

Minimally invasive anterolateral approach to the hip

Risk to the superior gluteal nerve

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Background Minimally invasive approaches to the hip show promise of less muscle trauma compared to conventional approaches. What is the risk of damage to the superior gluteal nerve? We studied the course of the superior gluteal nerve.

Method 20 legs of 11 formalin-fixed Caucasian cadavers were dissected and the course and the distances of the superior gluteal nerve branches from the tip of the greater trochanter were documented.

Results The branch of the gluteal superior nerve leading to the gluteal minimus muscle was 33 (20–50) mm from the tip of the greater trochanter, within a deeper layer. The nearest point of the superior gluteal nerve branches from the tip of the greater trochanter in the posterior region was 19 (10–30) mm, in the middle region 20 (20–30) mm and in the anterior region 20 (10–35) mm. In half of the cases, a distal intermuscular branch between gluteal medius and tensor fasciae latae muscle could be found, mean 27 (10–40) mm caudal and 38 (25–60) mm ventral to the tip of the greater trochanter. This distal branch is considered to create a loop with upper branches of the superior gluteal nerve within the tensor fasciae muscle.

Interpretation The safe zone for the superior gluteal nerve was smaller than previously reported. Use of a minimal direct lateral approach puts the inferior branches within the gluteal medius at risk; however, a minimal anterolateral approach to the hip may compromise branches of the superior gluteal nerve to the tensor fasciae latae muscle.

Compared to the anterolateral approach (Watson-Jones 1936), direct lateral exposures (Bauer et al. 1979, Hardinge 1982) have become widely used because of the excellent overview of cup and stem, a low complication rate and superior control of leg length. However, in extensile lateral approaches the gluteal superior nerve may be at risk (Baker and Bitounis 1989, Jacobs and Buxton 1989, Bos et al. 1994). Using the conventional lateral approach, persisting damage to the superior gluteal nerve was found in 9 of 81 patients in one study (Ramesh et al. 1996). The minimally invasive reinvention of the anterolateral approach (Watson-Jones 1936, Bertin and Rottinger 2004) endeavours to minimize the risk of nerve trauma by use of a smaller incision and by avoidance of any muscular detachments.

In order to preserve neural structures during a small lateral or a minimally invasive anterolateral exposure, it is essential to know the course of the superior gluteal nerve in relation to clinically useful landmarks such as the tip of the greater trochanter. Thus, we measured the course of the gluteal superior nerve and its branches in the light of these two approaches to the hip.

Material and methods

This work was carried out in accordance with the ethical standards of the responsible committee on human experimentation. We dissected 20 legs of 11 formalin-fixed Caucasian cadavers, 4 male. The mean height of the cadavers was 162 (144–180) cm.

The gluteus maximus muscle was detached from the outer border of the iliac crest. Then the gluteus medius muscle was detached in a semicircle from the greater trochanter and the intermuscular plane was exposed in order to examine the course of the superior gluteal nerve and its branches. The region between the fasciae latae muscle and gluteus medius muscle was studied, focusing on the course of the terminal branches to the tensor fasciae latae.

Two cephalad imaginary lines from the tip of the greater trochanter to the iliac crest divided the gluteus medius muscle in three parts (anterior, middle and posterior). The distances from the tip of the greater trochanter to i) the point at which the inferior branch entered the gluteus medius, ii) the branch to the tensor fasciae latae, and iii) the branch to the gluteus minimus muscle were recorded.

Tissue specimens of the intermuscular region which seemed to contain distal branches innervating the tensor fasciae muscle were formalin-fixed, stained with hematoxylin and eosin, and examined by a histopathologist.

Results

In 18 cases, the superior gluteal nerve showed a spray pattern; in the remaining 2, it showed a transverse neural trunk pattern (Figure 1). The spray pattern was formed by multiple divisions of the gluteal superior nerve after entering the intermuscular plane between gluteus medius and minimus muscles, whereas the transverse neural trunk has few but prominent branches. The branch of the gluteal superior nerve leading to the gluteus minimus muscle was 33 (20–50) mm proximal to the tip of the greater trochanter. The nearest point of the branches of the superior gluteal nerve to the tip of the greater trochanter was 19 (10–30) mm in the posterior region, 20 (20–30) mm in the middle region, and 20 (10–35) mm in the anterior region.

In 10 cases, we found a distal branch crossing between the ventral gluteus medius and the tensor fasciae latae muscles, which was mean 27 (10–40) mm caudal and 38 (25–60) mm ventral to the tip of the greater trochanter. This branch was independent of the lateral femoral circumflex artery (Figure 2). Histological examination of this branch

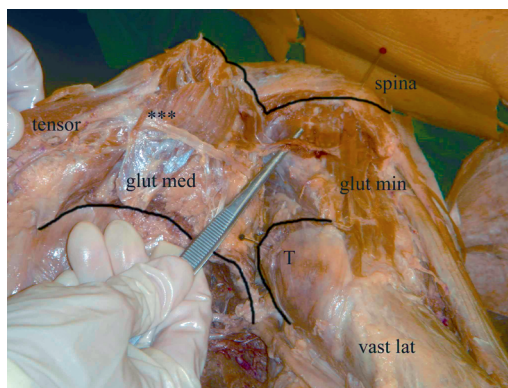


Figure 1. The gluteal medius muscle was detached from the crista iliaca and the greater trochanter, revealing the intermuscular plane. The superior gluteal nerve with its branch to tensor fasciae latae (***) and to the gluteal minimus muscle (with the tweezers) was demonstrated from the caudal view at the right side; (tensor: tensor fasciae latae muscle; glut med: gluteus medius muscle; glut min: gluteus minimus muscle; T: greater trochanter; vast lat: vastus lateralis muscle; spina: spina iliaca anterior superior).

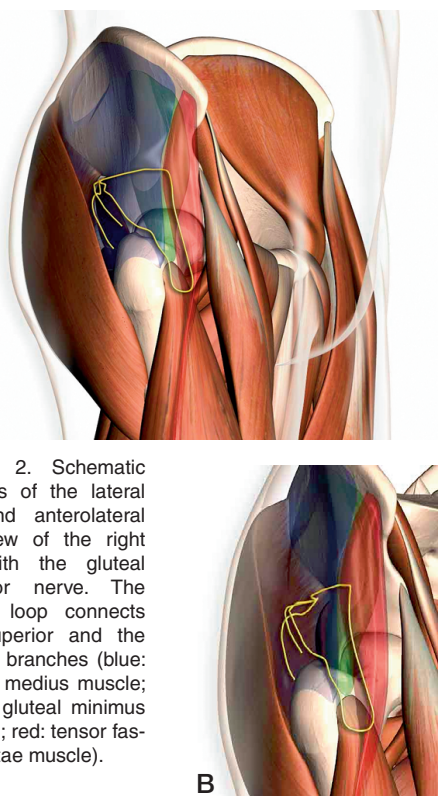


Figure 2. Schematic pictures of the lateral (A) and anterolateral (B) view of the right hip with the gluteal superior nerve. The neural loop connects the superior and the inferior branches (blue: gluteal medius muscle; green: gluteal minimus muscle; red: tensor fasciae latae muscle).

showed neural tissue that was considered to create a loop within the tensor fasciae muscle with upper branches.

Discussion

The roots of the superior gluteal nerve (L4, L5, and S1) arise within the pelvis from the sacral plexus, and enter the buttock through the greater sciatic foramen, above the piriformis muscle. The nerve proceeds laterally between the gluteus medius and minimus. It divides into the superior and inferior branches. Two patterns were found, based on previous findings in 10 cadavers (Jacobs and Buxton 1989): in 18 of our cases the “spray pattern” was observed and in 2 cases the “transverse neural trunk pattern” was seen. The spray pattern showed a division of the superior gluteal nerve within 1 or 2 cm of the superior border of the piriformis muscle, into branches that fanned out along the medius and minimus intermuscular plane. One of the major branches to the gluteus minimus muscle continues anteriorly to supply the tensor fasciae latae muscle. The transverse neural trunk pattern shows short branches to the medius and minimus muscle with a terminal branch to the tensor fasciae latae muscle.

It has been suggested that a standard “safe area” of at least 5 cm may not be useful in every patient because of differences in body height (Baker and Bitounis 1989, Comstock et al. 1994, Eksioglu et al. 2003).

Eksioglu and coworkers (2003) showed that there was a linear relationship between the heights of cadavers and the distances between the superior gluteal nerve and the tip of the greater trochanter. They demonstrated that the mean distance between the most distal branch of the superior gluteal nerve and the greater trochanter was 2.7 (2.0–3.3) cm in the anterior regions, and 4.6 (4.0–5.2) cm in the posterior region, in cadavers with an average body height of 166 (160–175) cm. In light of our findings, a “safe area” is hard to define. One explanation for the differences between our findings and those in previous investigations (Baker and Bitounis 1989, Jacobs and Buxton 1989, Bos et al. 1994) may be the smaller sizes of the cadavers we studied, which had a mean height of 162 cm.

In half of our cases, we found a neural structure between the gluteus medius and the tensor fasciae latae muscles which was connected to the terminal branch descending from the gluteus minimus muscle. This neural loop has not been described

before. In those cases, the tensor fasciae muscle may be innervated in two ways: from superior and inferior. It is unclear whether, after damage to one branch, the remaining branch is able to innervate the complete muscle.

From the clinical point of view, the minimally invasive anterolateral approach (Bertin and Rottinger 2004) provides less overview of the stem and runs the risk of damaging the branch of the gluteal superior nerve possibly innervating part of the tensor fasciae latae muscle. On the other hand, even a short-incision direct lateral approach to the hip provides a better overview of the femoral region, but damage to the ventral third of the gluteus medius muscle is more likely. The anterior approach using the interval of the tensor fasciae latae and the rectus muscle is an alternative (Judet and Judet 1950, Keggi et al. 2003). However, complications affecting the lateral femoral cutaneous nerve had been reported (Rachbauer 2005). In contrast, the risk of damaging the gluteal superior nerve is minimized (Rachbauer 2005).

Our current clinical practice is to use the lateral approach, aiming to split only 2 cm of the ventral region of the gluteal medius muscle. However, one must realize that even small anterolateral or lateral approaches may compromise gluteus medius and tensor fasciae latae muscle function.

Contributions of authors

AI, CH: study design. AI, MK, JW: anatomical study and data analysis. AI: draft manuscript. CH: manuscript revision.

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