

## ORIGINAL ARTICLE

# Sciatic nerve localization relative to the position of the hip, an anatomical study

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**ABSTRACT.** *The incidence of iatrogenic peripheral nerve injury during hip arthroplasty procedures has been reported to be between 0.6 and 1.3 percent. The relative risk of nerve palsy is higher in certain groups of patients such as women, patients with developmental dysplasia of the hip, and those who have undergone revision arthroplasty. In this study, the dynamic relationship between the acetabulum and the sciatic nerve, which is important for preventing sciatic nerve palsy during the hip surgery, was investigated. The sciatic nerve was exposed in 69 cadaveric hips. The relationship between the bony acetabulum and the sciatic nerve was examined in three different positions; as the ipsilateral hip was flexed; extended; or in neutral position. We found that the middle part of the posterior acetabular rim was closer to the sciatic nerve than its superior or inferior parts. The sciatic nerve was perilous when the ipsilateral hip was flexed and the middle part of the posterior acetabular rim was more risky than the superior or inferior parts, in terms of iatrogenic sciatic nerve injury.*

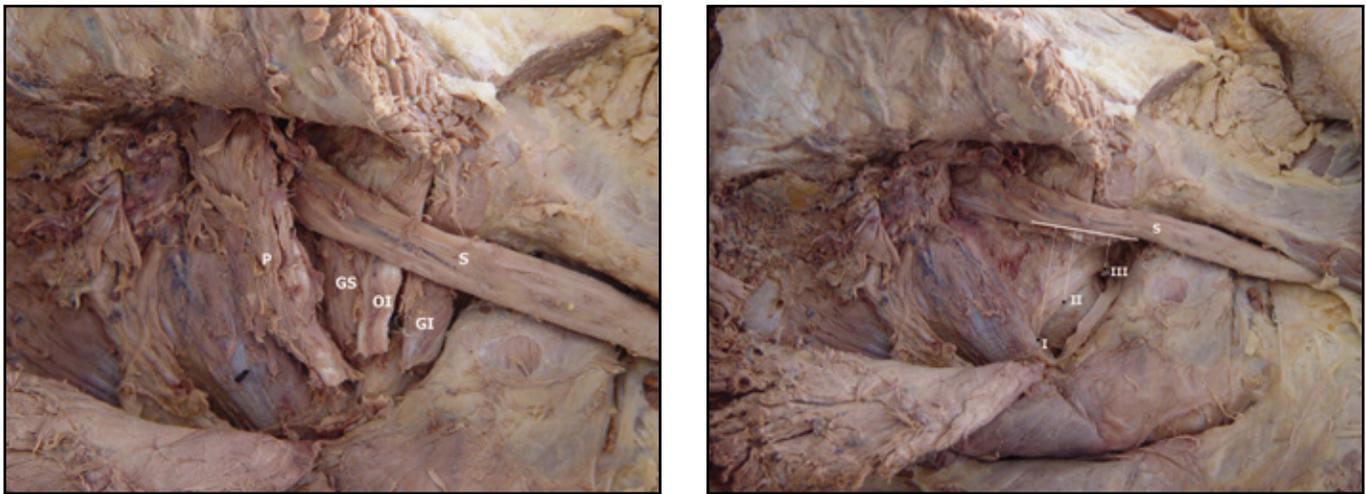
**KEY WORDS:** *Hip, Arthroplasty, Sciatic nerve, Iatrogenic, Injury*

*Accepted: January 14, 2011*

## INTRODUCTION

The incidence of iatrogenic peripheral nerve injury during hip arthroplasty procedures has been reported to be between 0.6 and 1.3 percent, and more than 90 percent of the observed nerve palsies involve the sciatic nerve (1). Sciatic nerve palsy may result from direct injury of the nerve, compression, or excessive retraction, thermal damage during cement polymerization and trauma during dislocation or reduction of total hip arthroplasty (THA) (2). The relative risk of nerve palsy is higher in certain groups of patients such as women, patients with developmental dysplasia of the hip, and those who have undergone revision arthroplasty (3).

Traditionally, lateral or posterior approaches are used in THA. The posterior approach provides comfortable exposure of the sciatic nerve. On the other hand, in the lateral approach, the surgeon can not identify the sciatic nerve during the procedure. When preparing the acetabulum, elevators which are placed to the posterior acetabulum are shown to be in close proximity to the sciatic nerve. To minimize the risk, it is necessary to define the relationship of the sciatic nerve with the acetabulum, according to the hip position, during THA. As far as we know, there are no such studies to report the distance between the posterior bony acetabulum and the sciatic nerve, according to hip movement. We aim to investigate human sciatic nerve localizations, relative to hip flexion or extension positions.



**Fig. 1** - Photographs of cadaveric dissection, demonstrating the Moore approach to the sciatic nerve (left hip); **A**) After elevating the gluteus maximus muscle, piriformis (P), gemellus superior (GS), obturator internus (OI), gemellus inferior (GI) muscles and the sciatic nerve were seen; **B**) Posterior joint capsule was removed to reveal the acetabular rim. Three reference points on the acetabular rim are marked as I (superior), II (middle), and III (inferior). To measure the distance between the sciatic nerve and the reference points, vertical lines were drawn to the sciatic nerve.

## MATERIALS AND METHODS

An anatomic cadaveric dissection study was performed in the Anatomy Department of the Istanbul Faculty of Medicine. We used 39 cadavers with 69 hips. Remaining nine hips were excluded because of the decomposition of the related region's integrity. 34 cadavers were male and five were female. Each cadaver was placed in the prone position on a stainless steel table. The sciatic nerve was exposed via a Moore approach; the piriformis, obturator internus, superior gemellus, and inferior gemellus muscles, as well as, the posterior joint capsule were removed to reveal the acetabulum and the sciatic nerve (Fig. 1). To determine the relationship between the sciatic nerve and acetabulum, we used three reference points on the acetabular rim as superior, middle, and inferior (Figs. 1, 2). The most proximal point of the superior acetabular rim was considered as the 12 o'clock position. The superior reference point was the one o'clock position for the left hip and the 11 o'clock position for the right hip. The middle reference point was the 3 o'clock position for the left hip and 9 o'clock position for the right hip. The inferior reference point was the 5 o'clock position for left hip and 7 o'clock position for the right hip (Fig. 2). The distances on the vertical axis between the reference points and the sciatic nerve were measured with a digital callipers when the hip was extended, flexed, and in the neutral position.

## Statistics

Statistical analyses were performed with the NCSS 2007 pocket program. Results were evaluated with descriptive statistical methods such as mean and standard deviation. Kruskal Wallis analysis was used to compare the groups and Dunn's multiple comparison test was used to compare the subgroups. Significance level was set to  $p < 0.05$ .

## RESULTS

59 male hips compared to 10 female hip, but there was no statistical difference between male and female hips.

The superior reference point is significantly distant, relative to the middle reference point, regarding all positions of the hip ( $p < 0.0001$ ). The middle reference point is significantly close, relative to the inferior reference point, for all positions of the hip ( $p < 0.001$ ) (Tab. I). Thus, for all positions of the hip, the closest point to the sciatic nerve is the middle reference point, as compared to the superior and inferior reference points (Tab. II).

For the middle reference point, the mean extension measurement is significantly distant compared to the mean flexion measurement ( $p = 0,0001$ ), and the mean extension measurement is significantly distant compared to the mean neutral measurement ( $p = 0,031$ ). Therefore, the saf-

est retractor replacement posture for the middle reference point is in extension (Tab. III).

Except for the superior reference point, the flexion posture is more risky than the neutral or extension position with respect to the middle and inferior reference points ( $p < 0.046$ ,  $p < 0.011$ , and  $p < 0.0001$ , respectively) (Tab. III). For flexion posture of the hip, the safest point for retractor replacement is the superior reference point ( $p < 0.0001$ ) (Table I).

## DISCUSSION

We know that the acetabular quadrant system, that has been described by Wasielewski, helps surgeons during transacetabular screw placement in THA (4). The posterior superior, and posterior inferior acetabular quadrants contain the best available bone stock and are relatively safe for the transacetabular screw placement (4). The most important structure that is defined in the posterior quadrant is the sciatic nerve. The relative risk of the sciatic nerve palsy is higher in certain groups of patients such as women, patients with developmental dysplasia of the hip, and those who have undergone revision arthroplasty (3). We studied in normal hips, and no significance difference found between male and female hips.



**Fig. 2** - Bony anatomy of the left hip is seen from the posterior aspect. The superior reference point (I) is the 1 o'clock position, the middle reference point (II) is the 3 o'clock position, and the inferior reference point (III) is the 5 o'clock position.

In the lateral Hardinge approach, the surgeon should place the retractor on the posterior bony acetabulum for better exposure. As a result of this study, it has been found that the middle reference point, which is always used for acetabular retractors, is more risky than the superior or inferior reference points for the sciatic nerve injury. The

**TABLE I** - KRUSKAL WALLIS (KW) TEST RESULTS

Hip position	Flexion	Neutral	Extension	KW	p
Superior reference point	24,42 ± 4,95	25,66 ± 4,96	26,82 ± 5,19	8,77	0,012
Middle reference point	19,36 ± 4,11	21,05 ± 4,03	22,84 ± 4,26	22,50	0,0001
Inferior reference point	22,2 ± 4,72	24,74 ± 4,98	26,47 ± 5,59	19,88	0,0001
KW	35,82	33,61	25,61		
p	0,0001	0,0001	0,0001		

**TABLE II** - DUNN'S MULTIPLE COMPARISON TEST

	Flexion	Neutral	Extension
Superior / Middle	0,0001	0,0001	0,0001
Superior / Inferior	0,014	0,478	0,912
Middle / Inferior	0,001	0,0001	0,0001

**TABLE III** - DUNN'S MULTIPLE COMPARISON TEST

	Superior	Middle	Inferior
Flexion / Neutral	0,317	0,046	0,011
Flexion / Extension	0,015	0,0001	0,0001
Neutral / Extension	0,365	0,031	0,116

surgeon should prefer the posteroinferior acetabulum instead of the middle one or should put a retractor to the middle of the posterior acetabulum when the hip is in extension posture.

This is particularly important in hip arthroscopy. The posterolateral portal is closest to the sciatic nerve at the level of the capsule, with the average distance of 2.9 cm (5). Our direction should not course to the middle part of the posterior acetabulum when introducing the posterolateral portal.

The current data support a correlation between the position of the hip and localization of the sciatic nerve. The sciatic nerve is at a risk when the hip is in the flexion posture. In a study of Fleming et al, significant increases in strain (up to 30 percent) in the sciatic nerve were observed during flexion of the hip and extension of the knee (3). Borelli and coworkers demonstrated that intraneural tissue fluid pressures, measured within a localized section of the sciatic nerve, appeared to exceed the published critical thresholds for alterations of blood flow and neural function only when the hip was flexed to 90 degrees and the knee was fully extended (6). Another study in canine sciatic nerves showed that while the hip was flexed and internal rotated and the knee was slightly flexed, blood flow was decreased (7). Maintaining the hip in neutral or in extension position during the acetabular procedure can keep us in a safe distance from the sciatic nerve reduce tension on the nerve, preserve its blood supply, and decrease the risk of nerve palsy. The result of the study reveals that, retractors should not be used in the flexion posture of the hip. If necessary, posterosuperior acetabulum should be used for retractor placement.

Some surgeons advocate resecting the posterior capsule, especially when the posterior capsule is tight (8). However, we think that the posterior capsule is a preventive tissue to avoid retractors to be placed too deep, and thus protects the sciatic nerve. We prefer not to resect the posterior capsule in cases such as primary coxarthrosis or non-dysplastic hips.

The surgeon must be aware of another important anatomical characteristics of the sciatic nerve. Exiting from the greater sciatic notch, the sciatic nerve descends between the greater trochanter of the femur and the ischial tuberosity. The nerve passes along the back of the thigh, where it is crossed by the long head of the biceps femoris muscle and it divides into the tibial and common peroneal (fibular) nerves proximal to the knee. The actual level of

division is very variable as the tibial and common peroneal nerves are structurally separate and only loosely connected throughout their proximal course (9). Therefore, if the sciatic nerve is damaged with the malposition of the retractor, the patient can have just fibular nerve palsy rather than total sciatic nerve palsy.

Several limitations of this model should be acknowledged. We did not determine sciatic nerve localization relative to knee position, because all knees were in the extension position. Moreover, it would be better for us to use an equal number of female and male cadavers for statistical conclusion.

In conclusion, sciatic nerve localization is influenced by the position of the ipsilateral limb. The sciatic nerve is at risk when the hip is in the flexed posture and the closest point between the posterior acetabulum and sciatic nerve is the middle part of the posterior acetabular rim. We should prefer posterior acetabulum for retractor placement when the hip is in the extension posture or at least neutral posture. We should keep away from the middle of the posterior bony acetabulum during THA.

## ACKNOWLEDGEMENTS

*Statistical consultation of this study was provided by Rana Konyalioglu, Istanbul University Medical Faculty Graduate School Of Health Sciences, Department of Biostatistics MSC.*

*Financial support: No sources or public and private grants and funds were used in support of this study.*

*Conflict of interest statement: All authors state that they have no proprietary interest.*

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