CASE REPORT

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The recurrent motor nerve, a possible cause of denervation following hamstring injury and repair: a cadaveric case

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SUMMARY

Severe hamstring injuries warranting surgical repair are rare and mainly affect athletes, young and middle-aged people. A minority of these patients report postoperative complications of denervation. Symptoms of denervation range from muscle weakness to sciatic nerve palsy. Recent anatomical observations suggest that a recurrent motor nerve, which inserts into the proximal hamstrings, may be responsible for this denervation. The recurrent motor nerve was identified through cadaveric dissection and the site of nerve penetration into the muscle, measured 1.5 cm from the ischial tuberosity. This distance is significantly shorter than previous studies report. Awareness of this nerve branch is an important consideration in hamstring injury and repair. Due to its course, the recurrent motor nerve's name is also a source of discussion.

Key words: Hamstring anatomy – Hamstring injury – Proximal hamstring repair – Recurrent motor nerve – Denervation – Sciatic nerve

List of Abbreviations

Long head of Biceps Femoris: lhBF
Short head of Biceps Femoris: shBF
Semitendinosus: ST
Semimembranosus: SM

INTRODUCTION

Surgical repair of the proximal hamstrings is rarely indicated and is reserved for severe hamstring injuries. Despite high patient satisfaction rates, 23.17% of patients suffer from complications (Bodendorfer et al., 2018). These include symptoms of denervation such as: muscle weakness, sensory deficit, re-rupture and, in the most severe cases, sciatic nerve palsy (Stępień et al., 2019). Recent anatomical observations have suggested that the innervation to the proximal hamstrings, supplied by the recurrent motor nerve, may have an important role in this pathology (Stępień et al., 2019). This nerve may be at risk of damage during either injury or surgery to the proximal hamstrings. We aimed to locate and investigate the recurrent motor nerve using cadaveric dissection.

Background

The hamstring muscle complex consists of three muscles: the biceps femoris (long head—lhBF— and short head—shBF), semitendinosus (ST) and semimembranosus (SM). With the exception of the shBF, which originates from the lateral facet of the linea aspera, the remaining muscles of the hamstring muscle complex, the ischiocrural muscle

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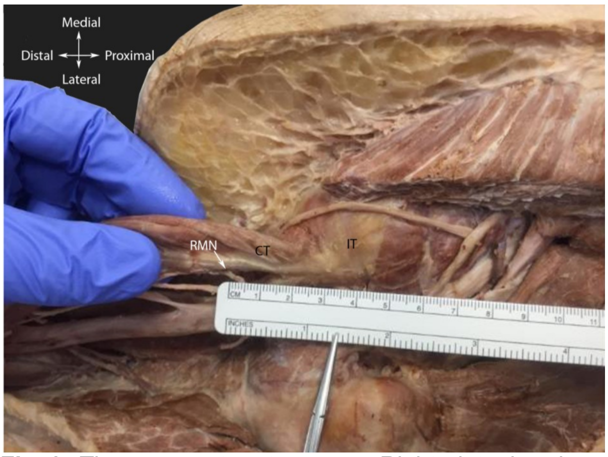

Fig 1. The recurrent motor nerve. Right gluteal and superior posterior thigh dissection. Lateral view. Demonstrating the distance between the origin of the conjoined tendon and the recurrent motor nerve's point of entry. RMN = recurrent motor nerve, CT = conjoined tendon of lhBF and ST, IT = ischial tuberosity.

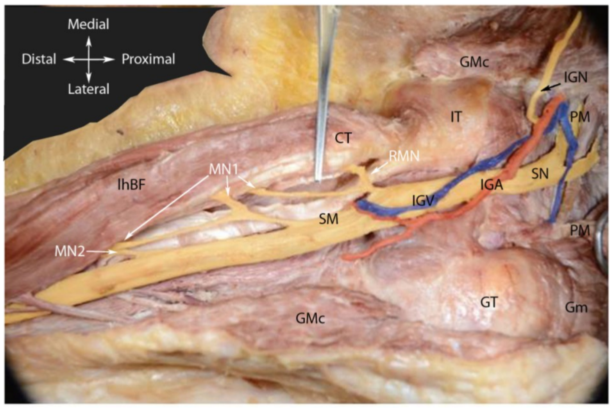

Fig 2. The proximal hamstrings and surrounding structures. Right gluteal and posterior superior thigh dissection, demonstrating the attachments and motor supply of the proximal hamstrings. Lateral view. MN1 = motor nerves to lhBF, MN2 = motor nerve to ST, RMN = recurrent motor nerve to CT, lhBF = long head of biceps femoris, IT = ischial tuberosity, CT = conjoined tendon of lhBF and ST, SM = semimembranosus, GMc = gluteus maximus cut, PM = piriformis, Gm = gluteus medius, SN = sciatic nerve, IGN = inferior gluteal nerve, IGA = inferior gluteal artery, IGV = inferior gluteal vein, GT = greater trochanter, Yellow = nerves, Red = arteries, Blue = veins.

group, share a common origin at the ischial tuberosity (Molini et al., 2011; Stępień et al., 2019).

All the muscles of the hamstring complex are supplied by the sciatic nerve. Anatomical studies have investigated the distance from the ischial tuberosity to motor entry points of the sciatic nerve to the hamstring muscles (Table 1).

Motor entry points of interest are those inserting into the lhBF and the superior ST, as these muscles form the conjoined tendon proximally. The proximal hamstring is a common site of injury and is the location of insertion by the recurrent motor nerve (Stępień et al., 2019).

Differences in motor entry point have been shown in studies from various countries (Table 1), which demonstrates a potential area for further research. Currently, studies have emerged from the following regions: Austrian, by Rab et al. (1997); New Zealand, by Woodely and Mercer (2005); America, by Seidel et al. (1996), and Korean by An et al. (2010).

CASE REPORT

The recurrent motor nerve was found by the author to insert into the proximal hamstrings by a distance of 1.5cm from the ischial tuberosity (Figs. 1 and 2). The reference point of the ischial tuberosity was located by dissecting the conjoined tendon proximally and palpating the bony origin of the ischiocrural muscle group. The recurrent motor nerve, inserted into the conjoined tendon of the hamstring muscle complex, formed from the tendons of the lhBF and ST.

The fixation of the cadaver was: 1.6% formaldehyde, 3.8% methanol, 9% water, 10% phenol and 75.6% ethanol per 25 lts.

COMMENTS

This finding, built upon the anatomical study of the hamstrings by Stępień et al. (2019), noted the presence of a proximal nerve, the recurrent motor nerve, a branch of the motor nerve to the lhBF. They provided a cadaveric dissection that demonstrated the course of this nerve and discussed that it may be responsible for symptoms of muscle denervation after proximal hamstring injury, which

Table 1. Insertion points of sciatic nerve motor branches to the hamstring muscles, established by measuring a distance from the ischial tuberosity

	Rab et al. (1977)	An et al. (2010)	Woodley and Mercer (2005)	Seidel et al. (1996)
No. of lower limbs	30	50	6	30
lhBF (cm)	**15.1 ± 3 .4**	**14.1 ± 3.3**	No information	**6.9 - 19.7**
shBF (cm)	No information	19.1 ± 2.3	20 - 34.2	No information
Superior ST (cm)	**4.75 ± 1.4**	**7.0 ± 2.2**	**4.2 - 12.2**	**7.1 - 9.2**
Inferior ST (cm)	14.47 ± 2.6	20.3 ± 2.9	7.5 - 19	14.3 - 20.2
SM (cm)	No information	21.1 ± 3.3	14.6 - 34.5	13.1 - 31.2

may remain after surgical repair (Stępień et al., 2019). However, motor entry distances were not provided.

In this cadaveric case report, the entry point of the recurrent branch into the conjoined tendon was found to insert by a significantly shorter distance than existing literature describes (Seidel et al., 1996; Rab et al., 1997; Woodley and Mercer, 2005; An et al., 2010). This discrepancy may be explained by the difficulty in dissecting the tightly packed areolar tissue away from the recurrent motor nerve and its neighbouring structures, particularly when you are not looking for it. In Hollinshead's Anatomy for Surgeons, proximal branches to the hamstrings from the sciatic nerve are described to arise above the ischial tuberosity (Hollinshead, 1954). Neither the frequency nor the measurements of these branches are provided.

As observed in Figs. 1 and 2, the route of the recurrent motor nerve runs proximal to distal, therefore making the recurrent aspect of this name incorrect. Therefore, it is reasonable to suggest that this nerve should be renamed. The nerve to the conjoined tendon would be a topographically correct name.

Injuries resulting in retraction of the hamstrings from the ischial tuberosity pose a threat to proximal nerves. Retraction greater than 1.5 centimetres would begin to add tension, in this cadaver, to the recurrent motor nerve and begin stretching it. If a large degree of retraction occurred, such as those in grade 3 hamstring tears, this would avulse the nerve entirely from its motor entry point in the muscle belly or conjoined tendon.

Anecdotal evidence, provided by a senior author, described that 18% of patients report postoperative chronic pain that is not present preoperatively. Therefore, iatrogenic intraoperative damage to this nerve, which is often encased in scar tissue, is also a consideration. Denervation of the proximal hamstrings would lead to: muscular atrophy, a decrease in weight and diameter, and, in turn, a decrease in muscle fibre conduction velocity, as seen in all denervated muscles (Wu et al., 2014).

Conclusion

The recurrent motor nerve, or the nerve to the conjoined tendon, does not appear in literature describing the surgical technique for hamstring repair (Dierckman and Guanche, 2012; harris et al., 2011, 2015; Lefevre et al., 2013; Moatshe et al., 2017; Laskovski et al., 2018; Wilson et al., 2017). Therefore, further studies into the innervation of the proximal hamstrings are warranted. This would confirm the variability seen in the innervation to this region, and, in particular, determine the recurrent motor nerve's distance from motor entry to the ischial tuberosity. This would be of use to surgeons and may provide further considerations in surgical technique when repairing hamstring injuries, with the aim of reducing postoperative symptoms of denervation.

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DECLARATIONS

Ethical approval is in accordance with the ethical standards of The University of Leeds body donation programme. The Anatomy Associations Advisory Committee: "The Human Tissue Act allows anatomical research to be undertaken on consented donated bodies and does not necessitate further ethical permission or records to be requested". This work was conducted under the authority of License 12279 issued by the Human Tissue Authority in accordance with its requirements of the Human Tissue Act (2004). All donors had given written consent to the use of their bodies for anatomical examination and research.

Authors' contributions: CH and RH participated in the design of this study. SS drafted the manuscript and participated in its design. NR conceived of the study, carried out the cadaveric dissection and drafted the manuscript. All authors read and approved the final manuscript.

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