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The Anatomy of Accessory Obturator Nerve in Human Cadavers

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Abstract

Background: Standard anatomy textbooks describe accessory obturator nerve (AON) as small arising from ventral branches of third and fourth lumbar ventral rami. It descends along medial border of psoas major, the accessory nerve emerges from the medial border of the psoas muscle and travels parallel but 2–3 *cm* ventrolateral to the main nerve. It reaches the thigh by crossing the superior pubic ramus behind the pectineus muscle and then divides into several branches. One branch directly innervates the pectineus, another joins the anterior division of the obturator nerve, and a third conveys sensory input from the hip joint. AON is still under recognized and its presence has great clinical consequences for lumbar plexus blockade. The presence of the AON leads to incomplete anesthesia during obturator nerve block, thus unable to achieve painless hip joint surgeries. The AON may also contribute to continued adductor spasm despite ON blockade. Misidentification of the nerve can also lead to injury. *Objective:* Looking to the applied anatomy of AON and its anatomical variability, we planned to study the detailed anatomy of AON in human cadavers. *Methods:* Permission from the Institutional Ethical Committee was obtained before starting the project. We have carried out thorough dissection of lumbar plexus in forty-six cadavers bilaterally. Only one male cadaver had a large retroperitoneal mass distorting the anatomy of concerned region on right side, was excluded from the study. The fibers of psoas major were then meticulously dissected at their origin from the lateral surface of the lumbar vertebra and the accessory obturator nerve was traced till its roots at the intervertebral foramen. The course and branches of AON was carefully recorded. *Results:* AON was observed in 29 of 91 cases (31%) of cases. Most commonly the AON was forming from the ventral rami of L3 and L4 but in cases AON was taking origin from the trunk of obturator nerve. The branching pattern of AON was variable: AON was connected to obturator nerve in 20 (21%), to anterior branch in 30 (31%) and to posterior branch in 4 (5%) of cases in present study. Pectineus muscle was solely supplied by AON in 13 (14%) specimens. *Conclusion:* The presence of AON is clinically important as it is also considered during ON blockade. The AON blockade can be indicated in superficial surgeries of thigh, treatment of pain due to thigh tourniquet, as a diagnostic aid for pain syndromes in the hip joint, inguinal areas or lumbar spine, and in relief of intractable hip pain due to osteoarthritis. These anatomical details of AON will help anesthetists, orthopedic surgeons, neurophysicians to perform safe and uncomplicated procedures.

Keywords: Accessory obturator nerve; Obturator nerve block; Branches; Anesthetic; Orthopedic surgeon.

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Introduction

The accessory obturator nerve (AON) was first described in 1672 by Isbrand van Diemerbroeck.[1] He reported that it was found in roughly one out of every three persons and originated from the third and fourth lumbar nerves.[1] *Since* its discovery, it has been called the anterior internal crural nerve, accessory nerve of the internal crural nerve, and the nerve of the coxo-femoral articulation.[2] Some have proposed that it should be named the accessory femoral nerve owing to its typical derivation from the posterior part of the anterior division of L3 and L4, its function, and its anatomical course over the pubic ramus.[3]

Standard anatomy textbooks describe AON as

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small arising from ventral branches of third and fourth lumbar ventral rami. It descends along medial border of psoas major, the accessory nerve emerges from the medial border of the psoas muscle and travels parallel but 2–3 *cm* ventrolateral to the main nerve. It reaches the thigh by crossing the superior pubic ramus behind the pectineus muscle and then divides into several branches. One branch directly innervates the pectineus, another joins the anterior division of the obturator nerve, and a third conveys sensory input from the hip joint.[4–5]

AON is still under recognized and its presence has great clinical consequences for lumbar plexus blockade. The presence of the AON leads to incomplete anesthesia during obturator nerve block, thus unable to achieve painless hip joint surgeries. The AON may also contribute to continued adductor spasm despite ON blockade.[6] Misidentification of the nerve can also lead to injury.[5] Looking to this applied anatomy of AON, we planned to study the detailed anatomy of AON in human cadavers.

Materials and Methods

Permission from the Institutional Ethical Committee was obtained before starting the project. The cadaver populations belonging to age group *30 to 84 years*, of Asian origin were included in the study. In the supine position, forty-six cadavers (91 sides) underwent an anterior approach to the retroperitoneal space. Adult human cadavers (38 Males and 8 Female), embalmed in neutral formalin, were dissected bilaterally. After routine dissection of abdominal cavity by medical graduates, the specimens were used in the study. There were no signs of surgery, wound scars or trauma in the abdominal lumbar region of any of the cadavers included in the present study. Specimen having any pathology distorting the shape of kidney or renal pelvis was excluded from the study. One male cadaver having a large retroperitoneal mass distorting the anatomy of concerned region on right side, was excluded from the study.

Following the removal of abdominal viscera and peritoneum, the lumbar plexus was exposed by an anterior approach. The branches were identified as they pierced the anterior, medial and lateral borders of the psoas major muscle. The fibers of psoas major were then meticulously dissected at their origin from the lateral surface of the lumbar vertebra and the accessory obturator nerve was traced till its roots at the intervertebral foramen. The course and branches of AON was carefully recorded.

Results

AON was observed in 29 of 91 cases (31%) of cases. The mode of formation and branches of AON are

Table1: Formation of the accessory Obturator Nerve and its prevalence.

Sl. No.	Root value	Number of cases observed	Percentage (%)
1.	L2–L4	23	21.60%
2.	L3–L4	51	57%
3.	L2–L3	10	9%
4.	L3	12	11%
5.	Trunk of obturator nerve	2	2%

Table 2: Reported pattern of terminal branches of the accessory Obturator Nerve.

Sl. No.	Terminal branches	Prevalence	Percentage (%)
1.	Anastomosing with obturator nerve and supplying skin on inner thigh	8	10%
2.	Supplying Adductor longus by additional branch	2	3%
3.	Pectineus muscle sole innervation	13	14%
4.	Pectineus muscle duel innervation (femoral)	6	7%
5. (a)	Connects with obturator nerve	20	21%
(b)	Trunk of obturator nerve	8	9%
(c)	Anterior branch of the obturator nerve 14.30%	30	31%
(d)	Posterior branch of the obturator nerve	4	5%

described in **Table 1 and 2** respectively.

Origin

The formation of accessory obturator nerve was found variable as arising from L2 to L4, L3 to L4, L2 to L3 and L3 only and from the trunk of obturator nerve (**Table 1**). Most commonly AON was formed from the ventral rami of L3 to L4 but in cases AON was taking origin from the trunk of obturator nerve. The percentage of findings as shown in **Table 1**. Many variations are found in branching pattern of AON in present study. The branches of AON are shown in **Table 2** along with some interesting findings.

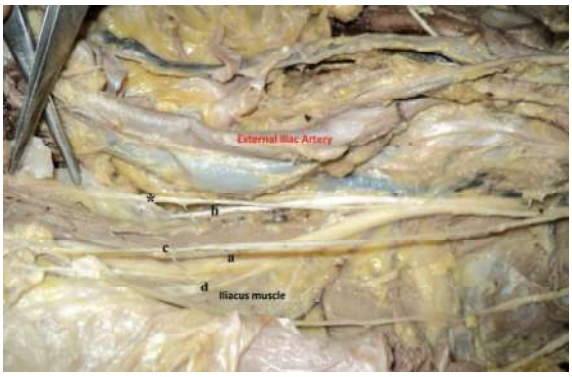

Fig 1: Left Lumbar plexus is shown with Left Accessory obturator nerve taking origin from L3–L4 is shown with Astrix (*). All the other branches of lumbar plexus are shown as femoral nerve (a), obturator nerve (b), genitofemoral nerve (c) and lateral femoral cutaneous nerve of thigh (d). The image is also published in our manuscript in the Journal of Anatomical Society of India 2013 (62) 47–51.

Discussion

The results of the present cadaveric study clearly demonstrate that the branching pattern of the accessory obturator nerve is highly variable. Anatomic variability of the accessory obturator nerve may explain some of the difficulties experienced when locating and blocking the obturator nerve. Prevalence of an AON in humans has reported an incidence of 30%, which is in line with our findings. Other authors have reported an incidence range of 8% to 30% (**Table 3**).[7]

Akkaya *et al.* reported that the presence of an AON could negatively affect the clinical efficacy of an obturator nerve block. He stated that if the patient has an AON, it could be necessary to block this as well while obturator nerve blocks. AON blockage can be recommended for thigh surgeries, treatment of pain, and diagnosis of hip joint pain.[6]

Jirsch JD and Colin H. Chalk reported an interesting case of a 38-year-old woman who developed obturator mononeuropathy during elective laparoscopic tubal ligation, presumably due to accidental electrocauterization of the nerve along the lateral wall of the lesser pelvis. Compared to open pelvic surgery, laparoscopic techniques offer a more limited field of exposure and may hinder the identification of neural structures. Lying relatively deep in the pelvis, the obturator nerve may be particularly vulnerable

Table 3: Analysis of previous studies reporting the prevalence of the accessory Obturator Nerve.

Sl. No.	Author	Country	Year of study	Total number of specimens	Percentage observed
1.	Eisler		1892	120	29%
2.	Bardeen		1901	250	8.4%
3.	Kaiser		1949	24	8.3%
4.	Woodburne	Michigan	1960	550	8.7%
5.	Katritsis		1980	1000	13.2%
6.	Akkaya	Turkey	1999	24	12.5%
7.	Anloague and Hijibregt	Dayton, OH	2009	30	8.8%
8.	Turgut *et al.*	Turkey	2017	40	30%
9.	Present study	India	2018	91	31%

to misidentification and subsequent injury. This problem may be compounded by the presence of an accessory obturator nerve, an anatomical variant that is common yet under recognized, judging from standard laparoscopic textbooks. The accessory obturator nerve was mistakenly identified as the main nerve, and this confusion was a factor in the patient's injury.[5]

The basis for the existence of the present variant of AON can be explained by reviewing the embryological basis. Developmentally, it has been suggested that this small nerve may have been separated from the obturator nerve during the formation of the obturator foramen.[14] Howell AB noted that the pubis develops first as a process, subsequently hooking around the ON and joining the ischium so as to enclose this nerve in the obturator foramen.[15] The small AON arises from the lumbar plexus by roots from the third and fourth lumbar nerves and it emerges between the obturator and femoral nerves. Eisler P noted that the roots of the AON push out between those of the pre-axial obturator and the postaxial femoral nerves. At the same time, he unequivocally classified the accessory nerve as parts of the ventral division of the lumbar plexus.[8] The anatomical variations of AON are important to anesthetists, orthopedic surgeons, neurophysicians, physiotherapist and radiologists. Such comprehension is useful in delivering complete anesthesia along the obturator nerve supply and nerve grafting for peripheral neuropathies.[16]

Conclusion

The presence of AON is clinically important as it is also considered during ON blockade. The AON blockade can be indicated in superficial surgeries of thigh, treatment of pain due to thigh tourniquet, as a diagnostic aid for pain syndromes in the hip joint, inguinal areas or lumbar spine, and in relief of intractable hip pain due to osteoarthritis. The anatomical variations of nerve plexuses are also important to anesthetists, orthopedic surgeons, neurophysicians, physiotherapist and radiologists. Such comprehension is useful in delivering complete anesthesia along the obturator nerve supply, nerve grafting, neurophysiological evaluation for diagnosing peripheral neuropathies.

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