Anatomy and landmarks for the superior and middle cluneal nerves: application to posterior iliac crest harvest and entrapment syndromes

Laboratory investigation

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Object. To date, only scant descriptions of the cluneal nerves are available. As these nerves, and especially the superior group, may be encountered and injured during posterior iliac crest harvest for spinal arthrodesis procedures, the present study was performed to better elucidate their anatomy and to provide anatomical landmarks for their localization.

Methods. The superior and middle cluneal nerves were dissected from their origin to termination in 20 cadaveric sides. The distance between the posterior superior iliac spine (PSIS) and superior cluneal nerves at the iliac crest and the distance between this bony prominence and the origin of the middle cluneals were measured. The specific course of each nerve was documented, and the diameter and length of all cluneal nerves were measured.

Results. Superior and middle cluneal nerves were found on all sides. An intermediate superior cluneal nerve and lateral superior cluneal nerve were not identified on 4 and 5 sides, respectively. The superior cluneal nerves always passed through the psoas major and paraspinal muscles and traveled posterior to the quadratus lumborum. The mean diameters of the superior and middle cluneal nerves were 1.1 and 0.8 mm, respectively. From the PSIS, the superior cluneal branches passed at means of 5, 6.5, and 7.3 cm laterally on the iliac crest. At their origin, the middle cluneal nerves had mean distances of 2 cm superior to the PSIS, 0 cm from the PSIS, and 1.5 cm inferior to the PSIS. In their course, the middle cluneal nerves traversed the paraspinal muscles attaching onto the dorsal sacrum.

Conclusions. Knowledge of the cutaneous nerves that cross the posterior aspect of the iliac crest may assist in avoiding their injury during bone harvest. Additionally, an understanding of the anatomical pathway that these nerves take may be useful in decompressive procedures for entrapment syndromes involving the cluneal nerves.

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KEY WORDS • anatomy • iliac crest • nerve injury • anatomical landmark • gluteal region

The most common complication associated with autologous bone graft from the posterior iliac crest for lumbar spinal fusion procedures is loss of sensation or chronic pain at the donor site. Cutaneous nerves that cross the iliac crest include, from anterior to posterior, the lateral cutaneous branch of the subcostal nerve, the lateral cutaneous branch of the iliohypogastric nerve, and the superior cluneal nerves. The first, second, and third lumbar dorsal rami give rise to the superior cluneal nerves, which are the most likely cutaneous nerves to be encountered during a posterior iliac crest harvesting procedure. These nerves are the sensory innervation to the areas of the posterior iliac crest and the upper buttock (Fig. 1). In addition, and regionally, the middle cluneal nerves derived from the dorsal rami of the upper 3 sacral nerves travel near the PSIS. Lastly, the inferior cluneal nerves, branches of the posterior femoral cutaneous nerve, travel from inferior to superior along the inferior aspect of the gluteus maximus muscle.

Patients with cluneal nerve pathology may present with severe low-back pain that radiates to the gluteal region. This pain may be confused with lumbar spine disorders such as facet pain or with pathology of the sacro-
Cluneal nerve anatomy

Fig. 1. Schematic drawing of the left gluteal region illustrating the superior and middle cluneal nerves. Note the PSIS and the measurements made from this landmark to the superior cluneal nerves. Also note the relative safe zone (red shaded area) for avoiding the cluneal nerves.

iliac joint. Maigne syndrome, confirmed with facet block, is T12–L1 facet pathology that manifests as referred pain to the iliac crest via the cluneal nerves.

Studies regarding the cluneal nerves are lacking in the literature, particularly in the neurosurgical literature. As the cluneal nerves may be encountered or injured with posterior iliac crest harvest for spinal fusion procedures or become entrapped along their course, the present study was performed to further elucidate this anatomy.

Methods

The superior and middle cluneal nerves were dissected from their origin to their termination in 10 adult embalmed cadavers (20 sides). Twelve male and 8 female cadavers were used for this study. The patients’ ages at death ranged from 47 to 92 years (mean 70 years). No obvious pathology or signs of past surgical incisions were noted over the areas dissected. In a lateral position and following skin removal, the superior cluneal nerves were identified at their point of crossing the iliac crest, and this point was marked. The distance between this point of crossing the iliac crest and the PSIS was measured (Fig. 1). Next, each superior cluneal nerve was traced superiority to its point of origin from the upper lumbar nerves at their respective intervertebral foramina. The specific course of each nerve was documented. The distal extension of each of these nerves was then identified inferior to the iliac crest. Cadavers were then put into the prone position, and the middle cluneal nerves were identified and traced medially to their respective upper sacral intervertebral foramina. Again, the exact course of these branches was noted and the distance between their point of exit and the PSIS measured. The diameter of all cluneal nerves was measured. All measurements were made twice and the average taken. Measurements were made with calipers and rulers. Statistical analysis between sides and sexes was performed with Statistica (StatSoft) with statistical significance set at p < 0.05.

Results

Superior and middle cluneal nerves were found on all sides. However, an intermediate superior cluneal nerve and a lateral superior cluneal nerve were not identified on 4 (20%) and 5 sides (25%), respectively. All sides were, however, always found to have at least 2 superior cluneal nerves. When 1 of the superior cluneal nerves was absent, its territory was simply covered by the existing 2 superior cluneal nerves. All superior cluneal nerves originated from the upper 3 lumbar spinal nerves (that is, the medial superior cluneal from L-1, the intermediate superior cluneal from L-2, and the lateral superior cluneal from L-3). The superior cluneal nerves always passed through the psoas major and paraspinal muscles, and each of these nerves were found just posterior to the quadratus lumbo-rum in the plane between this muscle and the anterior layer of the thoracolumbar fascia. No osteofibrous tunnels were observed for the middle cluneal nerves on any specimen as these nerves simply pierced the posterior layer of the thoracolumbar fascia and inferior latissimus dorsi muscle prior to traveling across the iliac crest. The diameter of the superior cluneals ranged from 0.8 to 2.1 mm (mean 1.1 mm) and their average length was 17 cm (range 14.5–20 cm). The lateral superior cluneal nerve tended to be the largest of the 3 superior cluneal nerves and occupied a more superficial plane. From the midpoint of the PSIS, the superior cluneal branches passed at means of 5 cm (range 4.5–5.8 cm), 6.5 cm (range 4–8.2 cm), and 7.3 cm (range 5.5–8.5 cm) laterally on the iliac crest. The superior cluneal nerves, as a whole, supplied the skin overlying the upper half of the gluteus maximus and medius muscles. The superior lateral cluneal nerve often extended distally to the level of the greater trochanter of the femur. These nerves traveled from their origin to termination in a more or less oblique course from medial to lateral and, more often than not, anastomosed with one another in their distal course inferior to the iliac crest.

Middle cluneal nerves were identified on all sides. These nerves arose from the posterior sacral foramina of S1–3 (Figs. 1 and 2). The S-1 branch was constant on all sides. The S-2 branch was found on 14 sides (70%) and the S-3 branch was found on 9 sides (45%). The diameter of the middle cluneal nerves measured 0.5–1 mm (mean 0.8 mm). At their origin, the middle cluneal nerves had mean distances of 2 cm superior to the PSIS (range 1.2–2.3 cm), 0 cm from the PSIS (range 0.8 cm superior to 0.5 cm inferior), and 1.5 cm inferior to the PSIS (0.5–2.2 cm). From their exit from the respective sacral foramina, the middle cluneal nerves traversed the paraspinal muscles attached to the dorsal sacrum and overlying fascia to run into the subcutaneous tissue overlying the gluteus maximus mus-
No osteofibrous tunnels were observed for the middle cluneal nerves in any specimen. In general, the middle cluneal nerves supplied the skin overlying the posteromedial fifth of the gluteus maximus muscle and traveled in an approximately horizontal or superomedial-to-inferolateral course from origin to termination (Fig. 1). The middle cluneal nerves, especially the superior branches, were found to often communicate with the medial superior cluneal nerve. Although the cluneal nerves tended to be smaller in diameter in female specimens, this difference did not reach significance. Based on the course of the nerves, a relative safe zone was defined for incisions near the PSIS to avoid the superior and middle cluneal nerves (Figs. 1–3). No statistical significance was found comparing measurements between the cluneal nerves and the PSIS for sides or sex.

**Discussion**

Based on our study, the superior cluneal nerves might be encountered during far-lateral approaches to the lumbar spine or during harvest of posterior iliac crest. The middle cluneals would most likely be encountered during approaches to the dorsal sacrum or harvest procedures of the posterior iliac crest that approach the PSIS.

**Iatrogenic Injury**

The most common site for harvesting autologous bone graft is the iliac crest, and the most common complication of this procedure is postoperative pain at the donor site. In one study with more than 10 years of follow-up in almost 100 patients who underwent lumbar disc surgery with fusion using iliac crest, 37% of patients complained of persistent graft site pain. One of the possible causes of this pain is injury to the superior cluneal nerves. Superior cluneal nerve injury can lead to several different sensations at the donor site, such as chronic pain, dysesthesia, and hyper- or hypesthesia. Local injection of steroid agents and local anesthetics are conventional treatments for postoperative pain after iliac crest bone graft harvesting. Patients with superior cluneal nerve injury following iliac crest bone graft harvesting have also been successfully treated for persistent pain with alcohol neurolysis.

Colterjohn and Bednar have proposed a method that avoids the superior cluneal nerves during the harvesting of the iliac crest. This technique utilizes parallel incisions parallel to the superior cluneal nerves and perpendicular to the posterior iliac crest. Patients who underwent surgery using this method experienced fewer postoperative symptoms than patients who underwent surgery with standard incisions, which were more or less parallel to the posterior iliac crest. The superior cluneal nerves have also been described as crossing the iliac crest approximately 8 cm lateral to the midline and 7 cm cephalad to the PSIS. For posterior iliac crest harvesting and in the orthopedic literature, Lu et al. found that the medial superior cluneal nerve was roughly 6.5 cm from the PSIS and 8 cm from the midline. Xu et al. stated that the “cluneal nerves” were approximately 7 cm from the PSIS, although whether this was the medial, intermediate, or lateral nerve was not mentioned. Laterally on the iliac crest, we found that the 3 superior cluneal nerves were an average distance from the PSIS of 5 cm, 6.5 cm, and 7.3 cm.
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To avoid injury to these nerves during harvesting of bone graft, we, therefore, recommend a linear incision approximately 2.5 cm anterior to the PSIS and perpendicular to the long axis of the posterior iliac crest. Subperiosteal dissection over the PSIS on each side of the axis of the incision (2.5 cm on each side) will most likely avoid injury to the superior and middle cluneal nerves.

Entrapment Syndromes

The cluneal nerve syndrome was first described in 1957 in patients with the chief complaint of low-back pain.10 Trescot12 has stated that cluneal neuralgia is more commonly the result of an entrapped nerve than a nerve injury following iliac crest harvest. Patients with this syndrome have been treated with deafferentation of the cluneal nerve triggering the pain.10 Talu and colleagues11 found that the superior cluneal nerves were prone to entrapment where they pass through the fascia near the iliac crest. This may be true, but based on our observations, no osteofibrous tunnels or obvious compression sites were identified in this location. According to our findings, the middle cluneal nerves would be less likely to become entrapped due to their shorter length and course through multiple fasciae.

Entrapment neuropathy of the cluneal nerves is an uncommon cause of chronic low-back pain.3 However, cluneal entrapment neuropathies may be underdiagnosed and should be considered as a potential cause of chronic low-back pain.3 A specific physical sign for entrapment of the cluneal nerves does not exist, and therefore, the condition often remains undiagnosed.3 Other causes of pain must be excluded before considering entrapment neuropathy.3 Surgery can be considered when less-invasive procedures, such as steroid injection, fail to control patients' symptoms.3,4,6 One group of authors reported that 13 of 19 patients treated with surgical nerve release had excellent results.6

Conclusions

We have identified the anatomical course and landmarks for the superior and middle cluneal nerves. Based on the literature, this is an underdiagnosed cause of low-back pain that has good outcome if recognized and treated.1,12 Our hopes are that our data will be of use to the surgeon who operates in the region of the superior and middle cluneal nerves.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Tubbs. Acquisition of data: Tubbs, Levin, Loukas. Analysis and interpretation of data: Tubbs, Loukas, Cohen-Gadol. Drafting the article: Tubbs, Levin, Loukas. Critically revising the article: Tubbs, Potts, Cohen-Gadol. Reviewed final version of the manuscript and approved it for submission: all authors. Statistical analysis: Tubbs. Study supervision: Tubbs.

References


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