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Six Intriguing Sciatic Nerve-Piriformis Muscle Variants Investigated in the Northeastern Thai Population

Seis Variantes Intrigantes del Nervio Ciático y del Músculo Piriforme Investigadas en la Población del Noreste de Tailandia

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SUMMARY: Clinically, it is known that the sciatic nerve-piriformis muscle variants (SPV) can increase the susceptibility to piriformis syndrome and gluteal pain syndromes. Specialized medical care might be required for patients with piriformis syndrome due to their unique SPVs. Different patterns and prevalence of such variations have been reported in many populations, but not in Northeastern Thais. This recent study aimed to investigate the types and incidence of SPV in Thai body donors. In this study, 33 embalmed body donors (66 lower limbs in total) were examined to collect anatomical variations between the sciatic nerve (SCN) and piriformis muscle (PM) before classifying their specific types. The results showed that SPV could be classified into 6 types with a novel pattern (Type I; undivided SCN passes below PM, Type II; divided SCNs pass below PM, Type III; divided SCNs pass between & below PM, Type IV; divided SCNs pass above PM, Type V; divided SCNs pass above & below PM, and Type VI; trifurcates of SCN (Y-shape common fibular & tibial nerves) pass above PM, respectively). The incidence of such SPVs is 83.33 % (Type I), 7.57 % (Type II), 1.51 % (Type III), 3.03 % (Type IV), 3.03 % (Type V), and 1.51 % (Type VI), respectively. In conclusion, these population-specific data have enhanced regional anatomical knowledge and underscore the critical need for preoperative recognition of SPV to mitigate surgical complications in the gluteal region, particularly for the management of piriformis syndrome in the Northeastern Thai population.

KEY WORDS: Piriformis,; Sciatic nerve; Piriformis syndrome; Northeastern Thais.

INTRODUCTION

The sciatic nerve (SCN) is known as the largest and longest peripheral nerve in the human body. This nerve originates from the lumbosacral plexus of L4 to S3, and it normally exits the pelvis via the greater sciatic foramen beneath the piriformis muscle (PM). This typically anatomical feature plays an important role in the function and biomechanics of the lower limbs. However, the variations in the relationship between the SCN and the PM have been reported in various populations including Japanese (Chiba, 1992; Chiba *et al*., 1994), Americans (Fishman *et al*., 2002; Benzon *et al*., 2003; Lewis *et al*., 2016), Brazilian (Vincente *et al*., 2007; Brooks *et al*., 2011; Gomes *et al*., 2014), Czechs (Pokorny *et al*., 2006), Turkish (Uluutku & Kurtoglu, 1999; Güvençer *et al*., 2009; Sulak *et al*., 2014), Polish (Okraszewska *et al*., 2002), Norwegians (Indrekvam & Sudmann, 2002), Africans (Ndiaye *et al*., 2004; Kukiriza *et al*., 2010; Ogeng'o *et al*., 2011a; Desalegn & Tesfay, 2014; Chukwuanukwu *et al*., 2017), Serbs and Montenegrins (Ugrenovic *et al*., 2005), Croats (Pecina *et al*., 2008), French (Delabie *et al*., 2013), Greeks (Natsis *et al*., 2014), and Indians (Patel *et al*., 2011; Sabnis, 2012; Prathiba *et al*., 2013; Adibatti & Sangeetha, 2014), respectively.

Basically, such sciatic nerve-piriformis muscle variants (SPV) have clinical significance, such as gluteal pain syndromes, piriformis syndrome and nerve compression affecting 6-8 % of patients with sciatica, in which the SCN may pass through, cross over, or separate around the PM, increasing the risk of nerve entrapment and posing diagnostic and therapeutic challenges (Poutoglidou *et al*., 2020; Wan-

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Ae-Loh *et al*., 2020). In addition, these variants may affect the safety of hip surgery or local gluteal injection therapy. In a systematic review and meta-analysis, it has been reported that the prevalence of this variant varies greatly among populations, ranging from 4 - 40 %, with East Asian populations reporting a prevalence of over 30 % (Poutoglidou *et al*., 2020). In Thailand, the prevalence of the typical morphological pattern, undivided SCN running below the PM, was approximately 74.02 % while the atypical patterns were documented as 25.98 % in only the central population (Wan-Ae-Loh *et al*., 2020). Northeastern Thailand has a high prevalence of agricultural laborers, increasing susceptibility to repetitive strain injuries and gluteal pain. This makes anatomical variation knowledge particularly relevant for our population. Therefore, understanding SPV is crucial for preventing surgical complications, improving diagnostic accuracy, and enhancing treatment outcomes in Thai populations. This recent study aimed to investigate the patterns and prevalence of SPV in Thai cadavers to provide the essential region-specific anatomical data for improved clinical care and surgical safety.

MATERIAL AND METHOD

Sample collection and ethics. This was a cross-sectional study that was conducted at the Gross Anatomy Laboratory, College of Medicine and Public Health, Ubon Ratchathani University, Thailand (2019-2020). The sample size was calculated based on Wayne's proportion estimation formula (Wayne, 1995), assuming 25 % prevalence of sciatic nerve-piriformis muscle relationship abnormalities as demonstrated in a previous study (Berihu & Debeb, 2015), yielding a required sample of 33 cadavers. Thirty-three embalmed cadavers (18 males, 15 females) representing dissected 66 gluteal regions were investigated. All body donors were kindly obtained from the Department of Anatomy, Faculty of Medicine, Khon Kaen University, and they were originated from individuals who resided in Northeastern Thailand. Ethical approval was obtained from the Ubon Ratchathani University Research Ethics Committee (UBU-REC-130/2563).

Dissection procedure. Dissections were performed on the embalmed cadavers under the faculty supervision to expose the skeletal structures of the gluteal region and investigate the anatomical relationship between the sciatic nerve (SCN) with its branches and piriformis muscle (PM). The procedure involved:

1. Initial exposure: removal of skin and superficial fascia to reveal superficial muscles.
2. Deep dissection: reflection of superficial muscles to carefully expose deep muscles, including piriformis.
3. Investigation and recording data: examination of piriformis muscle and its relationship with the running of sciatic nerve, documenting variations.

RESULTS

Types of sciatic nerve-piriformis muscle relationship observed in Northeastern Thais

The results showed that the patterns of the sciatic nerve (SCN)-piriformis (PM) muscle relationship observed in Northeastern Thais could be classified into 6 types as shown in the representative specimens of gluteal regions and their schematic diagrams (Figs. 1 to 3).

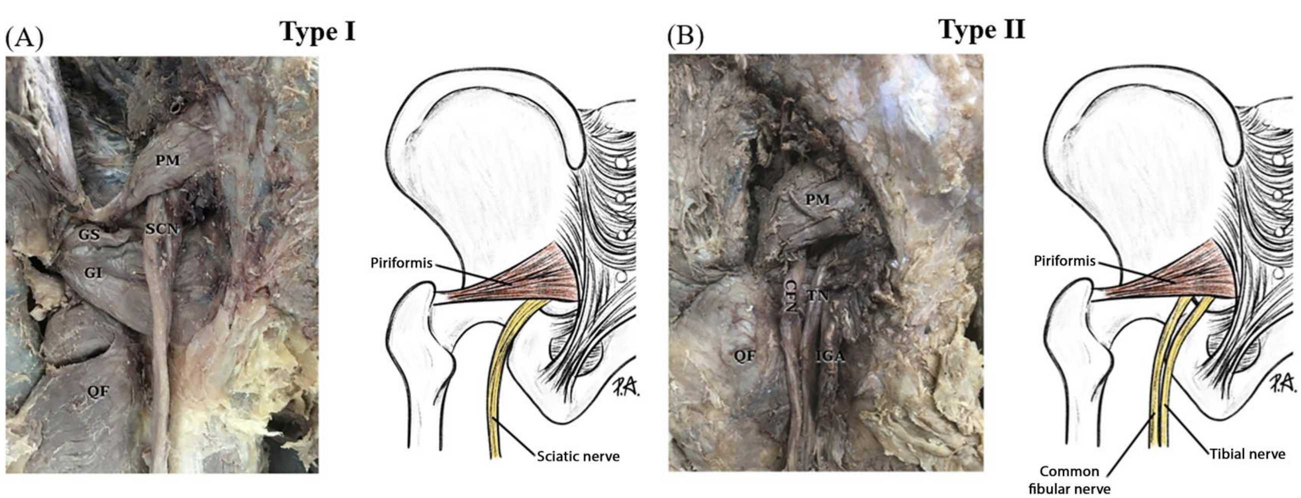

Fig. 1. Specimens of gluteal regions and their schematic diagrams showing sciatic nerve-piriformis muscle relationship observed in this study. A) Type I; undivided SCN passes below PM, and B) Type II; divided SCNs (common fibular & tibial nerves) pass below PM. PM; piriformis muscle, GS= gemellus superior muscle, GI; gemellus inferior muscle, SCN; sciatic nerve, TN; tibial nerve, CFN; common fibular nerve, PCN; posterior femoral cutaneous nerve, QF; quadratus femoris muscle, IGA; inferior gluteal artery.

Classically, the type I or normal pattern described in the literatures was found approximately 83.33 % that the undivided SCN passes below the PM (Fig. 1A). For the type II (7.57 %), it was observed that the divided SCNs containing upper common fibular & lower tibial nerves pass below the PM (Fig.1B). Type III (1.51 %) showed that the divided SCNs as similar to type II but they pass between and below PM (Fig. 2A). For the type IV (3.03 %), the divided SCNs of common fibular & tibial nerves just obviously run above the PM (Fig. 2B).

Type V (3.03 %) showed the divisions of SCN to be common fibular & tibial nerves that run above & below PM (Fig. 3A). Interestingly, it was found that the Type VI (1.51 %) has the trifurcates of SCN branches containing 2 common fibular nerves (Y-shape) and a tibial nerve to pass above the PM as demonstrated in the Figure 3B.

Prevalence of sciatic nerve-piriformis muscle variants. The incidence of sciatic nerve-piriformis muscle (SCN-PM) variants is summarized in Table I. It was observed that the prevalence of SCN-PM variations in Type I, II, III, IV, and VI were 83.33 %, 7.57 %, 1.51 %, 3.03 %, 3.03 %, and 1.51 %, respectively (Table I). As compared between sexes, Thai males have more SCN-PM variations than that of females shown in the Table I.

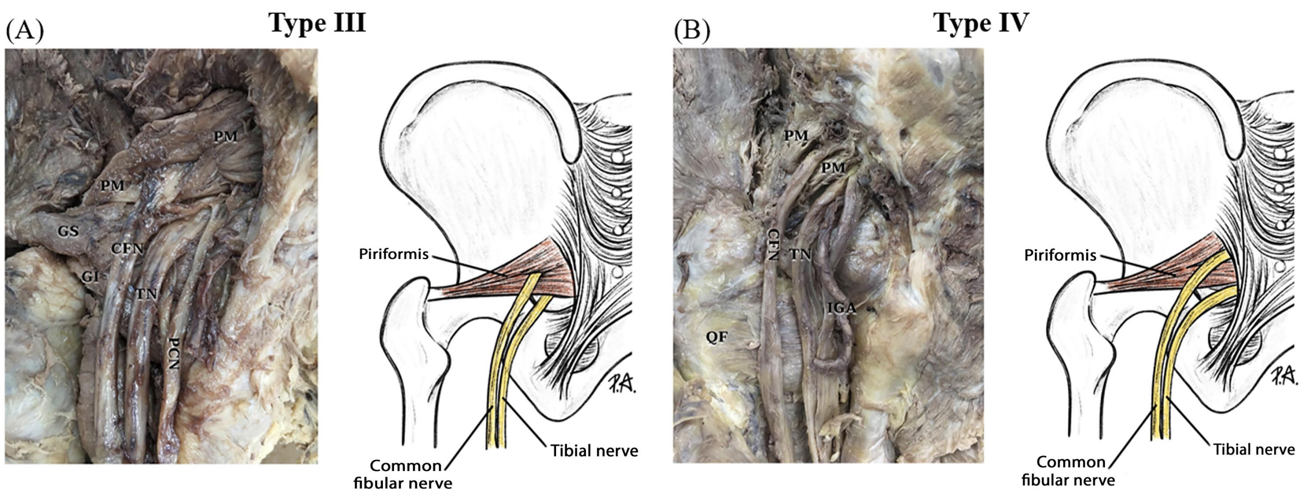

Fig. 2. Specimens of gluteal regions and their schematic diagrams showing Type III & Type IV of sciatic nerve-piriformis muscle relationship observed in this study. A) Type III; divided SCNs (common fibular & tibial nerves) pass between and below PM, and B) Type IV; divided SCN (common fibular & tibial nerves) pass above PM. PM; piriformis muscle, GS= gemellus superior muscle, GI; gemellus inferior muscle, SCN; sciatic nerve, TN; tibial nerve, CFN; common fibular nerve, QF; quadratus femoris muscle, IGA; inferior gluteal artery.

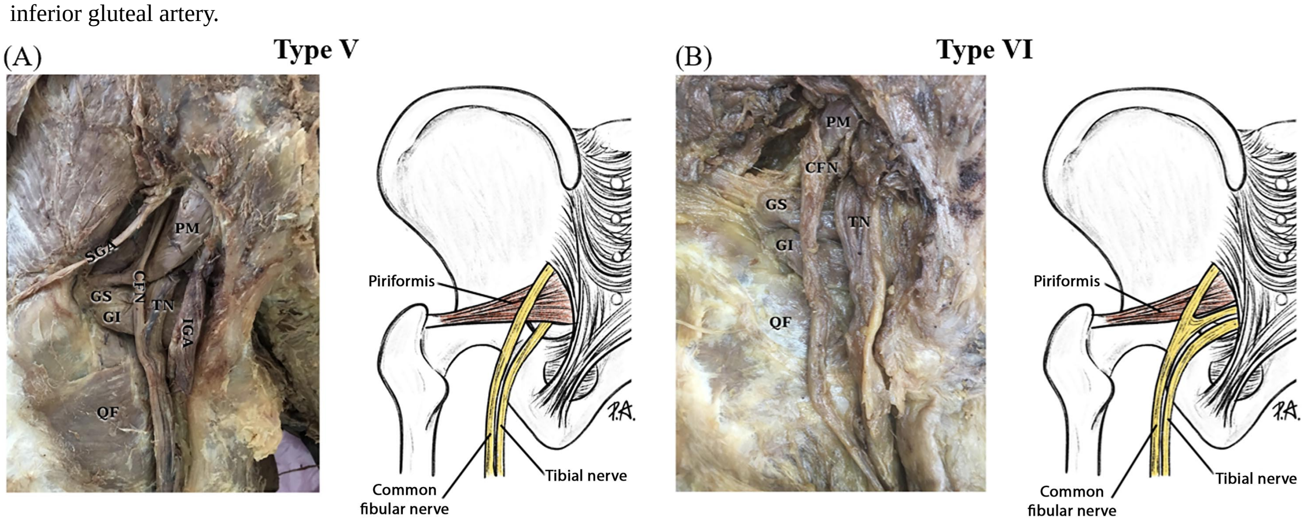

Fig. 3. Specimens of gluteal regions and their schematic diagrams showing Type V & Type VI of sciatic nerve-piriformis muscle relationship observed in this study. A) Type V; divided SCN (common fibular & tibial nerves) pass above & below PM, and B) Type VI; trifurcates of SCN (Y-shape common fibular & tibial nerves) pass above PM. PM; piriformis muscle, GS= gemellus superior muscle, GI; gemellus inferior muscle, SCN; sciatic nerve, TN; tibial nerve, CFN; common fibular nerve, PCN; posterior femoral cutaneous nerve, QF; quadratus femoris muscle, IGA; inferior gluteal artery, SGA; superior gluteal artery.

Table I. Prevalence of type I, II, III, IV, V, and VI of SCN-PM relationship investigated in Northeastern Thai cadavers.

Types	Descriptions of anatomical SCN-PM relationships	Prevalence(%)		
		Males (N: 36)	Females (N: 30)	Total (N: 66)
I	Undivided SCN passes below PM	29 (43.94 %)	26 (39.39 %)	55 (83.33 %)
II	Divided SCN (common fibular & tibial nerves) pass below PM	5 (7.57 %)	0 (0 %)	5 (7.57 %)
III	Divided SCN (common fibular & tibial nerves) pass between & below PM	0 (0 %)	1 (1.51 %)	1 (1.51 %)
IV	Divided SCN (common fibular & tibial nerves) above PM	0 (0 %)	2 (3.03 %)	2 (3.03 %)
V	Divided SCN (common fibular & tibial nerves) pass above & below PM	2 (3.03 %)	0 (0 %)	2 (3.03 %)
VI	Trifurcates of SCN (Y-shape common fibular & tibial nerves) pass above PM	0 (0 %)	1 (1.51 %)	1 (1.51 %)

SCN; sciatic nerve, PM; piriformis muscle.

DISCUSSION

This recent study has elucidated the significant anatomical variations in the anatomical relationship between the sciatic nerve (SCN) and piriformis muscle (PM) among cadaveric specimens from Northeastern Thailand for the first time, thereby contributing essential region-specific data to the anatomical literature. Our findings possess the considerable implications for clinical practice, particularly regarding the diagnosis and management of piriformis syndrome, as well as for surgical interventions within the gluteal region. In comparison with our study, the prevalence of anatomical variations observed in our population (16.65 %) aligns with the findings from other global populations but also reflects unique regional trends. For instance, Type I (Typical configuration), observed in 83.33 % of gluteal regions, was consistent with two studies in Kenyan populations (79.9 %) and Greek populations (93.6 %) (Ogeng'o *et al*., 2011b; Natsis *et al*., 2014). The higher prevalence of Type I in males in recent study mirrors findings by an investigation by Haladaj *et al*. (2015). This may suggest the possible sex-related morphological differences. For the Type II (7.57 %), the similar rates have been reported in both Ethiopian (9 %) and Polish populations (10 %) (Berihu & Debeb, 2015; Haladaj *et al*., 2015). This configuration, involving early bifurcation of the sciatic nerve passing below the piriformis, underscores the importance of preoperative imaging to identify such variations, reducing the risk of nerve injury during procedures like total hip replacement. Intriguingly, the Type VI (1.51 %), a rare trifurcation observed in our study aligns with occasional reports in other populations, underscoring the importance of considering rare configurations during anatomical and radiological evaluations.

In clinical implications, the comprehensive understanding of anatomical variations within the SCN-PM complex is paramount for multiple medical specialties, with direct implications for diagnostic accuracy and therapeutic outcomes. For piriformis syndrome pathophysiology, anatomical variation such as Type III and Type VI patterns, characterized by SCN perforation or trifurcation around the PM, demonstrate the significant association with nerve entrapment syndromes. These morphological variants may manifest as atypical sciatic presentations, thereby complicating differential diagnosis. Specifically, patients presenting with Type VI pattern may exhibit more diffuse symptomatology secondary to multiple anatomical compression points, necessitating modified diagnostic approaches and therapeutic strategies. In surgical risk management, Type II, where SCN bifurcation occurs inferior to the PM, demands meticulous intraoperative nerve identification and preservation protocols. Inadequate recognition of these variants during procedures such as total hip arthroplasty or PM release may result in iatrogenic neural injury, with subsequent functional impairment and medicolegal implications.

The anatomical variations investigated in this study reflect the population-specific morphological patterns that may demonstrate significant deviation from those observed in Western or African populations (Fishman *et al*., 2002; Okraszewska *et al*., 2002; Benzon *et al*., 2003; Ndiaye *et al*., 2004; Pokorny *et al*., 2006; Pecina *et al*., 2008; Brooks *et al*., 2011; Delabie *et al*., 2013; Natsis *et al*., 2014; Gomes *et al*., 2014; Sulak *et al*., 2014; Desalegn & Tesfay, 2014; Lewis *et al*., 2016; Chukwuanukwu *et al*., 2017). Multiple factors including environmental influences, genetic predispositions, and lifestyle characteristics, particularly the predominant agricultural occupations in Northeastern Thailand, may contribute to distinctive musculoskeletal and neural morphological development. We assumed that the comprehensive comparative investigations across diverse Thai demographic groups would provide valuable insights into the multifactorial determinants of anatomical variation.

Our investigation's reliance on cadaveric specimens has limitation of direct extrapolation to living populations, as dynamic factors including muscle tone and postural variations significantly influence SCN-PM relationships in vivo. Future investigations utilizing advanced imaging techniques in living subjects need to be addressed for this methodological limitation.

CONCLUSION

This anatomical study of Northeastern Thai cadavers classified 6 distinct sciatic nerve-piriformis muscle (SPV) patterns, including a novel trifurcation pattern (Type VI). The predominant Type I configuration (83.33 %) aligns with global populations, while variants occurred in 16.65 % of specimens. These findings provide essential regional anatomical data that enhance diagnostic accuracy and surgical safety in the Northeastern Thais, emphasizing the importance of understanding population-specific anatomical variations in clinical practice.

MANEENIN, C.; MANEENIN, N.; JIRAPORNKUL, C.; WANRAM, S.; AORACHON, P. & IAMSAARD, S. Seis variantes intrigantes del nervio ciático y del músculo piriforme investigadas en la población del noreste de Tailandia. *Int. J. Morphol., 43(6)*:2056-2061, 2025.

RESUMEN: Clínicamente, se sabe que las variantes del nervio ciático y del músculo piriforme (VCP) pueden aumentar la susceptibilidad al síndrome piriforme y a los síndromes de dolor glúteo. Los pacientes con síndrome piriforme podrían requerir atención médica especializada debido a sus VCP únicas. Se han reportado diferentes patrones y prevalencias de dichas variaciones en muchas poblaciones, pero no en la población del noreste de Tailandia. Este estudio reciente tuvo como objetivo investigar los tipos y la incidencia de VCP en donantes de cuerpos tailandeses. En este estudio, se examinaron 33 donantes de cuerpos embalsamados (66 miembros inferiores en total) para recolectar variaciones anatómicas entre el nervio ciático (NC) y el músculo piriforme (MP) antes de clasificar sus tipos específicos. Los resultados mostraron que el SPV podría clasificarse en 6 tipos con un patrón novedoso (Tipo I; NC indiviso pasa por debajo de MP, Tipo II; NC divididos pasan por debajo de MP, Tipo III; NC divididos pasan entre y por debajo de MP, Tipo VI; NC divididos pasan por encima de MP, Tipo V; NC divididos pasan por encima y por debajo de MP, y Tipo VI; trifurcados de NC (nervios fibular común y tibial en forma de Y) pasan por encima de MP, respectivamente). La incidencia de tales VCP es 83.33 % (Tipo I), 7.57 % (Tipo II), 1.51 % (Tipo III), 3.03 % (Tipo IV), 3.03 % (Tipo V) y 1.51 % (Tipo VI), respectivamente. En conclusión, estos datos poblacionales han mejorado el conocimiento anatómico regional y subrayan la necesidad crítica del reconocimiento preoperatorio de la VSP para mitigar las complicaciones quirúrgicas en la región glútea, en particular para el tratamiento del síndrome piriforme en la población del noreste de Tailandia.

PALABRAS CLAVE: Piriforme; Nervio ciático; Síndrome piriforme; Tailandeses del noreste.

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