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Original article

A new concept and classification of corona mortis and its clinical significance

Waseem Al Talalwah*

King Abdullah International Medical Research Center/King Saud bin Abdulaziz University for Health Sciences, College of Medicine, Department of Basic Medical Sciences, Hospital – NGHA, Riyadh 11481, Saudi Arabia

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ABSTRACT

Purpose: The obturator artery and its accessory (aberrant) arising from different origins and crossing the pubic rami are vascular variations. The internal iliac artery usually provides the obturator artery which may communicate with the external iliac artery through either the accessory obturator or inferior epigastric artery. A collateral circulation between the external and internal iliac system is known as corona mortis. The aim of current study is to provide sufficient data of vascular variability crossing the pubic rami for clinical field.

Methods: Present study includes 208 hemipelvises dissected in the Institution of Anatomy, Medical University of Graz. During dissection, the obturator artery and its accessory crossing the superior rami of pubic bone were found to have different origins.

Results: The obturator artery arising from the external iliac artery and from the femoral artery accounts for 9.8% and 1.1% respectively. Therefore, it passes over the superior pubic rami in 10.9%. Further, the accessory (aberrant) artery arises only from the femoral artery in 1.1%. In present study, the vascular variation crossing the superior pubic rami with or without collateral circulation between external and internal iliac system referred as corona mortis is addressed. This study includes new classification of obturator and accessory obturator arteries as well as the corona mortis. It includes a comparison of corona mortis incidence in Austria population and other populations. The corona mortis found to be in 12% of Austrian population.

Conclusion: A great attention of clinicians, radiologists, surgeons, orthopedic surgeons, obstetricians and gynecologists has to be considered before pubic surgical procedures such as internal fixation of pubic fracture, an inguinal hernia repair. Further, traumatic pubic rami fracture may lead to massive hemorrhage due to laceration of the obturator artery.

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Introduction

The obturator and accessory obturator arteries may arise from the external iliac artery and pass at the pubic rami. The vascular variation crosses the pubic rami and anastomoses with obturator artery arising from the internal iliac artery known as corona mortis. Therefore, corona mortis is a vascular connection between the external and internal iliac arteries. This collateral circulation occurs due to either the inferior epigastric or accessory obturator artery arising from the external iliac artery joining the obturator artery

arising from the internal iliac artery. Usually, the obturator artery arises from the anterior trunk of the internal iliac artery. Occasionally, it may arise from the external iliac or femoral artery instead of the internal iliac artery. The accessory obturator artery usually arises from the external iliac artery. Further, the obturator or accessory obturator artery may arise with the inferior epigastric artery from a common trunk of either the external iliac or femoral artery.¹ Due to vascular variation, the current study focuses on the anatomical morphology of the obturator and accessory obturator arteries crossing over the pubic rami, and further categorizes them into several forms of corona mortis. It estimates the incidence of corona mortis and its different forms in Austria population. It also helps to comparatively analyze the incidence of corona mortis in different populations. The present study will enhance the awareness of orthopedics and surgeons to prevent iatrogenic errors in several pubic surgical procedures.

* Corresponding author: Tel.: +966 555888967.

E-mail address: altalalwahw@ksau-hs.edu.sa.

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Materials and methods

The present study includes 104 (76 male and 28 female) dissected cadavers to study the vascular connection between the external and internal iliac artery through their inferior epigastric and obturator branches. The current study was conducted in the Institute of Anatomy, Medical University of Graz in Austria. It is under regulation and rule of Austria research which has been approved from the anatomy institution. The photo permission has been taken under the Medical University of Graz Regulations. The SPSS (Statistical Package for the Social Sciences) software program is used for data collection and analysis. The missing data has been excluded to get the accurate incidence rate of variation. Once students had finished dissecting the anterior abdominal wall and the entire gastrointestinal system, a transverse section above L₅ was made. After sagittal section of the pelvis, the peritoneum was removed carefully. At the level of the sacral promontory, the sigmoid colon was sectioned from the rectum at the rectosigmoidal junction. Consequently, the venous and arterial iliac systems were exposed. The veins were carefully removed up to the level of the common iliac vein to provide a clear picture of internal iliac artery's trunks and branches.

The common iliac artery bifurcates into external and internal iliac arteries between L₃ and L₅. At the level of the internal iliac artery bifurcation, the ureter and gonadal artery were reflected to observe the obturator artery origin. The obturator artery usually arose either on the lateral or dorsolateral surface of the anterior trunk, but it also arose from the anterior trunk below the origin of umbilical artery. Occasionally, the obturator artery arose either from the anterior or posterior trunk. To observe the obturator artery easily, the obturator nerve was identified to trace the obturator artery just inferior to the nerve.

At the pubic bone, the peritoneum is attached to the superior pubic ramus and has to be released to identify the possibility of an obturator artery or accessory (aberrant) obturator artery as a branch of the external iliac artery. Therefore, the urinary bladder has to be moved away from the pubic bone. The retropubic space is frequently occupied by a variable amount of fat which has to be removed carefully. The external iliac artery was inspected and its branches identified, being careful not to miss the inferior epigastric or accessory obturator artery. In cases of obturator artery running on the lateral wall of the pelvis, the possibility of its communication either with the accessory artery or the inferior epigastric artery was considered.

Results

The current study includes 208 hemipelvises to investigate the incidence of corona mortis and their forms. The obturator artery arose from the external iliac artery being 9.8%. The obturator artery arose from the external iliac artery directly being 6.5% and indirectly 3.3%. The obturator artery indirectly arose either from the common trunk with inferior epigastric artery being 2.2% or from the inferior epigastric artery being 1.1%. Further, the obturator artery arose from the femoral artery being 1.1%. In present study, the accessory obturator artery arose only from the femoral artery being 1.1%.

Discussion

The obturator artery arises from the anterior trunk of internal iliac artery and run on the lateral wall of pelvis to traverse in the obturator foramen (Fig. 1). It has a collateral circulation with the external iliac system via the inferior epigastric artery before leaving

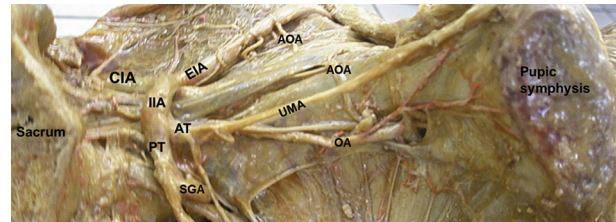


Fig. 1. The obturator artery arising from the anterior trunk of the internal iliac artery. CIA: common iliac artery; EIA: external iliac artery; IIA: internal iliac artery; IEA: inferior epigastric artery; OA: obturator artery.

the pelvic cavity.¹ The obturator artery arising from the external iliac artery is highly linked with the coexistence of sciatic artery.²

Knowing the variability of the double obturator artery origins (corona mortis) is clinically significant.³ Over two centuries, the obturator artery crossing over superior pubic ramus has been studied in different researches.^{3–41} The obturator artery crossing the pubic rami is reported in following research studies.^{3,6,7,16,17,19–21,23–27,30–32,35,37–39} In current study, the obturator artery can be classified into three types based on its origin. The first type is the obturator artery arising directly from the external iliac artery (Fig. 2).^{3,5,7,17,24,26,27,30,31,35,38} The second type is the obturator artery arising indirectly from the external iliac artery (Fig. 3). The second type is divided into two subtypes according to origin morphology. The first subtype is the obturator artery arising from the inferior epigastric artery ranging between 14% and 33%.^{13,30} The incidence of obturator artery arising from the inferior epigastric artery is found to be from 2.6% to 44%.^{3,5,6,14,16,17,19,21,23–26,30,31,37,38} The second subtype is the obturator artery arising from a common trunk of the external iliac artery^{1,5,22} (20%–30% or 10.5%–27.3%^{1,19,23}). The incidence of the obturator artery arising from a common trunk of the external iliac artery is 4% of 75 specimens in Polska population,¹⁷ 1% of 100 specimens in Turkey,⁴ 14.2% of 98 specimens in Indian population³⁰ and 2.2% of 104 cadavers in Austria in present study. The third type is obturator artery arising from the femoral artery¹ in 1.1% of American population²³ as well as in Austria in current study.

In the past, the coexistence of accessory obturator artery arising from the external iliac artery with obturator artery arising from the internal iliac artery was defined as a double obturator²³ ranging between 1% and 34%.^{3,7,11,20,23,26,28,36,37,39,41} According to literature review, the accessory obturator artery is found to be more in American population while the Chinese and Turkish populations become the second and third highest incidences respectively. In general, the Austrian population is found to be the lowest incidence

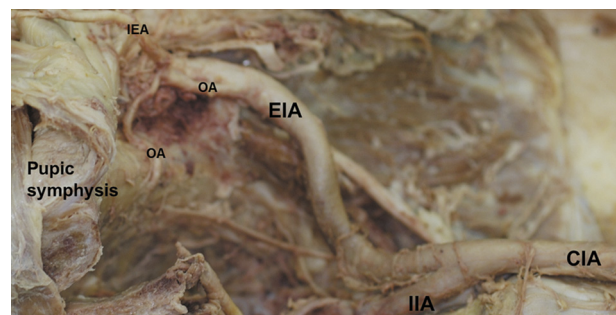


Fig. 2. The obturator artery arising directly from the external iliac artery. EIA: external iliac artery; IIA: internal iliac artery; IEA: inferior epigastric artery; OA: obturator artery.

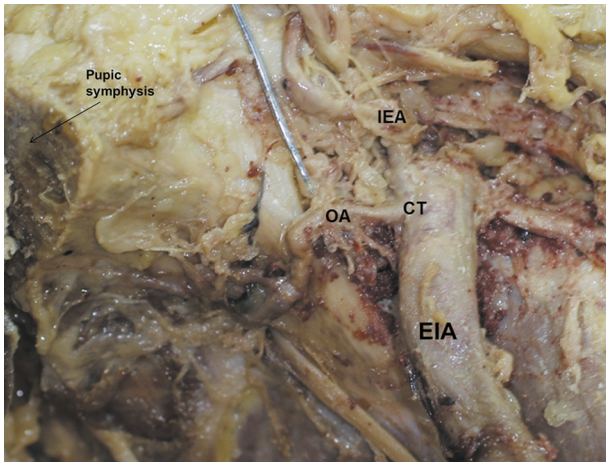


Fig. 3. The obturator artery arising indirectly from the external iliac artery, that is, from a common trunk with the inferior epigastric artery. EIA: external iliac artery; IIA: internal iliac artery; CT: common trunk; IEA: inferior epigastric artery; OA: obturator artery.

rate of the accessory obturator artery in Europe as well as in worldwide population.

According to morphological origin of the accessory obturator artery, the current study proposed new classification. The first type is the accessory obturator artery arising directly from the external iliac artery,²⁶ whereas the second type is the accessory obturator artery arising indirectly from the external iliac artery (either directly or indirectly from a common trunk of the inferior epigastric artery, Fig. 4).²⁶ The third type is the accessory obturator artery arising from the femoral artery (1.1%) in current study. A great awareness should be considered by treating physicians in cases of repairing femoral or inguinal hernia as well as internal fixation of ventral pubic fracture.

In earlier studies, presentation of collateral circulation of the obturator and accessory (aberrant) obturator arteries were described as double obturator arteries.²⁶ Later, the collateral circulation between internal and external iliac system is referred as a Crown of death, Circle of death or corona

mortis.^{3,8,9,12,17,26,29,38,41} Generally, the incidence rate of venous and arterial types of corona mortis is found to be variable in different studies in which the venous type is more common than the arterial one.^{3,11,17,28,29,38,40,41} The arterial type of corona mortis is found to be between 1% and 65% in following researches.^{3,7,9–11,15,18,20,23,28–30,33–38,40,41}

According to morphology of the obturator and its accessory artery, the corona mortis can be classified into ten types. In the first type, the obturator artery arises from the external iliac artery. In the second type, it arises from the inferior epigastric artery. In the third type the obturator and inferior epigastric arteries anastomose together. A fourth type is the pubic branches of the obturator artery replacing the anastomosis with the external iliac artery.²³ The fifth type is that the obturator artery arises from the femoral artery. The sixth type is the accessory obturator artery arising from the external iliac artery. The seventh type is the accessory obturator artery arising from the inferior epigastric artery. The eighth type is the accessory obturator artery arising from a common trunk of the external iliac artery with inferior epigastric artery. While, the ninth type is obturator and accessory obturator arteries having a collateral circulation. Finally, the accessory obturator artery arising from the femoral artery is the tenth type of corona mortis.

The corona mortis is thought to be more common in Black South Americans compared to North Americans, European and Japanese populations.²⁶ According to current review study, the arterial corona mortis is found to be more common in American population. The Turkish is the second highest incidences of arterial corona mortis. The incidence of arterial corona mortis in Austrian, Greece and Hong Kong populations is found to be almost equal. The incidence of arterial corona mortis in Austrian population is found to be less common than Thailand and Romania populations. On the other hand, the incidence of arterial corona mortis in Austrian population is found to be more common than Indian, China and United Kingdom populations.

Conclusion

The pubic rami fractures may lead to massive bleeding and ends with death. Therefore, if the obturator or accessory obturator artery crosses over the superior pubic ramus, it is highly susceptible to injuries in either scalpel dissection or mesh insertion. Therefore, coexistence of the vascular variations from either the external iliac or the femoral arteries requires a great awareness from surgeons during herniorrhaphy and hernioplasty of inguinal and femoral hernia. In addition, gynecologists and obstetricians have to be aware of the vascular variations in the origin, course and branches to avoid postsurgical complications in cases of hysterectomy as well as in orthopedics in cases of anterior pelvic fracture (superior pubic rami fracture). Consequently, the radiologists must alert the treating physicians to avoid intra-pelvic bleeding due to iatrogenic fault resulting from lacerating corona mortis. Accordingly, a great precaution has to be considered prior to surgical interference at the retropubic region such as hernia repair, internal fixation of pubic fracture and skin flap transplantation.

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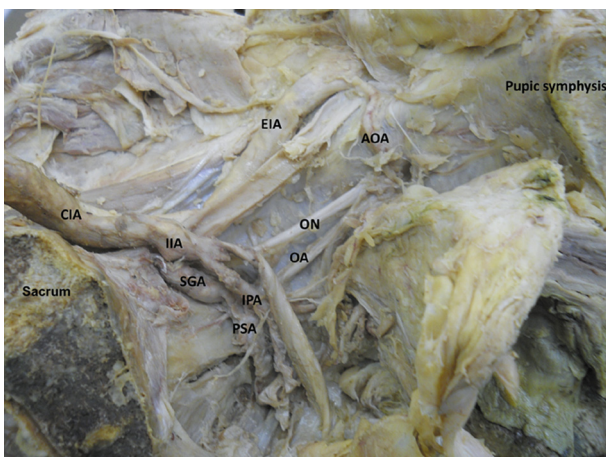


Fig. 4. The obturator artery arising from the internal iliac artery anastomosing with the accessory obturator artery arising from the external iliac artery known as arterial corona mortis. CIA: common iliac artery; EIA: external iliac artery; IIA: internal iliac artery; IEA: inferior epigastric artery; OA: obturator artery. ON: obturator nerve; AOA: accessory obturator artery; SGA: superior gluteal artery; IPA: internal pudendal artery; PSA: persistent sciatic artery.

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