volunteers produced patterns of local and referred pain lasting no more than 5 min. More recently, Bogduk and Munro (1979) confirmed these findings in two experiments. The exact placement of the stimulus within the multifidus muscle was not specified in either of these studies, other than being opposite the L5 spinous process.

Clinical evidence of pain arising from back muscles comes from Simons and Travell (1983). These authors stated that the referred pain pattern characteristic of each muscle is often the most valuable single source of information to identify the muscular origin of pain. Confirmation of muscle pain arising from a trigger point is by location of spot tenderness and a taut palpable band, palpation of which elicits a twitch response and distinctive pattern of referred pain (Travell and Simons, 1983). Each lumbar muscle therefore has a specific pattern of local and referred pain that may be used for diagnosis.

The lumbar multifidus has a myotomal structure (Macintosh et al., 1986). Haig et al. (1991) have demonstrated that specific placement of EMG needles into each band of multifidus demonstrates electrical

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recording at a segmental level. A segmental distribution of pain should therefore be observable following stimulation of a band of multifidus.

The aim of this study was to determine whether stimulation of the L4 band of the multifidus muscle would produce a specific distribution of pain, and whether this pattern would agree with pain maps produced by stimulating the medial branch of the L4 dorsal rami (Fukui et al., 1997), or the L4-5 interspinous ligaments which are innervated by the interspinous branch of the L4 dorsal ramus (Kellgren, 1939; Bogduk et al., 1982). Clinical ramifications of this study lie in comparing these pain patterns with those resulting from a positive trigger point in multifidus.

## 2. Methods

Fifteen adult volunteers (11 males, 4 females) were recruited through the University of Otago. Criteria for inclusion in the study were that the subjects were skeletally mature (24–45 years of age, mean 32 years) and had no history of musculoskeletal disorders or allergic disease. The study was designed as a double blind randomized trial. Informed consent was gained from all participants, and the Ethics Committee of the University of Otago approved the study.

Noxious stimulation was achieved through 0.3 ml intramuscular injection of hypertonic saline (5%) while isotonic saline was used as the placebo. Both the injector and subject were blind to the specific contents of each injection and were unaware of previously described pain maps (Kellgren, 1939; Bogduk and Munro, 1979; McCall et al., 1979; Simons and Travell, 1983; Fukui et al., 1997). One active and one placebo injection were introduced at different stages to each subject. The first injection was randomly assigned to a side. The subsequent injection was introduced to the contralateral side.

Each subject lay prone with a small pillow under their pelvis. The L5 spinous process was identified using standard techniques (Spangberg et al., 1990). A 27 gauge needle was inserted level with the L5 spinous process at an angle of 60° ventrally and medially, 2.5 cm lateral to the midline (Fig. 1). The needle was inserted until a solid end feel was noted when it was withdrawn slightly and the agent introduced. An interval of 5 min between injections allowed for subsidence of any pain.

Following each injection the subject was asked to describe the intensity and location of any sensations. Pain around the injection site was defined as local pain while pain occurring outside and isolated from the local site was defined as referred pain. Maximum intensity of discomfort or pain was reported using a sliding visual analogue scale (VAS). The location of symptoms was first reported by the subject and confirmed by the investigator lightly tracing on the subject's skin the

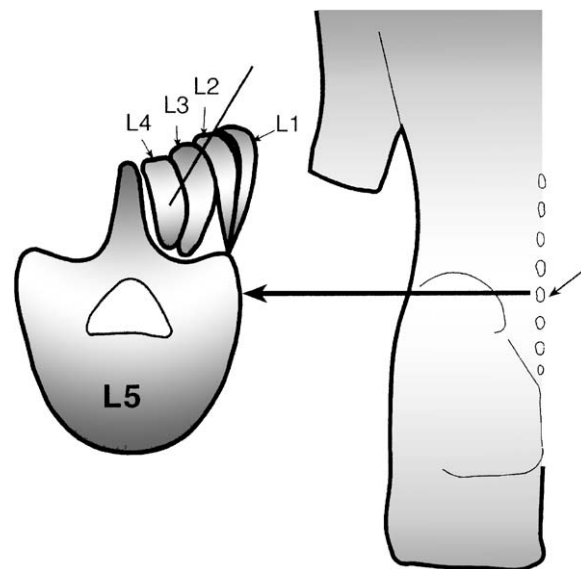


Fig. 1. Diagram of the proposed placement of the needle relative to the multifidus muscle. The needle was inserted lateral to the L5 spinous process, directed at an angle of 60° ventrally and medially and was inserted until a solid end feel was noted, then it was withdrawn slightly. The tip will lie in fibres arising from the L4 spinous process, innervated by the L4 dorsal ramus. (Adapted from Macintosh et al., 1986.)

outline of the area that was deemed uncomfortable or painful. The distribution of pain was then drawn by the investigator on an anatomical map and this map was checked by the subject.

## 3. Results

Apart from cutaneous pain on insertion of the needle no local or referred pain was reported following injections of the placebo. Injections of hypertonic saline caused local pain around the injection site in all subjects and referred pain in 13 of the 15 subjects.

Subjects reported either of two patterns of referred pain. Five subjects perceived pain in the anterior thigh while eight subjects felt pain in the posterior thigh. Anteriorly, pain or discomfort radiated from a wide band at the groin tapering inferiorly to a narrow band ending at the knee (Fig. 2A). Posteriorly, pain radiated as a band across the buttock inferiorly ending at the knee (Fig. 2B).

The mean score for maximum pain using the VAS was 5.5 (range 2.8, 9.0). The maximum pain scores were not differentiated between the local area of pain or the referred area of pain, but solely as the maximum pain experienced in any region.

## 4. Discussion

The results of this study confirm the previous work of Kellgren (1938) and Bogduk and Munro (1979) on

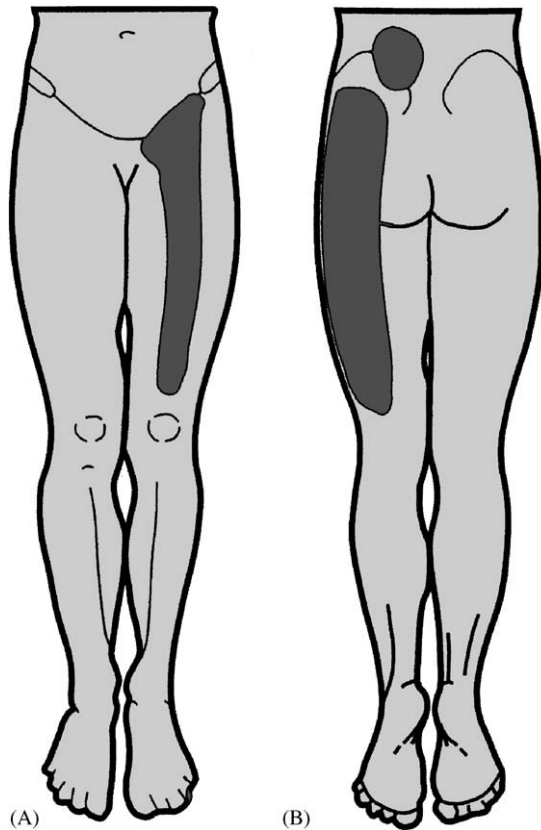


Fig. 2. Composite local and referred pain pattern of all 15 subjects: (A) anterior pattern, (B) posterior pattern.

patterns of local lumbar pain and referred pain into the lower extremity following noxious stimulation of the lumbar multifidus muscle. It therefore adds to the currently sparse experimental literature demonstrating that local and referred pain may arise from the multifidus muscle. Although this may appear simplistic there are only two previous studies, each using a small number of subjects, that have experimentally demonstrated the clinical observation that multifidus may be the source of both local and referred pain.

The patterns of referred pain were variable. This is not surprising as any pattern of referred pain reflects the intensity of the stimulation and the segmental innervation of the stimulated structure (Kellgren, 1939; Feinstein et al., 1954; Mooney and Robertson, 1976; McCall et al., 1979). Therefore, slightly different positioning of the injection site and different size of the subjects' muscles might lead to differing patterns of referred pain. In subjects who reported no referred pain it is possible that the injection missed the target muscle and saline may have been injected into the loose areolar and adipose tissue that lies between the lamina and the multifidus muscle (Bogduk et al., 1982). The finding of low back pain in all patients does agree with McCall et al. (1979) where all subjects reported low back pain

following stimulation of the medial branch of dorsal rami but only a small subset reported referred pain into the thigh.

Localization of pain sensation is thought to rely on activity in the somatosensory cortex (Ploner et al., 2002), with referred pain resulting from activity in adjacent but inappropriate cortical regions (Ramachandran and Rogers-Ramachandran, 2000). The two distinct patterns of pain we observed most likely reflect differences between subjects. However, we cannot dismiss the possibilities that different bands of multifidus were stimulated or that the stimulus spread through adjacent bands and therefore the stimulation was not band specific. The deepest band of multifidus located at the site of stimulation is innervated by L4 with the superjacent band innervated by the medial branch of the L3 dorsal ramus (Fig. 1). The only segmental patterns of pain available for comparison are those described following stimulation of the L3-4 and L4-5 interspinous ligaments (Kellgren, 1939) (Fig. 3) or the medial branch of the lumbar dorsal rami (Fukui et al., 1997) (Fig. 4). We can use this data to establish inferentially whether the distribution observed in this study appears segmental in nature.

Comparison with Kellgren (1939) reveals that the observed anterior pattern is in agreement with the

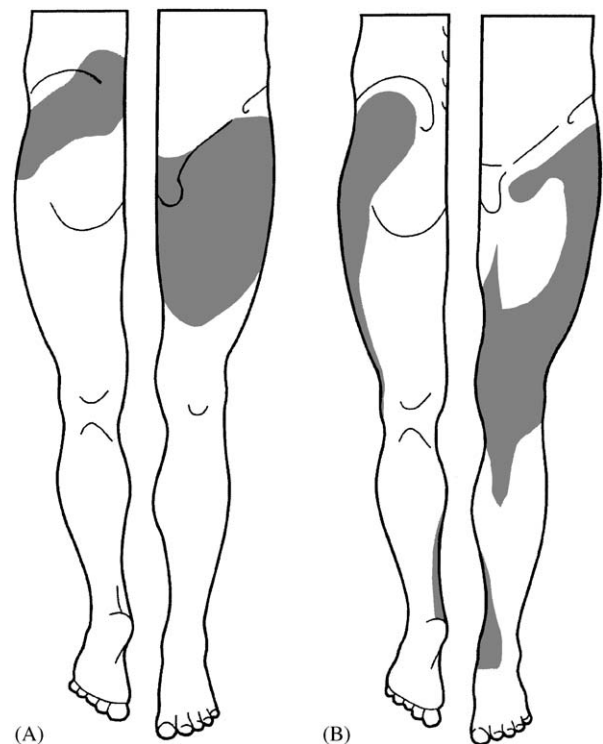


Fig. 3. Diagram showing: (A) the distribution of pain arising from injection of the L3-4 innervated by the interspinous branch of L3 dorsal ramus and (B) L4-5 interspinous ligaments innervated by the interspinous branch of L4 in 3 subjects. (Adapted from Kellgren, 1939.)

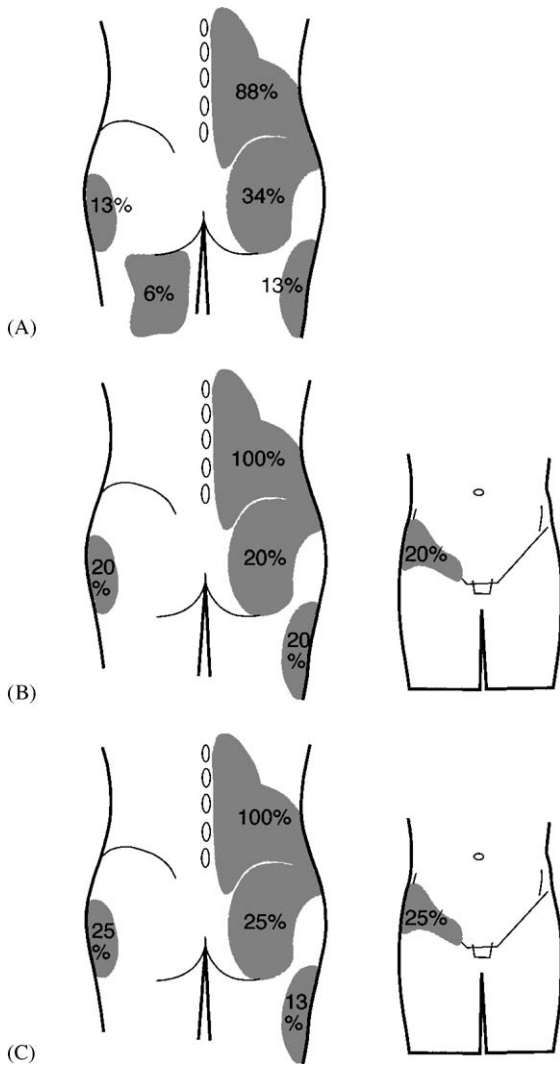


Fig. 4. Diagram of referred pain distribution: (A) following L4 medial branch stimulation ( $n = 32$ ), (B) following L3 medial branch stimulation ( $n = 15$ ), (C) following L2 medial branch stimulation ( $n = 8$ ). (Adapted from Fukui et al., 1997.)

anterior pattern of L3-4 interspinous ligament while the posterior pattern agrees with the posterior pattern of L4-5 innervated interspinous tissue (Fig. 3). On the basis of this general comparison our stimulation technique appears successful in stimulating the bands of multifidus innervated by the L4 dorsal ramus. It is conceivable that there is an overlap with the L3 pattern suggesting that the stimulus could have spilt over into the L3 innervated band of muscle or been erroneously introduced into the L3 multifidus fascicle.

Direct comparison of our results with Fukui et al. (1997) was not possible due to the presentation of his findings and overlap of observed patterns (Fig. 4). Unlike Dwyer et al. (1990) and Aprill et al. (1990), Fukui et al. did not record the specific primary and secondary areas of pain for each stimulation. Therefore

a characteristic pain distribution for each medial branch of the dorsal rami could not be drawn. Fukui et al. (1997) suggest that the primary area of pain for L1 through L4 is the entire low back region. Although all our subjects reported local pain similar to Fukui et al. (1997) a higher proportion of patients in our study also reported referred pain. The anterior and posterior patterns in our study agree with the pain distribution described following L2, L3 and L4 medial branch stimulation by Fukui et al. (1997) (Fig. 4), but due to their style of reporting it is not possible to make finer comparisons.

The patterns of referred pain that we observed overlap those described following stimulation of the multifidus muscle opposite the L5 spinous process by Kellgren (1938) and Bogduk and Munro (1979), although they were not identical (Fig. 5). Kellgren (1938) (Fig. 5) described a posterior pattern of referred pain similar in distribution to the posterior pattern reported in this study (Fig. 2). The pattern described by Bogduk and Munro (1979) (Fig. 5) around the iliac crest towards the groin overlapped with the proximal portion of the anterior pattern reported here but did not agree with the distal distribution down the anterior aspect of the thigh.

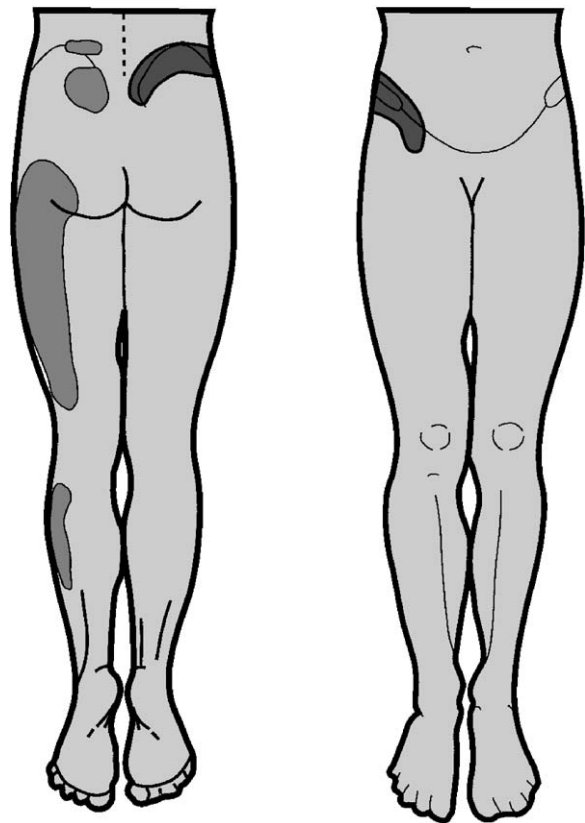


Fig. 5. Diagram of the distribution of referred pain after the injection of 6% saline into multifidus opposite L5. Based on data from Kellgren (1938) (light shading) and Bogduk and Munro (1979) (darker shading).

As neither Kellgren (1939) nor Bogduk and Munro (1979) took account of the myotomal structure of multifidus their work showed only that the multifidus could be a source of pain. They did not provide evidence for a segmental relationship between the source of pain and pattern of referral. If different bands or multiple bands of muscle are stimulated different patterns of pain arise; hence the overlap but not concordance of the pain maps between our study and previous studies (Kellgren, 1939; Bogduk and Munro, 1979). The segmental relationship between the source of pain and pattern of referral must be demonstrated if pain patterns are to be useful in the diagnosis of muscle pain.

Of immediate clinical relevance is the comparison between pain patterns observed in our study (Fig. 2) and those from stimulation of the multifidus muscle (Fig. 5) (Kellgren, 1939; Bogduk and Munro, 1979), the lumbar zygapophysial joints (Fig. 6) (McCall et al., 1979; Fukui et al., 1997), the medial branches of lumbar dorsal rami (Fig. 4) (Fukui et al., 1997) and the interspinous ligaments (Fig. 3) (Kellgren, 1939). The clear overlap that exists results from the shared common innervation of these structures (Bogduk, 1994). Inspection of Figs. 2–6 clearly demonstrates that no one pattern of referred pain is pathognomonic for lumbar multifidus.

Furthermore, examination of the pain map for trigger points in the lower lumbar multifidus (Travell and

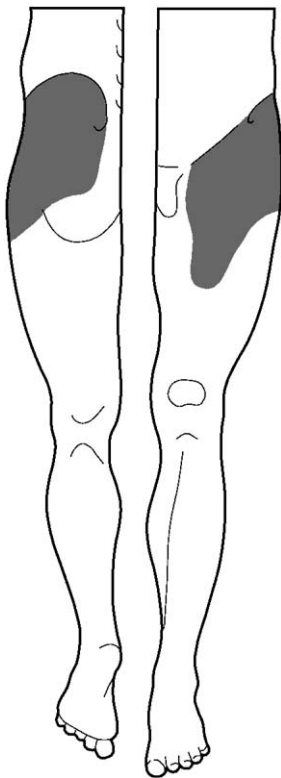


Fig. 6. Diagram of the distribution of referred pain after the injection of 6% saline into the L4-5 zygapophysial joint. Based on data from McCall et al. (1979).

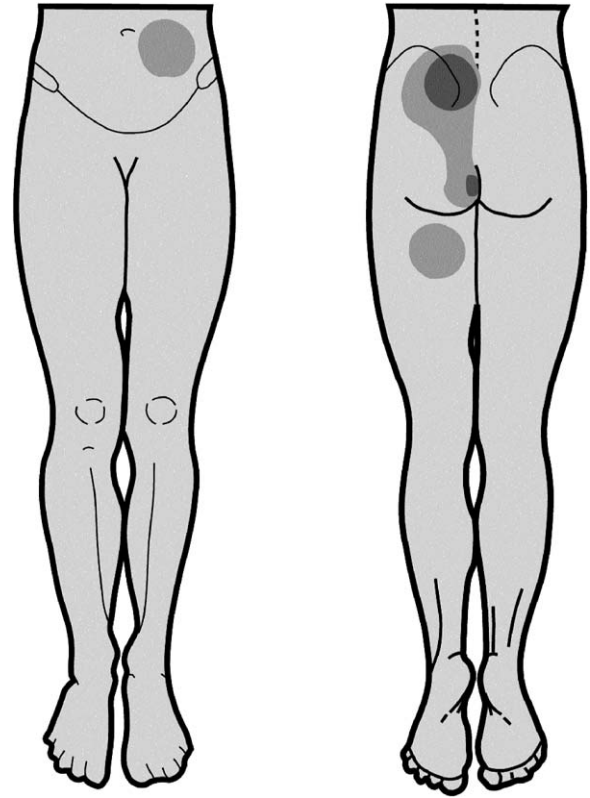


Fig. 7. Diagram of referred pain patterns that arise from a trigger point in the lower lumbar multifidus. (Adapted from Simons and Travell, 1983.)

Simons, 1983) reveals localized pain that may spread down the buttock close to the midline and into the posterior thigh. There is little agreement between this pattern of pain (Fig. 7) and the results of more specific stimulation of the multifidus muscle (Fig. 2). This observation raises questions regarding the specificity of palpation of the multifidus muscle. Palpation opposite L5 is through the overlying skin, superficial fascia, thoracolumbar fascia and erector spinae aponeurosis, all structures innervated by lumbar dorsal ramus.

## 5. Conclusion

This study confirms two previous experimental studies that lumbar multifidus may be the source of both local and referred pain. Noxious stimulation of the band of multifidus innervated by the L4 dorsal ramus produces patterns of pain that are concordant with pain arising from the medial branch of the L4 dorsal ramus and the L4-5 interspinous ligaments. The results of our study justify a larger study investigating each lumbar level and it will be interesting to see whether more distinct segmental maps may be described. Our results highlight the problems associated with diagnosis based primarily on the distribution of pain.

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