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Prevalence of the aberrant mode of double ilioinguinal nerve

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ABSTRACT

Background: An ilioinguinal nerve branches off the lumbar plexus' branches. Due to its anatomic variations, it can contribute to neuropathies accompanying lower abdominal procedures. *Aim:* The study's objective was to illustrate the double ilioinguinal nerve variation through the dissection of human cadavers. *Material and methods:* Following clearance from Alzaiem Alazhari University's ethics committee, a cross-sectional analysis of corpses conserved in formalin was conducted (January 2021–May 2022). Using the internal and external inguinal rings as well as established bone markers, the IINs were exposed and mapped on both sides during the cadaveric dissection from their lateral appearance on the anterior abdominal wall to their midline ending. SPSS edition 21.0 had being utilized to manage the gathered information. *Results:* In 77 cadavers, ilioinguinal nerves were recognized bilaterally. All IINs originated from L1 on the left side, while on the right 3 IINs abnormally originated from L3 or L1-3. The difference was not significant (P=0.22). Double ilioinguinal nerve was observed in 8.4%. This variability had been noticed on the left and right sides in 8 (5.2%) and 5 (3.2%) corpses, respectively (P=0.56). *Conclusion:* It is essential to be aware of the double ilioinguinal nerve variant to prevent its damage during lower abdominal procedures such as inguinal hernia and low transverse incisions for orthopedics, gynecology and anesthetic procedures.

Keywords: Double nerve, Ilioinguinal nerve, lumbar plexus, variations.

1. INTRODUCTION

In general, the nerves named ilioinguinal (IIN), iliohypogastric (IHGN) and genitofemoral (GFN) are considered boundary nerves as they supply sensual nerve fibers to the restricted cutaneous area along the anterior abdominal wall and the thigh (Paul and Shastri, 2019). Specifics of the IHGN and IIN general anatomy have been documented in several human anatomy references, including but not exclusive to (Moore and Agur, 2002). Injuries to these nerves reported during needle suspension, suprapubic (Pfannenstiel) incision, hernia

repair and trocar placement have justified the need to identify the most common variability (Klaassen et al., 2011). The branching and typical route pattern of these nerves must be understood clinically to provide a nerve block that minimizes surgical issues (Khedkar et al., 2015). These nerves are indicated for anesthesia in inguinal surgery, especially in the pediatric field (Schoor et al., 2005). As part of the lumbar plexus, the IIN is the 1st nerve that arises from L1 and occasionally in conjunction with T12 (Manolakos et al., 2022). Along with the IHGN, they emerge from the lateral edge of the psoas, passing ventral to the quadratus lumborum, posterior to the renal fossa, through renal fat and posterior to the inferior end of the kidney (Mirjalili, 2020; Manolakos et al., 2022). It may emerge in conjunction with the IHGN, but sometimes it could join terminal divisions when they go via the muscular tissue of the transversus abdominis (TAM) and internal oblique (IOM) (Oelrich and Moosman, 1977). Often, the IIN exhibits variation in its root, trajectory and termination. To comprehend the etiology of neuropathies within an inguinal area, it is crucial for surgeons to be aware of the prevalence of potential variants of the IIN (Satheesha et al., 2014). In comparison to the foregoing description of ordinary anatomy, the existing research intended to depict the double IIN variant in human corpses.

2. MATERIAL AND METHODS

Study design

In the Anatomy Departments at 11 Medical Schools in Khartoum, Sudan, a multi-center randomized cross-sectional study was carried out (January 2021 to May 2022).

Study population

The study included a simple random sample of corpses with the unharmed inguinal region, performed during the research period. The study excluded cadavers with formerly scrutinized IIN, as well as those with pathological findings, surgical scars and traumatic destruction due to their potential to disturb normal anatomy.

Data collection tool

The study questionnaire comprised predefined variables.

Procedure

A full-length dissection of the nerve was carried out via an anterior approach. The umbilicus, pubic tubercle, symphysis pubis and xiphoid process were all noted as landmarks. Exposure was performed by the creation of 3 incisions; one was a vertical incision extending between the symphysis pubis to the xiphoid process while preserving the intact umbilicus. The latter involves making an oblique incision throughout the length of the costal margin, commencing at the xiphoid process and ending at the mid-axillary line. While the third transverse incision was being created parallel to and just below the inguinal ligament, extending between the symphysis pubis and the ASIS. The skin was then meticulously reversed laterally. Up to their emergence in the region of the Poupart's ligament and external ring over the aponeurosis of external oblique muscle, the cutaneous branches of IIN dispersed over the inguinal and anterior thighs were closely examined. Subcutaneous tissue was removed and the anterior abdominal muscles were fully exposed for more dissection. Throughout the dissection process, every anatomic aspect was captured.

Statistical analysis

Employing SPSS software 21.0 for Microsoft, data was analyzed (IBM, Armonk, NY, USA). The quantitative information was displayed as mean values and standard deviation. With a 95% confidence level, a Chi-square test was employed to examine the IIN variations between both sides. Noteworthy data was defined as P less than 0.05. The results were accurately presented as tables or figures.

3. RESULTS

The IIN was identified bilaterally 100% in 77 cadavers. In intended cadavers, the nerve root egress from segments L1, L1-3 and L3 accounted for 98.1% (hundred fifty-one specimens), 1.3% (two specimens) and 0.6% (one specimen), respectively. On the left side, all nerves originated from L1. While in the right side of 3 cadavers it aberrantly arose from the lumbar segments of L1-3 or solely from L3 in 1 (0.6%) and 2 (1.3%) respectively. Despite this observational difference, it did not reach the point of being statistically significant as p= 0.22 (Table 1).

Table 1 The root provenance of IIN on the right side versus the left side (n=77 cadavers)

The side	Root origin			Total	P value
	L1	L3	L1-3		
Right	74 (48.1%)	1 (0.6%)	2 (1.3%)	77 (50.0%)	*0.22*
Left	77 (50.0%)	0	0	77 (50.0%)	
Total	151 (98.1%)	1 (0.6%)	2 (1.3%)	154 (100%)	

A dual nerve was identified in 13 examined nerves accounting for 8.4% of 154 IINs that had been scrutinized. A variant has been realized in the left and right sides representing 8 (5.2%) and 5 (3.2%) respectively. As illustrated in table 2 and figure 1 the observed difference of this anatomical variation on both sides was statistically not significant as p=0.56.

Table 2 The IINs in 77 human cadavers on both sides

*Dissected site	Numbers of IIN	
	Single	Double
Left	69 (44.8%)	8 (5.2%)
Right	72 (46.8%)	5 (3.2%)
Total	141 (91.6%)	13 (8.4%)

P=0.56

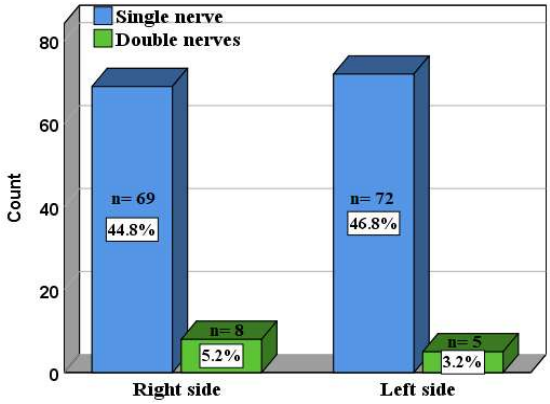

Figure 1 The number of IINs on both sides of 77 cadavers

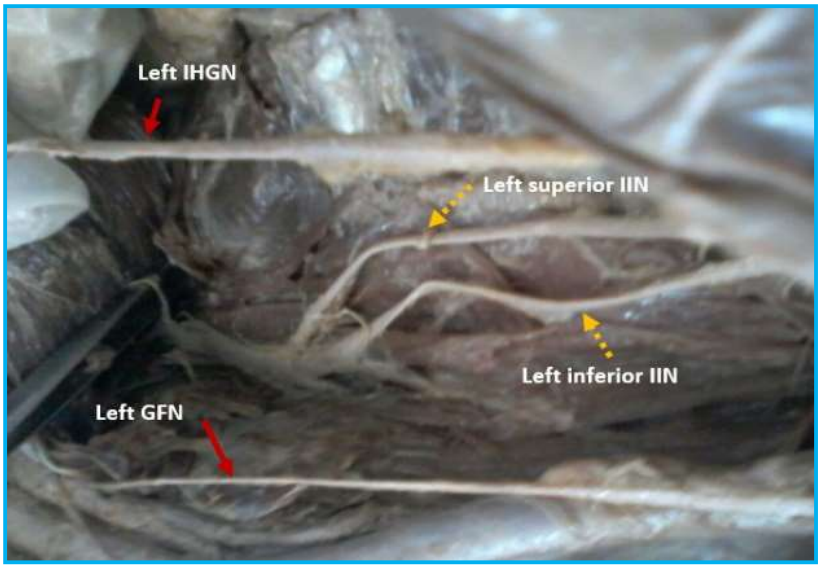

Figure 2 Two left separate ilioinguinal nerves, originate from L1

In eight of 77 corpses, the left IINs were double nerves, six of them (7.8%) emerged from the ventral ramus of the first lumbar spinal segment as a single trunk (Figure 2). They split into two, the medial sensory branch continued into the inguinal canal until emerging thru the external inguinal ring. It then supplied the upper inner thigh, penile root and the scrotum (Figure 3). In contrast, the lateral motor branch supplies frontal abdomen wall muscles. Whereas in the remaining 2 (2.6%), the nerve formed as dual nerve trunks: a thick upper branch that served as the motor branch to the anterior abdominal wall muscle and a thin lower branch that traveled to the inguinal canal as a sensory branch.

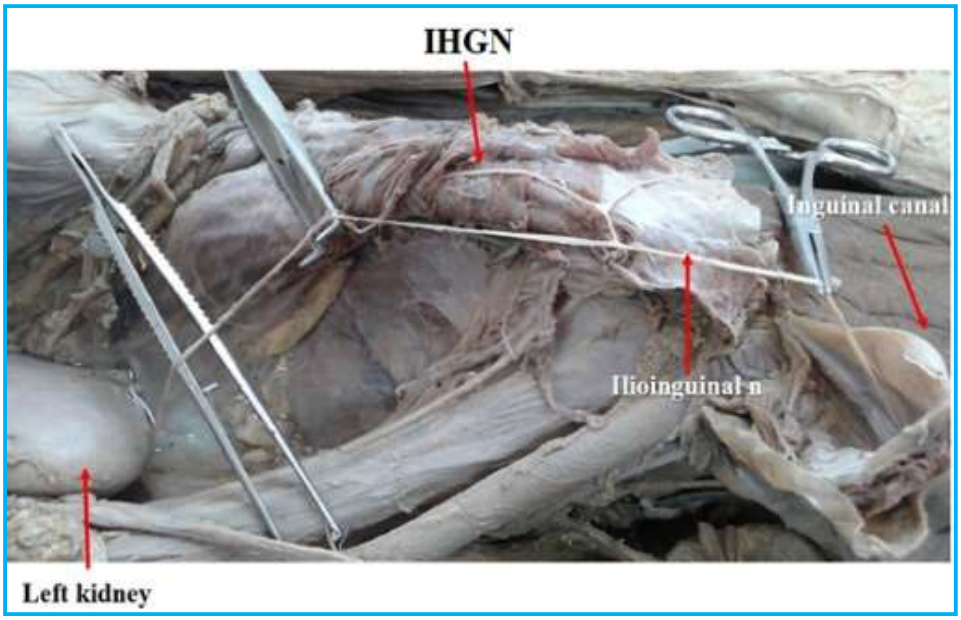

Figure 3 Left ilioinguinal nerve related to the inferior portion of the left kidney

On the other hand, there were five double IINs on the right side (Figure 4), in three corpses (3.9%), they derived from the common root that was created by the ventral ramus of the 1st lumbar spinal segment, which was then bifurcated into the upper and lower branches (Figure 5). Both nerves' upper and lower branches were running separately alongside one another from their point of origin. They all were located in front of the quadratus lumborum. The lower branch serves as a motor branch for both IOM and TAM at their iliac origin. However, the remaining 2 (2.6%) varieties of the right double IINs were derived from the ventral ramus of the first lumbar spinal segment. Thereafter, a single nerve was created once the two branches joined, pierced the TAM and continued as regular IIN.

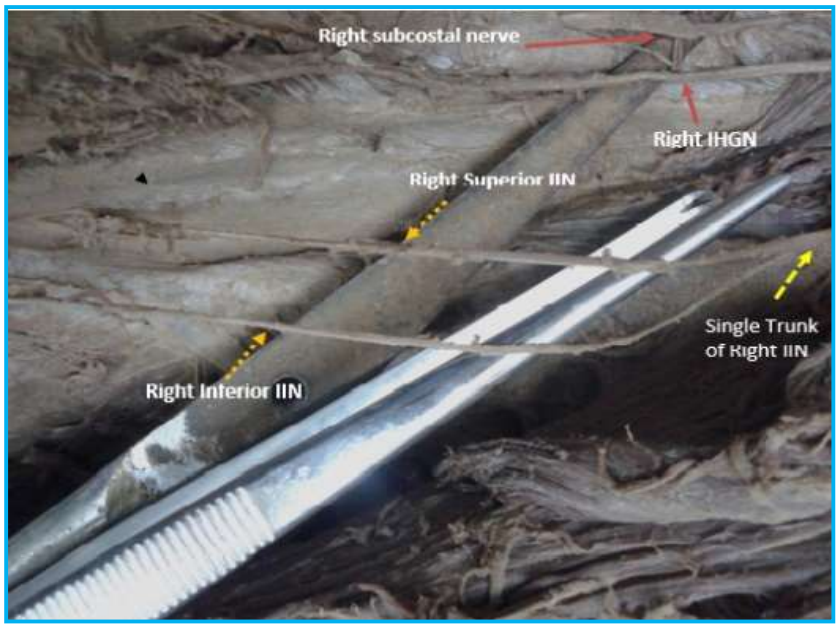

Figure 4 Right double ilioinguinal nerve, the nerve originates as a single trunk and then divided into two branches

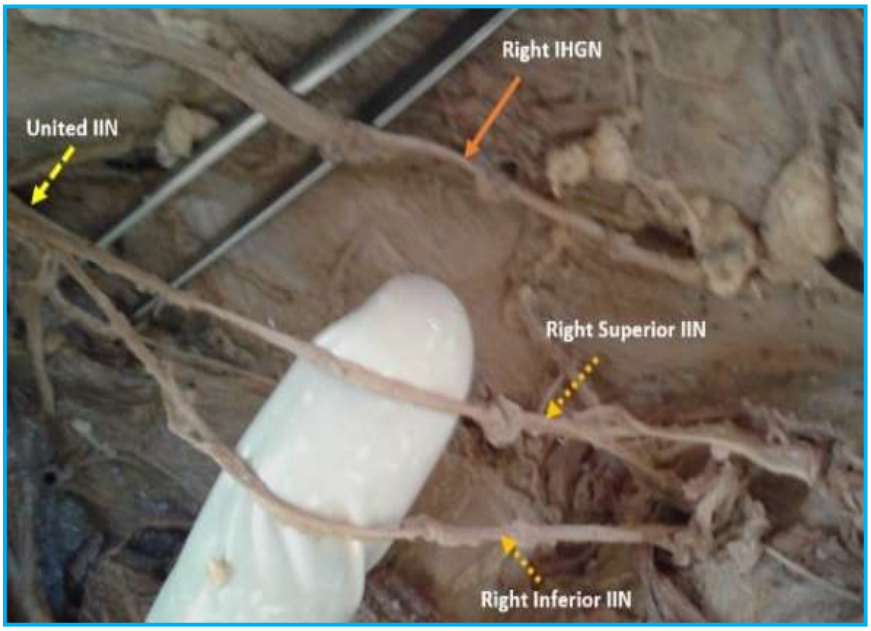

Figure 5 Right double ilioinguinal nerves arose from a separate origin from L1 and then united before piercing the transversus abdominis muscle

The IIN was found to arise from the lateral edge of the psoas, passing ventral to the quadratus lumborum, posterior to the renal fossa, through renal fat and posterior to the inferior end of the kidney in the majority 62 (80.5%) of dissected corpses (Figure 6).

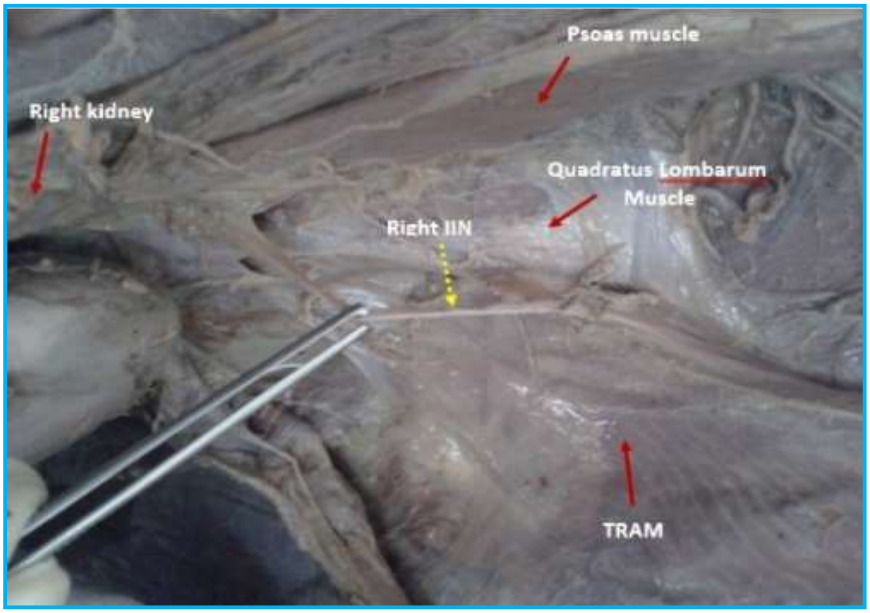

Figure 6 Ilioinguinal nerve related to the frontal aspect of quadratus lumborum muscle with no relation to the right kidney

4. DISCUSSION

Inguinal nerves are very important due to their numerous anatomical variations and susceptibility to injury. Studies showed that variations and absences of the IIN have been observed quite frequently (Kulacoglu et al., 2013). In contrast to reports published in classic medical books (Mandelkow and Loeweneck, 1988), the origin of the IIN is somewhat dissimilar in the present research. It has been formerly stated that the IINs are derivative of L1 and seldom of T12 (Clemente, 1985; Nyhus, 2004). However, the current study identified numerous distinct spinal nerves contributing to IIN creation. Based on the present study, IIN had different root values, including L1, L1-3 and L3. This coincides with the literature, as the IIN emerges from one root in 80% of instances and from two roots in the reminders. L1, L2 or L3 are the possible origin of these roots (Uzmansel et al., 2006). Conferring to a previous

research paper, IIN derived from L2 and L3 in 1.5% (Nontasaen et al., 2016) and 10% of corpses (Klaassen et al., 2011) however in the current study the incidence of such variation was 1.3%.

In the study by Klaassen et al., (2011) of 100 examined cadavers, different patterns of the IIN were shown to originate from several nerve roots. In 28 specimens, it was found to come from T12, in 130 specimens from L1, in 22 specimens from L1 and L2 and 20 specimens from L1 and L3. Whereas in the study by Moosman and Oelrich, (1977) it was reported that the IIN anatomical path varies, in 148 out of 424 dissected cadavers, the nerve did not follow the typical course pattern; instead, it was seen to pass behind or inside the round ligament or spermatic cord covering. Double IIN was documented in 8.4% of corpses in the current study. This coincides with the prevalence found in the literature where double IIN ranging from 0 to 6% (Ndiaye et al., 2010; Yıldız et al., 2012; Kotian et al., 2015; Anandhi et al., 2018; Paul and Shastri, 2019). A study by Ndiaye et al., (2010) stated that the double IINs were observed on one dissected cadaver out of 50 adult cadavers, while the IIN was absent in seven cadavers (4 right and 3 further left). While Wijsmuller et al., (2007) in their study, IIN was not identified bilaterally in 22% of 18 total dissected human cadavers. Furthermore, Paul and Shastri, (2019) in their study 30 adult cadavers, double IINs were found in two (6.7%), while the IIN was absent in the other two (6.7%). Whereas Kotian et al., (2015) in their research a double IIN was found in one dissected specimen on bilateral examination of 25 dissected fetuses, accounting for 4%, while the IIN was absent in four specimens, accounting for 8%. In another study by Anandhi et al., (2018) a double IIN was also identified in one female of 25 dissected corpses (right side), accounting for 4%, whereas the IIN was seen absent in one male dissected corpse (right side), which also accounts for 4%. Uzmansel et al., (2006) in their case report double IINs found on the right lumbar plexus of a female corpse. Likewise, Gogi, (2019) in his study concluded that the IINs were absent in four specimens accounting for 10% out of 40 examined cadavers. Similarly, Arora et al., (2016) found that IIN was not identified in 5 cadavers out of 30 embalmed cadavers, it was bilaterally absent in four cadavers and on the left side of one cadaver.

5. CONCLUSIONS

The incidence of double IIN variants was examined in the current study. Comparing the claimed incidence of such anatomical variants with relevant scientific publications revealed a wide range, which is not frequently included in traditional anatomical textbooks. It's possible to avoid iatrogenic nerve damage by being attentive to such apparent variations. Surgical operations involving the lower abdomen area, orthopedic procedures and regional inguinal anesthesia have the potential to harm the IIN's branches. Hence, it is crucial for the prevention of IIN injuries to have a better awareness of regional anatomy and its variability. Additional research outlining IIN topographical variances may raise the success rates of abdominal or orthopedic surgery operations, minimize the risk of IIN entrapment syndromes and enhance the effectiveness of nerve blockades.

Authors' contribution

Moaath AA: The principal participant and a major contributor to the introduction, results and discussion.
Mohammed SA: Contributed to study design, wrote an introduction and reviewed axial material components with decisiveness.
Sager HA: Helped organizes data, revised papers for inclusion, organized results and outlined the project.
Ahmed OA: Participated in gathering data, identifying related publications for inclusion and constructing materials and methods.
Mohammed A: Participated in data collection, recognize related literature for inclusion and construction of results section.
Fares A: Contributed to study design, wrote part of the discussion and revised papers for inclusion.
Saadeldin AI: Helped coordinate data, revised literature for inclusion and wrote the conclusions.
Abdalla AEE: He oversaw the project, expressing the documents' contents, reviewing the research data and rewriting a crucial academic aspect.
All writers contributed in distinct manners to the conception, editing and evaluation of the article.

Ethical considerations

Before undertaking the study, authorization from the 11 colleges was requested and the plan has been endorsed by the Human research ethics committee (HREC) at Alzaiem Alazhari University (No: HREC0107/AAU.12/20).

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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