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Original article

Comparison of two angles of approach for trigger point dry needling of the lumbar multifidus in human donors (cadavers)☆

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ABSTRACT

Study design: Descriptive comparison study.
Objective: To assess the accuracy of two needle angle approaches for dry needling of the lumbar multifidus.
Background: Low back pain is a leading cause of disability around the world; the lumbar multifidus plays a vital role in low back health. Manual therapy such as dry needling can improve pain mediation and motor control activation of the lumbar multifidus. Clinicians practicing dry needling at the lumbar multifidus typically use an inferomedial approach considered non-controversial. Clinicians practicing electromyography and nerve conduction studies commonly sample the lumbar multifidus in a directly posteroanterior approach that may provide another option for dry needling technique.
Methods: Four human donors were used for a total of eight needle placements—four with an inferomedial orientation and four with a posteroanterior orientation. Each needle was placed from 1 to 1.5 cm lateral to the spinous process of L4 to the depth of the lumbar lamina. Each lower lumbar spine was then dissected to determine the structures that the needle traversed and the needle's final resting place.
Results: All four inferomedial approach needles ended at the lamina of the vertebrae below. All four posterior-anterior approach needles ended in the lamina of the same level.
Conclusions: All eight needles traversed the lumbar multifidus and ended in the lumbar lamina with little possibility of the needle entering the subarachnoid space. Thus both the inferomedial and the posteroanterior angles of approach are efficacious for clinicians to use in dry needling of the lumbar mulifidus.

1. Introduction

The World Health Organization Bulletin reports that low back pain is the leading cause of disability around the world (Ehrlich, 2003). Studies investigating the association between impairment of the lumbar spine musculature and low back pain have proliferated over the past 30 years establishing a connection between dysfunction of the lumbar multifidus and chronic low back pain (Hodges and Richardson, 1996; Hides et al., 1996, 2001; Richardson et al., 1999; Hides, 2004; Hides et al., 2008; Freeman et al., 2010). Many researchers have found in concert with Freeman's 2010 review of the role of the multifidus in chronic low back pain that "muscle training directed at teaching patients to activate their lumbar multifidus muscles is an important feature of any clinical approach to the low back pain patient with demonstrated lumbar multifidus dysfunction or atrophy." (Freeman et al., 2010).

Given the importance of lumbar multifidus activation and/or strengthening for patients with low back pain, clinicians often seek ways to enhance motor control of the lumbar multifidus during functional movement patterns. Manual therapy and dry needling can change motor function via neurophysiological effects by reducing inflammatory mediators, changing spinal excitability, modifying cortical areas involved in pain processing, and changing excitation of the sympathetic nervous system (Bishop et al., 2015; Butts and Dunning, 2016). A theory by Dr. Chad Gunn suggests that shortening of the lumbar multifidus can cause myofascial pain which is the result of some peripheral neuropathy or radiculopathy. Dr. Gunn's "radiculopathic model" calls for dry needling of the lumbar multifidus not only for low back pain, but at the lumbar

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level that corresponds to muscle pain in peripheral muscles (The Gunn Approach to the, 1996; Gunn, 1997).

A growing number of studies have found clinical benefit of dry needling in other regions of the body (Cummings and White, 2001; Furlan et al., 2005; Tough et al., 2009; Kietrys et al., 2013), but only a few randomized controlled trials have considered dry needling of the lumbar multifidus muscle. Two recent studies by Koppenhaver et al. investigated physiologic changes compared to clinical outcomes with dry needling in lumbar multifidus (Koppenhaver et al., 2015a) and patient characteristics of those likely to respond to dry needling at the lumbar multifidus (Koppenhaver et al., 2015a, 2015b). One study found that responders to dry needling may exhibit different physiologic changes than non-responders; the second study found that pain exacerbation with the multifidus lift test during exam indicated patients whose dysfunction would improve with dry needling the lumbar multifidus.

Dry needling is therefore one treatment option for healthcare providers to consider for patients who have low back pain. However, few studies have investigated the actual anatomy that a needle traverses on the way to its intended clinical destination. These researchers found one such study by Mesa-Jimenez et al. using human donors to study dry needling accuracy in the lateral pterygoid muscles of two cadavers (Mesa-Jiménez et al., 2015), but no other anatomical accuracy studies. Like the lateral pterygoid study, this study uses human donor specimens to investigate needle placement accuracy of dry needling to the lumbar multifidus and goes further to consider a new angle of approach in the lumbar region.

Clinicians practicing dry needling to the lumbar multifidus commonly use a needle angle with an inferomedial approach which is not controversial (Dommerholt and de las Penas, 2013). Clinicians practicing electromyography (EMG) and nerve conduction studies have other options and commonly sample the lumbar multifidus in a directly posteroanterior approach (Haig et al., 1991; Stein et al., 1993). The posteroanterior approach at 90° perpendicular to the lamina is considered to be safe and efficacious as a needle angle for EMG and might be a useful technique to clinicians who practice dry needling (Haig et al., 1991; Stein et al., 1993). Both dry needling treatment and EMG testing seek to traverse the entire depth of the four layers of the multifidus to ensure full clinical coverage of the muscle.

In clinical practice and instruction of dry needling of the lumbar multifidus, agreement as to the angle of needle approach has coalesced around an inferomedial approach (Biomedical Acupuncture fo, 2010; Janet, 2015). The definitive textbook on the subject provides instructions for thoracic and lumbar multifidi starting with having the patient lie prone. The clinician then identifies the lumbar multifidus in the “safe zone” (Dommerholt and de las Penas, 2013)—the valley between the spinous process and one finger-width lateral to the spinous process which has a bony backdrop. The needle angle guidance instructs the clinician to insert the needle perpendicular to the skin and introduce the needle “in a medial caudal [inferomedial] direction towards the lamina” of the vertebra one level below (Dommerholt and de las Penas, 2013).

Recent publications considering dry needling in the lumbar multifidus document use the traditional dry needling angle, directing the needle angle inferomedially (Rainey, 2013; Koppenhaver et al., 2015a, 2015b). Kopenhaver et al. note their needle technique starting at approximately 1.5 cm lateral to the spinous process angling approximately 15–20° medially and slightly inferior and introduced to the depth of the lumbar lamina (Koppenhaver et al., 2015a, 2015b). Rainey reports placing the needle “one-finger breadth” lateral to the spinous process, angling the needle slightly medial to the vertical axis and perpendicular to the lamina, a slight variation on the traditional angle in that the needle was not directed inferiorly (Rainey, 2013).

In comparison, clinicians who practice EMG use several different techniques including inferomedial, medial, and a posteroanterior approach for placing a needle in the multifidus. The Haig EMG needle placement technique uses a needle insertion at 2.5 cm lateral and 1 cm cranial from the inferior tip of the spinal process, with a 45° medial direction (Haig et al., 1991). Stein et al. recommend two techniques: 1) inserting needle midway between spinous processes with a 30° inferior and 10–15° lateral angulation; and 2) the paramedian approach inserting the needle 3 mm away from the spinous process, perpendicular to the skin with a posteroanterior angle (Stein et al., 1993). In a human donor study using colored dye to mark multifidus fascicles and fluoroscopy to view needle insertions, Kim et al. compared the Haig and Stein needle approaches and concluded that all techniques safely reach the targeted muscle for EMG studies (Kim et al., 2005).

Traditionally, clinicians who teach and practice dry needling use an inferomedial angle of approach while clinicians practicing EMGs can also use a posteroanterior angle of approach when targeting the same muscle. The purpose of this study is to determine if both needle angles reach all layers of the targeted lumbar multifidus and end up in the vertebral lamina which would be a safe landing location (Fig. 1).

2. Methods

2.1. Subject selection

Five subjects were selected from a sample of convenience of six not-previously-dissected human donors at Elon University. Donors were embalmed with the Maryland embalming solution which is

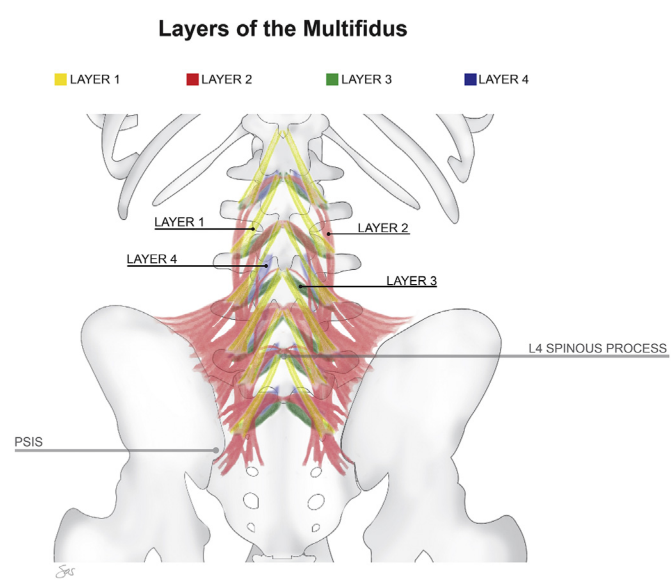

Fig. 1. Layers of the lumbar multifidus.
Layer 1: The most superficial layer of multifidus arises from the mammillary and superior articular processes and then spans two vertebrae to attach to the spinous processes superiorly.
Layer 2: The second layer arises from the spinous process and passes inferolaterally to attach to several consecutive lamina, eventually attaching to the iliac crest, sacroiliac joint, and the sacrum.
Layer 3: The third layer arises from the spinous process just deep to the second layer origin and passes inferolaterally to the mammillary processes one to two levels below.
Layer 4: The fourth and deepest layer of the lumbar multifidus arises from the superior articular process and inserts into the facet capsule and lamina of the vertebrae above (Lonnemann et al., 2008).

5.6% formaldehyde, 27.8% phenol, 33.3% methanol, and 33.3% glycerin which was mixed with 2 parts water. Donors with easily palpable iliac crests and lumbar spinous processes were included in the study while those with excessive adipose tissue obscuring pertinent bony landmarks were excluded. One of the six donors was omitted from this study due to exclusionary criteria and one was used in a pilot study to determine best methods. There were 4 subjects for needle placement and dissection included in the study. A typical dry needling needle is a thin, sterile, solid filament of 0.25–0.30 mm; however, the donor tissue was too thick for such a needle to fully penetrate. As such, the researchers used a 12.7 cm long, 1.0922 mm diameter Dritz® craft needle which allowed needle penetration to the required depth and remained stable during dissection.

2.2. Needle placement

The purpose of this investigation was to compare an inferomedial needle angle to a posteroanterior needle angle for dry needling of the lumbar multifidus. Each of the four donors' left and right lumbar multifidus muscles were used for a total of eight needle placements, with random assignment of the two angles side to side. A physical therapist and dry needling instructor with 14 years of experience placed the needle in all eight trials. To locate the correct starting point for each needle, the physical therapist palpated the iliac crest, moved medially to the posterior superior iliac spine, continuing medially to the sacrum, palpated the space between the sacrum and L5 spinous process, finally palpating superiorly to the L4 spinous process.

For the inferomedial approach, the needle was inserted 1.5 cm lateral to the spinous process of L4 at a 45° angle inferiorly and 45° medially to the spine, stopping when the needle hit the bony backdrop of the lumbar lamina. The posteroanterior needle was inserted 1 cm lateral to the spinous process and driven to the lamina in a posteroanterior direction, perpendicular to the body. Surface anatomy palpation to locate L4 spinous process was performed the same way for both approaches. The needles were inserted to the depth of the lamina in accordance with the clinical goal of treating the deepest part of that muscle. Ultrasound was used to verify the needle path and define the parameters for block dissection.

2.3. Dissection process

Following each needle placement, a block dissection of approximately 5 cm around the needle was performed in order to observe the tissue as the needle traversed to its final resting place. Three cuts from the spinous process on each side created a small block of undisturbed tissue to preserve the needle placement. It is important to note that tissue directly between the needle and spine was left intact. All three cuts of the block were executed to the depth of the vertebral lamina.

Next, a larger block of tissue was established and removed to expose the small undisturbed tissue block. To begin the larger block, two longitudinal incisions were made along the ipsilateral border of the spine. The first incision was made from the superior margin of the small undisturbed tissue block superiorly to the L1 spinous process. The second longitudinal incision was made from the inferior margin of the small undisturbed tissue block inferiorly to the sacrum. Then, two 10 cm incisions were made laterally from L1 and the sacrum where the previous two cuts ended. These lateral incisions were also connected by a longitudinal incision made parallel to the spine. These incisions were made to the depth of the lamina, sacrum, and spinous process allowing for removal of all

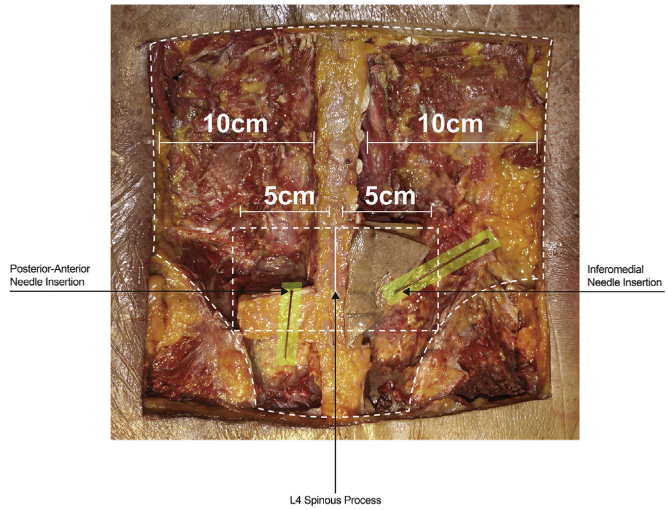

Fig. 2. Block dissection technique.

tissue surrounding the small block of tissue containing the placed needle (Fig. 2).

Following the removal of the large block of tissue, incisions were made to expose the final needle resting point. The needle was used as a guide for removing a section of the small block. In the posteroanterior approach needle blocks, a lateral incision was made from the spine to the lateral margin of the small block using the needle as a guide to remove the superior half of the small block of undisturbed tissue. In the inferomedial needle blocks, an oblique incision was made along the lateral border of the needle from the spine to the lateral border of the small block of undisturbed tissue, using the needle to guide the scalpel. These incisions allowed for visual observation of the tissue the needle traversed and the final needle resting place, which was the main outcome measure (Fig. 3).

3. Results

Once the dissection was complete, the researchers conducted an observation of all trials. In all eight cases, the needle transected the thoracolumbar fascia, all layers of the lumbar multifidus, and came to rest at the bony structure of the lumbar lamina. The researchers observed all four inferomedial needles from the skin adjacent to L4

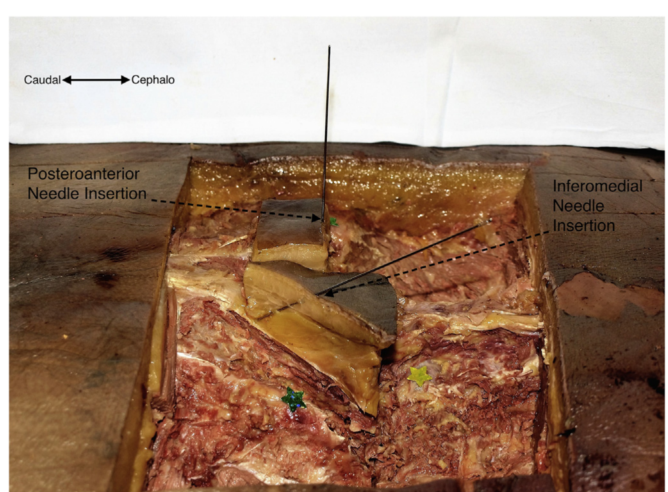

Fig. 3. Lateral view of needle angles.

progressing through all four layers of the lumbar multifidus and ending in the lamina below at L5. In the four posteroanterior trials posteroanterior the needle's starting point was observed at L4, piercing all four layers of the lumbar multifidus, and terminating at the lamina of L4 (Fig. 4).

In the case of one donor with abnormally excessive subcutaneous tissue, the dissections revealed needle placement between L4 and L5 (slightly distal to L4) rather than adjacent to L4 with both needle angle approaches, but still ended in lumbar multifidus tissue at the lamina.

4. Discussion

The primary purpose of this study was to investigate whether a posteroanterior needle angle compares favorably to the common inferomedial needle angle used in dry needling of the lumbar multifidus. These results show that all needles placed in both the inferomedial and the posteroanterior angles traversed all layers of the lumbar multifidus and ended at the lumbar lamina which is a safe location. Neither needle placement resulted in missing the lumbar multifidus or not ending at the lamina. Additionally, neither approach provided needle access to the subarachnoid space.

One potential clinical advantage to the posteroanterior angle is the ability to treat the exact intended spinal level rather than an oblique treatment from one level above. This could prove particularly useful and important when utilizing the radiculopathic model whereby a peripheral complaint is treated at the peripheral site and also at the nerve root level of the spine from where the peripheral site is innervated (The Gunn Approach to the, 1996; Gunn, 1997).

The lumbar multifidus muscles are important stabilizers of the lumbar spine and dysfunction in these muscles is strongly associated with low back pain (Freeman et al., 2010). Therefore, better understanding of appropriate needle angle and placement in the lumbar multifidus through this cadaveric study provides assurances for clinicians that both an inferomedial and a posteroanterior angle are viable treatment technique options.

5. Limitations

One donor was eliminated from this study because bony landmarks were impossible to assess, while another donor was included whose landmarks were difficult to identify secondary to excessive subcutaneous adipose tissue. After inserting the needle and dissecting this particular donor, the needle's final destination was in the multifidus slightly distal to the intended target level, but still ending at the desired lamina. The exclusion of one donor and difficulty locating and referencing bony landmarks of one of the remaining four subjects during this study foreshadows unique challenges to the application of dry needling on the ever-growing, obese demographic of patients (Ogden et al., 2014). Furthermore, it raises the clinical question as to whether dry needling should be considered a viable treatment option for patients whose three-dimensional anatomy is difficult or impossible to distinguish. Further research is warranted to assess anatomical accuracy of dry needling with obese patients.

Another consideration is the generalizability between the type of needles used in dry needling (0.25–0.30 mm diameter solid filament needle) and the needles used to penetrate donors in this study (1.0922 mm diameter Dritz® craft needle). Donor tissue undergoes many biological processes both naturally and chemically through the embalming process. From the inevitable tightening of soft tissues to the compounding effects of chemical preservation, the typical very fine gauge needles used in dry needling were not a viable option in this study.

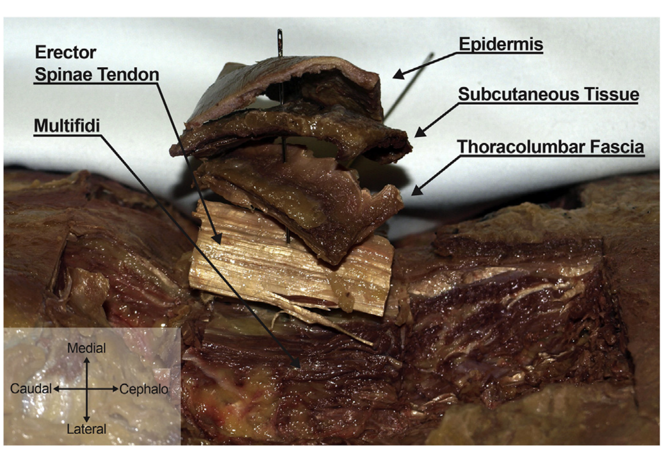

Fig. 4. Dissected layers at lumbar multifidus.

6. Conclusion

This is the first anatomical study that investigates the accuracy of needle placement for dry needling at the lumbar multifidus. The results support the use of both the traditional dry needle inferomedial angle of approach as well as a posteroanterior angle of approach sometimes used by electromyographers. Ultimately, the focus of this study was to determine if the posteroanterior needle angle approach and the inferomedial needle angle approach would traverse the lumbar multifidus and end at the clinically relevant bony landmark, the lumbar lamina. Although the inferomedial angle ended in the vertebral lamina below the starting point spinous process location and the posterior-inferior angle ended in the same level of lamina, the researchers validated the efficacy of both approaches in this study. Each approach is effective in reaching the target tissue and the desired bony backdrop.

Conflict of interest

There is no other conflict of interest (ie, personal associations or involvement as a director, officer, or expert witness).

Ethical approval

Not required.

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