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Variations in the High Division of the Sciatic Nerve and Relationship Between the Sciatic Nerve and the Piriformis

Siyatik Sinirin Yüksek Divizyon Varyasyonları ve Piriformis-Siyatik Sinir İlişkisi

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ABSTRACT

OBJECTIVE: The sciatic nerve (SN) separates into its branches, the tibial and common fibular nerves, outside the pelvis. However, it may rarely be separated within the pelvis. In such cases, the tibial nerve and the common fibular nerve may leave the pelvis through different routes. These variations may cause nerve compressions under other anatomic structures, resulting in non-discogenic sciatica. The aim of this study was to define the level of the SN exit and of the SN division.

MATERIAL and METHOD: 50 gluteal regions were examined in 25 formalin-fixed adult male cadavers.

RESULTS: In 52% of the cases, the SN exited the pelvis as a whole nerve without any division, whereas in 48% a high division was observed. Branches of the SN left the pelvis through the infrapiriform foramen (IP) as two separate nerves In 24%. One branch of the SN left the pelvis through the IP and other through a different route in another 24%.

CONCLUSION: The differences in the exit routes of these two nerves are important in clarifying the clinical etiology of nondiscogenic sciatica. These variations require reviewing the piriformis syndrome.

KEYWORDS: Greater sciatic foramen, Piriformis syndrome, Sciatica, Anatomic variation, Gluteal region

ÖZ

AMAÇ: Siyatik sinir (SS) çoğunlukla, pelvis dışında tibial (TS) ve common fibular (CFS) dallarına ayrılır. Ancak bazan pelvis içinde de dallara ayrılabilir. Bu durumlarda iki sinir farklı yollardan geçerek pelvisten çıkabilirler. Bu varyasyonlar, nondiskojenik siyatika ile sonuçlanan sinir basılarına neden olabilir. Bu çalışmanın amacı, SS'nin farklı bölünme mesafelerini ve pelvisten çıkış varyasyonlarına dikkat çekmektir.

GEREÇ-YÖNTEM: 25 formalin ile fikse erişkin erkek kadavranın 50 gluteal bölgesi disseke edilerek değerlendirildi.

BULGULAR: SS, %52 oranında dallarına ayrılmadan bütün olarak çıkmakta, %48'inde ise yüksek bölünme göstermektedir. %24'ünde SS'nin ayrılmış dalları infrapiriform foramen (IP)'den geçerek pelvisten çıkarken diğer %24'ünde ise dallardan biri IP dışında farklı bir yoldan geçer.

SONUÇ: SS'nin dallarının farklı yollardan geçerek pelvisten çıkması non-diskojenik siyatika klinik etiyolojisinin tanımlanmasında önem taşır. Bu varyasyonlar piriformis sendromunu değerlendirmek için gereklidir.

ANAHTAR SÖZCÜKLER: Büyük siyatik foramen, Piriformis sendromu, Siyatika, Anatomik varyasyon, Gluteal bölge

INTRODUCTION

The sciatic nerve (SN) is formed in the pelvis by joining anterior divisions of L4-S3 spinal nerve roots. It is almost 2 cm wide at its origin near the sacral plexus. Two separate nerve trunks (the Tibial Nerve and the Common Fibular Nerve) enveloped by a common fascial sheath (epineural sheath) can be distinguished from the onset. These two trunks leave the pelvis through the greater sciatic foramen below the piriformis. The nerve passes along the back of the thigh, and divides into the tibial (TN) and common fibular nerves (CFN) proximal to the knee (23). There is a close relationship between the SN and the intrapelvic muscles (especially piriformis) along its course (10).

The piriformis, one of the intrapelvic muscles, may compress the SN and cause the piriformis syndrome (PS) (3,6,9,18,21,22). PS not only occurs due to piriformis hypertrophy, inflammation or irritation, but also may be caused by congenital variations of the piriformis and the SN.

Previous studies reported a variety of different anatomic relations between the SN or its terminal branches and the piriformis (1,2,4,7,8,11–17,19–21,24,25). The undivided nerve may emerge above the piriformis or through the muscle. The major divisions of the nerve may lie either side of the muscle, or (the most common variant) one division either above or below. The evidence of each variation may cause different clinical presentation.

It is known that each anatomical variation may reflect a different and a case-specific clinical presentation. This requires a detailed description of anatomical variations. The aim of this study was to define the level of the SN exit, and to determine the level of the SN division.

MATERIAL and METHOD

Twenty-five adult male cadavers with no pathology were used for this study. 50 gluteal regions of 25 adult male cadavers fixed with formalin were evaluated. The gluteus maximus was elevated to explore the piriformis, the superior gemellus, the obturator internus, the inferior gemellus and the quadratus femoris. Following proper exposure of the pelvis, the evidence of variation in the SN was recorded. The location where the SN exits the pelvis and the level of the SN division were all recorded.

RESULTS

The SN exited the pelvis through the infrapiriform portion of greater sciatic foramen (IP) with no variation in 38 of the 50 gluteal regions (76%).

The SN exited the pelvis as an undivided nerve in 26 gluteal regions (52%) (Figure 1). There was evidence of high division of the SN in 24 gluteal regions (48%). The TN and the CFN leave the pelvis through the infrapiriform portion of greater sciatic foramen (IP) together within the different sheath in 12 out of 24 gluteal regions with high division (24%) (Figure 2).

In the remaining 12 gluteal regions with high division (24%), one of the branches left the pelvis following a different route (Figures 3,4).

The CFN passed through the piriformis and the TN through the IP in seven gluteal regions (bilaterally on one of the cadavers and unilaterally on five cadavers) (16%) (Figure 3). The CFN passed

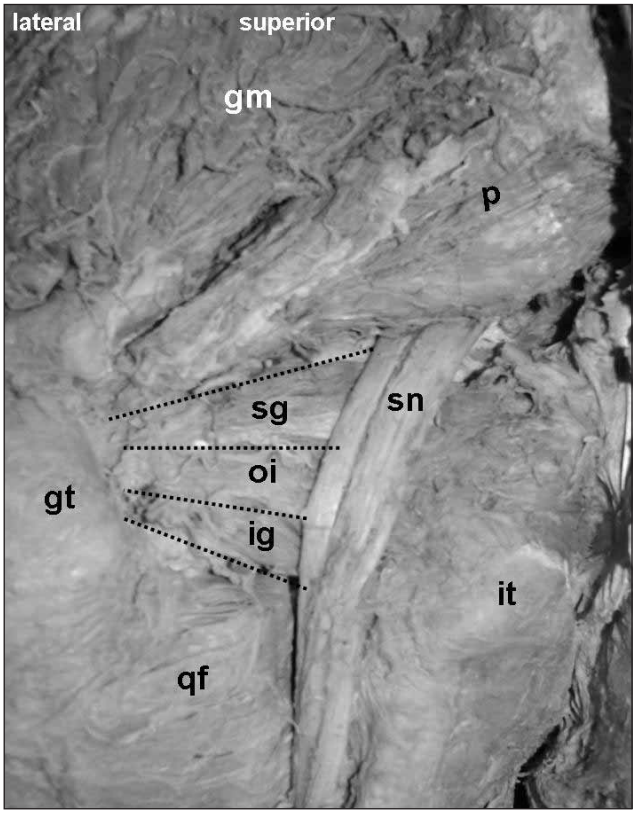

Figure 1: *The SN exits the pelvis as an undivided nerve through the infrapiriform portion of the greater sciatic foramen in the left gluteal region:* ***gm****: gluteus medius,* ***p****: piriformis,* ***sg****: superior gemellus,* ***oi****: obturator internus,* ***ig****: inferior gemellus,* ***qf****: quadratus femoris,* ***it****: ischial tuberosity,* ***gt****: greater trochanter,* ***sn****: sciatic nerve.*

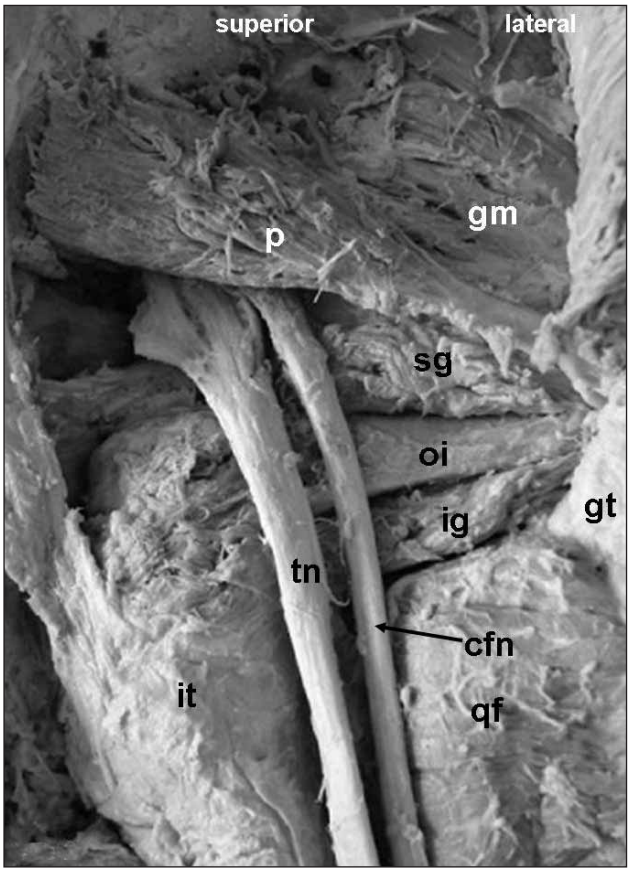

Figure 2: *The tibial (**tn**) and the common fibular nerve (**cfn**) branched from sciatic nerve but again from the infrapiriform portion of the greater sciatic foramen together with the common fibular nerve and tibial nerve in the right gluteal region. **gt**: greater trochanter, **it:** ischial tuberosity, **gm**: gluteus minimus, **p**: piriformis, **sg**: superior gemellus, **oi**: obturator internus, **ig**: inferior gemellus, **qf**: quadratus femoris.*

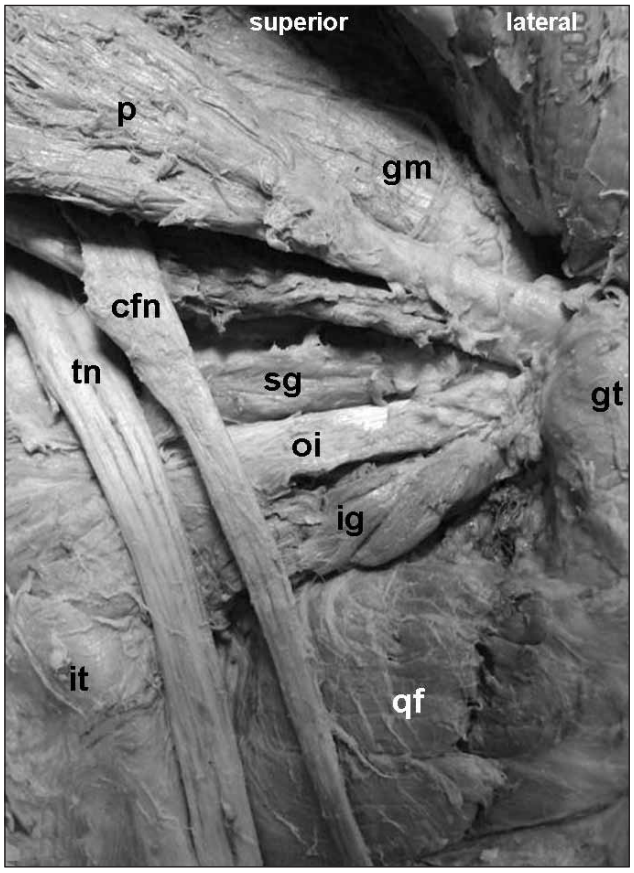

Figure 3: *The common fibular nerve (**cfn**) passed through the piriformis (**p**) fibers and the tibial nerve (**tn**) got through the infrapiriform portion of greater sciatic foramen in the right gluteal region. **gt**: greater trochanter, **it**: ischial tuberosity, **gm:** gluteus minimus, **p**: piriformis, **sg**: superior gemellus, **oi**: obturator internus, **ig**: inferior gemellus, **qf**: quadratus femoris.*

through the suprapiriform portion of greater sciatic foramen (SP) and the TN through the IP in four gluteal regions (two unilateral and one bilateral) (8%) (Figure 4).

DISCUSSION

The piriformis syndrome is one of the causes of the non-discogenic sciatica. It occurs secondary to the compression of the sciatic nerve (SN) by an abnormal piriformis. The presence of variations in the relationship between the SN and the piriformis may contribute to the occurrence of the piriformis syndrome. The type of variation may reflect the clinical presentation of the piriformis syndrome. In other words, the compression of the unsplitted SN, the CFN and the compression of the TN may cause different clinical pictures.

This study demonstrated the existence of high SN division in 48% of the cases, as well as the abnormal exit of the SN or its branches from the pelvis in 24% of the cases. Both conditions may facilitate SN compression.

Previous anatomical studies demonstrated 15–30% variation in the relationship between the piriformis and the SN (20). The existence of variation was also reported in many case reports (1,2,7,8,11–17,19–21,25) (Table 1). The comparison of the previously published results and those of the current study revealed a higher rate of high division in the current series.

The SN may be divided into the CFN and the TN in the pelvis, and each nerve can leave the pelvis using a separate route. Moore (16) reported that CFN passed through the piriformis, and the TN passed

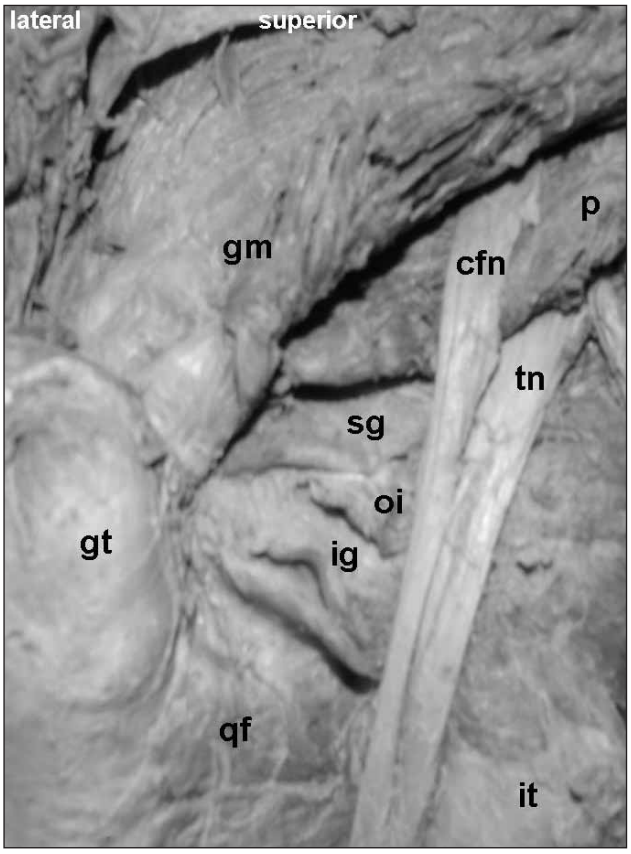

Figure 4: *The common fibular nerve (**cfn**) going through the suprapiriform portion of greater sciatic foramen, and, the tibial nerve (**tn**) going through the infrapiriform portion of the greater sciatic foramen in the left gluteal region. **gt**: greater trochanter, **it**: ischial tuberosity, **gm**: gluteus minimus, **p**: piriformis, **sg**: superior gemellus, **oi**: obturator internus, **ig**: inferior gemellus, **qf**: quadratus femoris.*

through the IP in 12.2% of the specimens, and that the CFN passed through the SP, and the TN passed through the IP in 0.5% of the specimens in a study conducted on 650 extremities (Table I).

Chiba (8) reported that CFN passed through the piriformis in 34% of the cases in another study using 514 extremities. The rate of this variation was higher than other published rates (4,25) (Table I).

Machado et al (14), performed a gluteus dissection in 100 fetuses and reported three types of variation, including type 1 where the CFN penetrated the piriformis and the TN passed under the piriformis (16%), type 2 where the CFN passed above the piriformis and the TN passed under the piriformis and type 3 where the SN penetrated the piriformis (Table I). The passage of the SN through the piriformis was also reported by Pecina (19) in 22% of 130 cadavers. It included penetration of the piriformis by the SN in 5%, and presence of the piriformis with two heads in 17%. The same rate was reported to be 7% by Beaton (4) (Table I).

Ugrenovic et al. (24) found high division of the SN in 27.5% of the specimens in a cadaveric study performed in 100 fetuses. The SN left the pelvis through the IP in 96% of 200 gluteal regions. The CFN passed through the IP in 2.5% of the specimens, and the CFN passed through the SP and the TN passed through the IP in 1.5% of the cadavers.

Table I: Variations in the High Division of the Sciatic Nerve and Relationship Between the Sciatic Nerve and the Piriformis.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Beaton & Anson (4) 120 cadavers	84.2%	11.7%	3.3%	0.8%		
Beaton (5) 240 cadavers	90%	7.1%	2.1%	0.8%		
Uluutku&Kurtoğlu (25) 25 fetuses	74%	16%	10%			
Moore&Dalley (16) 650 extremities		12.2%	0.5%			
Chiba (8) 514 extremities		34%				
Machado et al. (14) 100 fetus extremities		16%	2%			
Pecina (19) 130 cadavers		6.15%				
Ugrenovic et al. (24) 100 fetuses	96%	2.5%	1.5%			
Pokorny et al. (20) 91 cadavers	79.1%	14.3%	4.4%	2.2%		
Ozaki et al. (17)						Only one case
Sayson et al. (21)						Only one case
Current study 50 extremities	**76%**	**16%**	**8%**			

Beaton & Anson classified variations of the piriformis and SN in 120 specimens in 1937, and in 240 specimens in 1938 (4,5). Their classification, known as the Beaton & Anson classification, is as follows:

Type 1: Undivided nerve below undivided muscle

Type 2: Divisions of nerve between and below undivided muscle

Type 3: Divisions above and below undivided muscle

Type 4: Undivided nerve between heads

Type 5: Divisions between and above heads

Type 6: Undivided nerve above undivided muscle

Pokorny et al. (20), using 91 fresh cadavers, modified the Beaton & Anson classification and stated that the first variation, undivided nerve below undivided muscle, was the most common type, and seen in 79.1% of the specimens.

Type 2 variation was reported in one case by Arifoğlu et al. (1), and by Kırıcı and Ozan (12) . There were 7 cases of type 2 variation in the current series (14%). Type 4 variation, an extremely rare variation, was reported by Chen (7), and by Kosukegawa et al. (13). There was no type 4 variation in the current series.

The type 6 variation, a variation defined hypothetically by Beaton & Anson (4), was reported in one case by Ozaki et al. (17) and Sayson et al. (21).

The passage of the CFN through the IP, and passage of the TN under the superior gemellus is also rare variation, which was not described by Beaton & Anson (4). This variation, to our knowledge, was only reported by Babinski (2), and Mas et al. (15) in one case. This variation may be nominated as Beaton & Anson type 7.

CONCLUSION

The knowledge regarding the level of division of the SN and the location where it leaves the pelvis is of great importance. The abnormal passage of the SN, the CFN, and the TN, either through the SP or below the superior gemellus may facilitate compression of these nerves. Further radiological studies addressing the aforementioned variations should be carried out in cases with atypical sciatica.

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