Bleeding from the superior gluteal (SG) blood vessels at the greater sciatic notch is frequently encountered during acetabular fracture surgery. The purpose of this study is to define the positional anatomy of the superior gluteal vessels and nerve (SGVAN) at the greater sciatic notch. Twenty-three hemipelvis were dissected in whole human cadavers. The greater sciatic notch and SGVAN were visualized via a posterior surgical approach, identified deep in the greater sciatic notch, and traced superficially. Branches of the SGVAN and their anatomical relationship to each other were recorded. In the notch, SG arteries comprised a single vessel in 18 (78%) of 23 specimens, with all of these dividing at varying distances (1-3.5 cm) along the lateral ilium after dividing into superior and inferior branches. The SG artery branches were contiguous with periosteum of the bony notch in all specimens. More than 1 SG nerve branch was seen in the greater sciatic notch of all specimens, including an inferior branch that exited caudal or caudal-superficial to the SG vessels. The caudal-most SG nerve branch was directly adjacent to the bony notch’s periosteum in 15 (65%) of 23 specimens. The SGVAN are at risk in patients undergoing acetabular fracture surgery. Individuals performing surgery along the acetabulum’s posterior column would expect to encounter a major SG nerve branch (deep inferior) before encountering the SG vessels in all cases. Iatrogenic injuries to the SGVAN might be prevented by avoiding use of cautery in this area if hemorrhage is encountered. [Orthopedics. 2015; 38(10):e929-e933.]

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The origin and the intra- and extra-pelvic anatomy of the superior gluteal (SG) nerve and vessels have been well described. The SG artery is the largest branch of the internal iliac artery, exiting the pelvis through the greater sciatic notch above the piriformis and ultimately branching to provide blood supply to the posterior abductors, including the gluteus medius and minimus, and ultimately connecting with the femoral system more anteriorly. The SG veins are venae comitantes of the superior gluteal artery; they receive tributaries from the buttock closely corresponding with the branches of the artery and frequently unite before ending in the hypogastric vein. The SG nerve originates from the sacral plexus, arising from the fourth and fifth lumbar and first sacral nerves, and follows a similar course as the SG blood vessels.

The relationship of the SG nerve to the nerve in the greater sciatic notch, although recognized, has not been fully investigated. These structures may be injured either from an acetabular or pelvic fracture or during its surgical repair. Iatrogenic injury to the SG vessels and nerve (SGVAN) can occur during the Kocher-Langenbeck approach or the posterior approaches to the sacrum, ilium, or sacroiliac joint. Treatment recommendations for SG vessel injury (ie, bleeding) from the notch are based on the close anatomic relationship of these structures to each other. For example, authors recommend treating SG artery or vein injury in the greater sciatic notch with packing, which may not be successful at stopping a hemorrhage.

In the setting of a hemorrhage, Letournel and Judet stated that the isolation of the SG nerve from its associated vessels is practically impossible. The rationale for packing is to avoid inadvertent ligation, clipping, or cauterization of the SG nerve, which would be expected to cause permanent abductor dysfunction, including limping. Sequelae of injuries to these structures, such as hemorrhage, pain, abductor weakness, or gait disturbances, may potentially be unrecognized iatrogenic injuries. Based on the close proximity of the SGVAN in the notch and the potential for iatrogenic injury, it is helpful for the surgeon to understand the SGVAN anatomical relationship and potential variations. However, little information is available describing the actual anatomy and spatial relationships between the SGVAN at the greater sciatic notch. The purpose of this study is to define the anatomical relationships of the SGVAN in the greater sciatic notch in a human cadaver model.

**Materials and Methods**

This study was conducted in a bioskills laboratory adjoining a medical school gross anatomy laboratory. Twenty-three hemipelvis were evaluated in 17 embalmed whole human cadavers using an open posterior approach to the sciatic notch and the SG neurovascular structures. A single fellowship-trained orthopedic trauma surgeon performed the approaches with the assistance of an orthopedic resident (C.A.C.). Cadavers were positioned prone on the operating table. The gluteal musculature was elevated to expose the greater sciatic notch and posterior ilium. The SGVAN were identified in the greater sciatic notch and carefully traced deep into the notch and superficially with elevation of the gluteal muscles along the posterior ilium. The piriformis was mobilized medially to fully assess the structures and assess for branching. Branching and positional information of the SGVAN were recorded in a computer database.

Data collected included the gender, age, and side of the specimens. The SG artery was evaluated for its proximity to bone and whether it had major branches present. The SG vein was characterized by 2 or more venae comitantes, closely and predictably associated with the artery and its branches. The SG veins were capacious, thin walled/brittle, and easily damaged, making quantification of their and the associated relational anatomy difficult to assess. Thus, for purposes of this study, the veins were sacrificed in the dissection and the SG vessels were considered together. The SG nerve was evaluated for branching, proximity to bone, and anatomical relationship to the artery.

The demographic and morphologic data are strictly descriptive not comparative; therefore, descriptive statistics were used.

**Results**

Thirteen male and 4 female specimens were included, with a mean age of 71.2 years (range, 44-94 years). Fourteen right and 10 left sides were studied. All specimens had a superficial branch dividing off the main artery (or its branches) upon exiting the notch that travelled peripherally toward the gluteus maximus muscle. At the notch, the SG arteries comprised a single vessel in 18 (78%) of 23 specimens, with all of these dividing at varying distances (1-3.5 cm) along the lateral ilium after exiting into superior and inferior branches (Figure 1). In the other 5 (22%) specimens, branching of the artery occurred deep to or in the notch, resulting in 2 similar sized vessels that exited following a similar path as the others along the outer ilium (Figure 2). The SG artery (or its 2 branches) was contiguous with periosteum of the bony notch in all 23 cadavers.

More than 1 SG nerve branch was observed at the greater sciatic notch in all specimens (Figures 1-2). A superior branch typically exited cranial to the SG artery and an inferior branch exited caudal to the artery. The relationship between the inferior branch of the SG nerve and artery in the notch was consistent in 21 (91%) of 23 specimens, with the nerve branch found in the caudal direction in all cases. In these cases, the inferior branch of the SG nerve was found adjacent and caudal to the artery, lying directly on periosteum in 14 (67%) specimens and caudal but superficial and nonadjacent to periosteum in 7 (33%) specimens. In the remaining 2 (9%) specimens, there was more of a “spray” pattern, where numerous branches of the nerve were present that notably...
intermingled around the vessels, including lying on periosteum in the caudal to the vessels. As such, individuals performing surgery along the posterior acetabular column would expect to encounter the deep inferior SG nerve branch before the SG vessels in all cases.

**DISCUSSION**

The SG artery, vein, and nerve exit the pelvis through the upper part of the greater sciatic notch proximal to the piriformis muscle. The artery divides into several branches shortly thereafter that travel anteriorly to supply the gluteal musculature or anastomose with the deep circumflex iliac and lateral femoral circumflex arteries. The nerve also branches, coursing along with the SG blood vessels, innervating the gluteus medius and minimus, and terminating in the tensor fascia lata.

Several prior studies have examined the SG artery and nerve anatomy on the posterior ilium exiting the greater sciatic notch. Ebraheim et al. performed a quantitative study of the superior gluteal artery in 20 cadavers and noted the following: (1) the artery exits through the upper part of the greater sciatic oramen above the piriformis and divides into a superficial branch (gluteus maximus) and a deep branch (medius/minimus); (2) the deep superior branch of the SG artery inserted into the medius at an average of 29 mm from the anterior superior iliac spine and provided 4 to 7 perforators to the medius and 0 to 2 perforators to the minimus; and (3) the average distance of the deep inferior branch of the SG artery from the superior acetabulum was 25 mm and provided 3 to 8 perforators to the medius and 1 to 3 perforators to the minimus. It is this deep inferior branch of the SG artery that is most at risk of being injured (ie, excessive retraction, laceration) during exposure of the posterior column during acetabular surgery (eg, Kocher-Langenbeck approach).

The authors also noted that, in the majority of cases, the SG nerve was located just anterior to the SG artery against the bony notch. Akita et al. described the anatomy of the superior gluteal nerve and relationship of the SG nerve to the SG artery external to the notch to their muscular terminations in 10 hemipelvi. Those authors reported the following: (1) in all specimens, the SG nerve was divided into a thick cranial part and a thin caudal part by the deep branch of the SG artery; (2) the cranial, or inferior, branch of the SG nerve ran on the lateral surface of the deep and upper branches of the SG artery and supplied the posterior part of the medius and upper branches of the cranial, or superior, branch of the SG nerve formed a bundle that ran along the medial surface of the deep and lower branches of the SG artery and supplied the anterior/middle parts of the medius, the minimus, and the tensor fascia lata. Jacobs and Buxton mapped the course of the SG nerve on the lateral ilium and found that in 18 of 20 specimens, the SG nerve divided within 1 or 2 cm from the superior border of the piriformis. These SG branches then “fanned” out along the intramuscular plane between the gluteus medius and minimus muscles. Despite numerous studies regarding the SGVAN anatomy deep and peripheral to the greater sciatic notch, to the authors’ knowledge, this study is the first that has evaluated the positional anatomy of the SGVAN at the notch, which might be valuable information for an acetabular or hip surgeon who encounters intraoperative bleeding from the greater sciatic notch. Furthermore, despite seemingly concise descriptions in some of these previous studies, the current authors encountered some variation of the SG anatomy in this area. The following anatomy was observed:

1. The SG artery lay on the periosteum of the posterior ilium at the notch, exit-
ing as 1 vessel (78%; Figure 1A) or divided in the notch into 2 similarly sized branches (22%; Figures 1B-C). Either way, upon exiting the notch, a superficial branch split off toward the medial gluteus maximus. Then, the deep SG artery coursed superiorly and anteriorly along the ilium between the gluteus medius and gluteus minimus. If the deep branch was 1 vessel exiting the notch, it quickly bifurcated into superior and inferior divisions that separated coursing anteriorly along the outer ilium.

2. Anatomy of the SG veins included more than 1 branch, intimately associated with the artery as is typical for *venae comitantes*. The positional relationships of the nerve and nerve branches to the vein were similar to that for the artery and nerve.

3. The SG nerve may exit the notch in 2 (superior and inferior) or more branches (Figure 1). These branches of the SG nerve then course along the outer ilium with the superior and inferior branches of the SG artery. The deep inferior branch(es) of the SG nerve appear to be at greatest risk during exposure of the posterior column or in attempts to stop bleeding from an injured artery.

**Conclusion**

Several scenarios exist in which specific knowledge of the SGVAN anatomy would be particularly important to a pelvis and acetabular surgeon.8 Posterior column fractures often exist in this area, creating sharp edges that may injure or predispose the SG anatomy to iatrogenic injury. The Kocher-Langenbeck approach to the posterior column itself risks injury to the superior gluteal vessels and nerves that are tethered through the greater sciatic notch. The SGVAN lie on the deep, or medial, surface of the gluteal muscles. During elevation of the glutei near the notch in acetabular surgery (or during retractor placement in the notch in posterior approach to sacrum), the vessels may be torn or stretched, typically where they lie against the ilium at the top of the notch. If transected, they may retract into the pelvis with subsequent intrapelvic hemorrhage, or more simply may be partially lacerated and continue to bleed because direct visualization is usually difficult in this area.

If injury occurs, placing a laparotomy sponge or a procoagulant substance in the notch is advised—as opposed to cautery or application of a ligature or vascular clip, which would place the SG nerve or its major branches at risk. In infrequent cases, angiography or the use of an anterior surgical approach have been necessary to control hemodynamic/physiologic instability despite these recommendations.

Although not in the scope of this article, some acetabular surgeons will perform a trochanteric slide osteotomy to facilitate mobilization of the abductors and prevent the aforementioned iatrogenic injury to the SGVAN.13

The SGVAN supply vascularity and innervation to the gluteus medius, gluteus minimus, and tensor fascia lata and are at risk in patients with a pelvic or acetabular fracture and those undergoing pelvic or acetabular surgery. During the Kocher-Langenbeck approach, the deep inferior branches of the SGVAN are at risk. The nerve is encountered first because the SG nerve is always caudal to the vessels. Although the anatomy of the individual structures (ie, nerve or artery) has been individually described and injuries to these neurovascular structures are documented, prior to the current study little attention had been paid to defining their anatomical relationships to dictate surgical treatment if the surgeon experiences uncontrolled bleeding from the greater sciatic notch. Iatrogenic injuries such as these should be averted if the surgeon is cognizant of the anatomic relationship of these structures to each other and uses appropriate practice (ie, packing or a procoagulant) if unforeseen hemorrhage is encountered.

**References**

