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Anatomical considerations on surgical implications of corona mortis: an Indian study

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Abstract

The blood vessels traversing the superior pubic ramus are usually vascular connections between obturator and external iliac systems of vessels. Dislocated fractures or iatrogenic injury can cause life threatening bleeding and hence these vascular anomalies are referred to as corona mortis meaning 'crown of death'. Except for a case report, no study on corona mortis has been attempted in India so far and hence the present study was intended at exploring the possible variations, both morphological and topographical, of these vascular connections in Indian population through cadaveric dissection. 24 adult cadavers dissected bilaterally (48 hemipelves) and 19 random hemipelves available in the Department of Anatomy were considered for the study.The vascular connections observed were classified as arterial, venous or both (Types I, II and III). Type III was further classified into subtypes a, b, c, d and e based on various combinations of the first two types. In a total of 67 pelvic halves corona mortis was detected in 56 (83.58%) specimens: arterial 7/56 (12.5%), venous 34/56 (60.7%) and both arterial and venous in 15/56 (26.78%) specimens respectively. 22 hemipelves had an artery on the superior pubic ramus out of which in 7 cases there was only an artery whereas in 15 cases both an artery and a vein were present. Commonest source of obturator artery was inferior epigastric artery 15/22 (68.18%) followed by external iliac artery 4/22 (18.18%). 49 of the 56 corona mortis positive specimens had a vein on the superior pubic ramus. In 34/56 specimens only a vein was present.12/49 (24.48%) veins drained into external iliac vein, 3/49 (6.12%) into inferior epigastric vein. A venous anastamosis was found between obturator vein and external iliac vein in 21/49 (42.85%) cases and between obturator and inferior epigastric vein in 10/49% (20.40%) cases. Corona mortis was observed in a significant percentage of specimens, venous corona mortis being more common than arterial. Every surgeon dealing with hernias or fractures of the region needs to be aware of the possible variations and ligate vessels if corona mortis presents itself or else it becomes difficult to control bleeding if a cut vessel retracts into the pelvis.

Key words

Corona mortis, pelvis, superior pubic ramus, external iliac vessels, obturator vessels.

Introduction

The vascular connection between obturator and external iliac systems of arteries, veins or both is generally referred to as 'corona mortis' which in latin means crown of death (Berberoglu et al., 2001; Okcu et al., 2004). Located behind the superior pubic ramus, the name signifies its importance, as considerable hemorrhage can occur when cut accidentaly and subsequent hemostasis is difficult to achieve (Darmanis

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et al., 2007). The blood vessels on the superior ramus of the pubis have tremendous surgical importance in orothopaedic approaches, hernia repair, trauma, embolizations and intraarterial infusions (Rusu et al., 2010). Hence surgeons operating on this area should be aware of the variations in morphology and topography of the vascular connections termed corona morti (Rusu et al., 2010).

Though few studies and case reports have been published on corona mortis in the recent years, no Indian study has explored corona mortis to the best of our knowledge. Our literature search revealed just a single case report from India (Sakthivelavan et al., 2010). Hence, this study was aimed at finding out the prevalence and variations in morphology and topography of the entity called "corona mortis" in Indian population by dissecting the cadavers available in the Department of Anatomy.

Materials and Methods

Twenty-four adult cadavers (23 male and 1 female) were dissected bilaterally (48 pelvic halves) to find out the prevalence of corona mortis. All the cadavers were alloted for undergraduate and postgraduate medical teaching. The lateral pelvic walls were carefully dissected to expose the obturator vessels and nerve which were traced to the obturator foramen. The external iliac and inferior epigastric vessels were also exposed. In addition, 19 random hemipelves (17 male and 2 female) available in the Department of Anatomy were also included in the study. These pelves had already been dissected by undergraduate medical students as a part of their training programme during the first year medical course. Only those pelves where the external iliac, inferior epigastric, and obturator vessels were intact were included in the study. Pelves where the said vessels were cut or where there was evidence of any cut vessel in the region were excluded from the study. The distance of the corona mortis from the pubic symphysis was measured in mm. We adapted the methodology proposed by Rusu et al (2010) in assessing corona mortis. Accordingly, the term corona mortis was applied to any blood vessel passing over the superior pubic ramus, including any vascular anastomosis, obturator vessel connecting with external iliac system or any other vessel. The vascular connections observed were classified as arterial, venous or both (Types I, II and III respectively). Type III was further classified into subtypes a, b, c, d and e based on various combinations of the first two types. Subtype a: Obturator artery arising from inferior epigastric artery, venous anastomosis between obturator vein and external iliac vein. Subtype b: Obturator artery from inferior epigastric artery, obturator vein draining into external iliac vein and an accessory obturator vein draining into inferior epigastric vein. Subtype c: Arterial anastomosis between pubic branch of obturator artery and inferior epigastric artery. Venous anastomosis between obturator vein and external iliac vein. Subtype d: Obturator artery from external iliac artery, venous anastomosis between obturator vein and external iliac vein. Subtype e: Obturator artery arising from inferior epigastric artery, obturator vein draining into external iliac vein.

Results

Corona mortis was noticed on the superior pubic ramus in 37 hemipelves of the 24 cadavers dissected (77.08%). Among the 19 random pelvic halves, corona mortis was present in all the specimens. Therefore out of a total of 67 pelvic halves studied, corona mortis was detected in 56 (83.58%) specimens.

In 37 hemipelves of 24 cadavers, where corona mortis was noticed, an arterial corona mortis was present in 3 (8.10%), a venous one in 20 (54.05%) and both arterial and venous corona mortis in 14 (37.83%). In 5 cadavers the presence was bilateral. In the 19 random hemipelves, an arterial corona mortis was present in 4 specimens (21.05%), a venous one in 14 (73.68%) and both artery and vein were present in 1 specimen (5.26%).

Therefore, out of the 56 pelvic halves in which corona mortis was observed, an arterial corona mortis (Fig. 1) was present in 7 (12.5%), corresponding to 10.44% of the total number of hemipelves, a venous corona mortis (Fig. 2) was present in 34 (60.71%), corresponding to 50.74% of the total pelvic halves and both an arterial and venous corona mortis (Fig. 3) was present in 15 (26.78%), corresponding to 22.38% of the total pelvic halves.

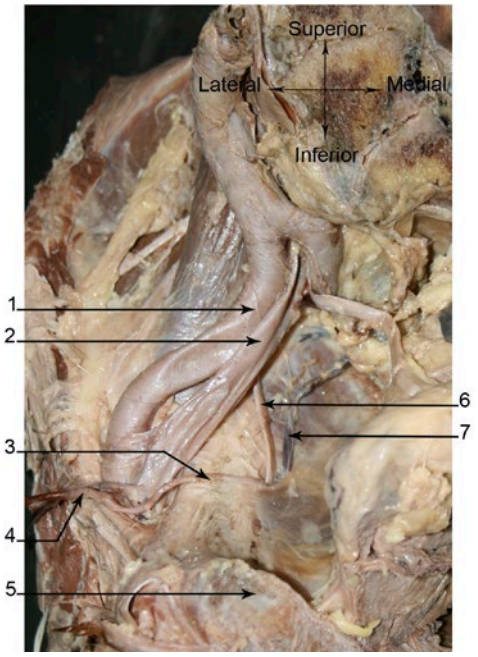

Figure 1 – Right side, arterial corona mortis (Type-I: obturator artery arising from inferior epigastric artery). 1 external iliac artery, 2 external iliac vein, 3 obturator artery, 4 inferior epigastric artery, 5 pubic symphysis, 6 obturator nerve, 7 obturator vein.

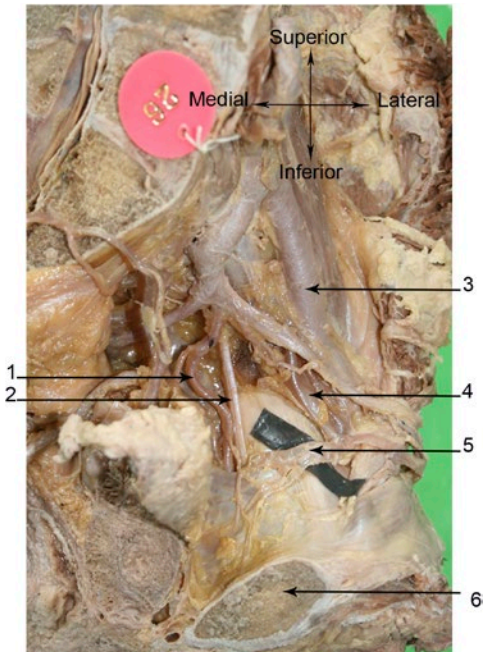

Figure 2 – Left side, venous corona mortis (Type-II: obturator vein draining into external iliac vein). 1 obturator artery, 2 obturator nerve, 3 external iliac artery, 4 external iliac vein, 5 obturator vein, 6 pubic symphysis.

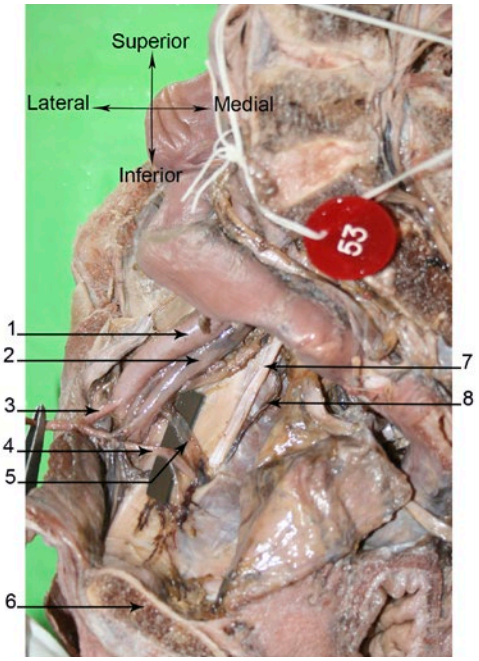

Figure 3 – Right side, combined arterial and venous corona mortis (Type-IIIa: obturator artery arising from inferior epigastric artery, Venous anastomosis between obturator and external iliac vein). 1 external iliac artery, 2 external iliac vein, 3 inferior epigastric artery, 4 obturator artery arising from inferior epigastric artery, 5 venous anastomosis between obturator and external iliac vein, 6 pubic symphysis, 7 obturator nerve, 8 obturator vein.

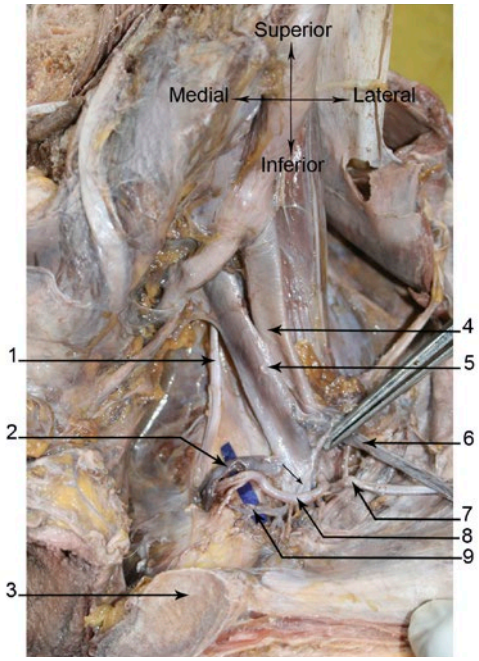

Figure 4 – Left side, combined, arterial and venous corona mortis (Type-IIIb: obturator artery arising from inferior epigastric artery, obturator vein draining into external iliac vein and accessory obturator vein draining into inferior epigastric vein). 1 obturator nerve, 2 obturator vein, 3 pubic symphysis, 4 external iliac artery, 5 external iliac vein, 6 inferior epigastric vein, 7 inferior epigastric artery, 8 obturator artery, 9 accessory obturator vein.

A total of 22 hemipelves had an artery on the superior pubic ramus. In 7 cases there was only an artery, whereas in 15 cases both an artery and a vein were present. Regarding the source of artery on the superior pubic ramus in those 22 hemipelves, the commonest source of obturator artery was inferior epigastric (15 cases, 68.18%) followed by external iliac artery in 4 (18.18%). In 1 specimen (4.54%) the pubic branch of obturator artery was found anastomosing with the pubic branch of inferior epigastric artery. In addition to the normal obturator artery, an accessory obturator artery was observed bilaterally in the pelvis of one cadaver (2 hemipelves, 9.09%), and on both the sides the said artery was found taking origin from the inferior epigastric artery.

In 49 hemipelves a vein was present on the superior pubic ramus, in 34 of these specimens there was only a vein (60.71%) whereas in 15 hemipelves there were an artery and a vein (30.61%). Twelve veins (24.48% of cases with a vein on the superior pubic ramus) drained into external iliac vein and 3 (6.12%) into the inferior epigastric vein. In 21 (42.85%) specimens with a vein on the superior pubic ramus a venous anastomosis was found between the obturator vein and the external iliac vein and in

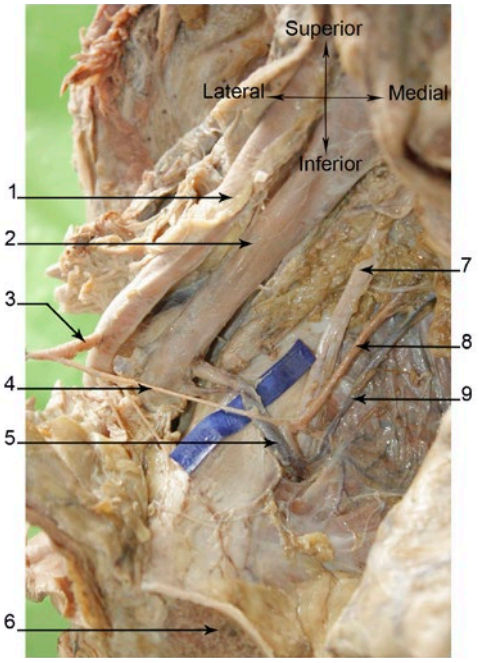

Figure 5 – Right side, combined arterial and venous corona mortis (Type-IIIc: anastomosis between pubic branch of inferior epigastric artery artery and pubic branch of obturator artery, venous anastomosis between obturator and external iliac veins). 1 external iliac artery, 2 external iliac vein,3 inferior epigastric artery, 4 anastomosis between pubic branch of IEG artery and pubic branch of obturator artery, 5 Venous anastomosis between obturator and external iliac vein, 6 pubic symphysis, 7 obturator nerve, 8 obturator artery, 9 obturator vein.

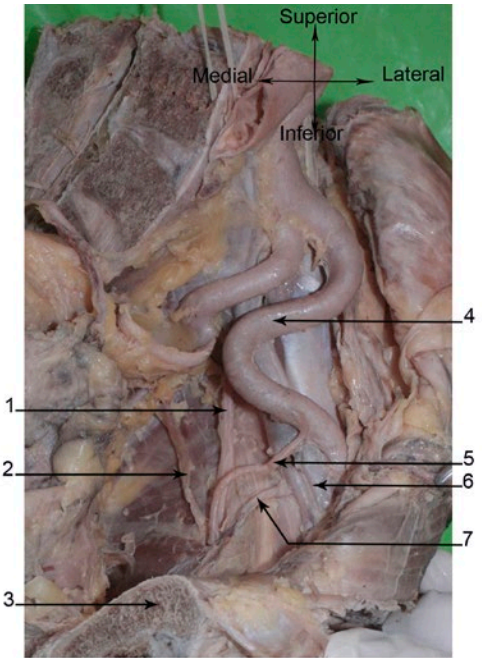

Figure 6 – Left side, venous corona mortis (Type-IIId: obturator artery arising from external iliac artery, venous anastomosis between obturator and external iliac veins). 1 obturator nerve, 2 obturator vein, 3 pubic symphysis, 4 external iliac artery, 5 obturator artery, 6 external iliac vein, 7 venous anastomosis between obturator and external iliac vein.

10 specimens (20.40%) a venous anastomosis was present between the obturator vein and the inferior epigastric vein. An accessory obturator vein with no connections to the main vein was noticed in 3 (6.12%) pelvic halves. Various combinations of arterial and venous corona mortis are depicted in (Figs. 3 to 7) and summarized in Fig. 8. The distance from the pubic symphysis to the corona mortis ranged from 38 to 79 mm with an average distance of 54.5 mm.

Discussion

Corona mortis is classically defined as connections between obturator and external iliac system of arteries or veins or both (Berberoglu et al., 2001). When the obturator artery takes origin from the external iliac artery or inferior epigastric artery it has to descend behind the superior pubic ramus to reach the obturator foramen (Tornetta

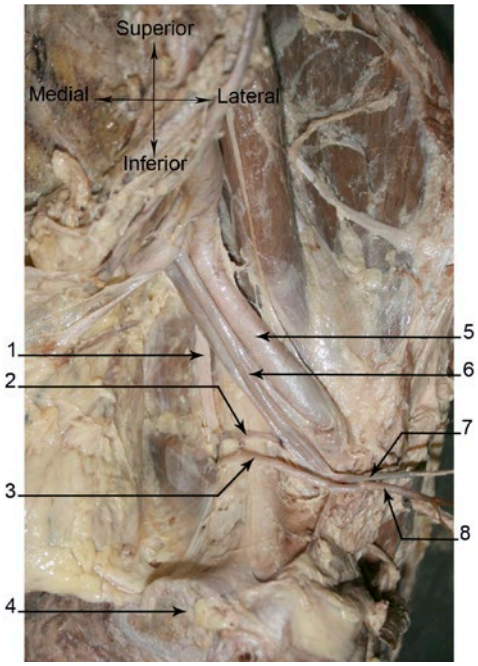

Figure 7 – Left side, combined arterial and venous corona mortis (Type-IIIe: obturator artery originates from inferior epigastric artery, obturator vein drains into external iliac vein). 1 obturator nerve, 2 obturator vein draining into external iliac vein, 3 obturator artery, 4 pubic symphysis, 5 external iliac artery, 6 external iliac vein, 7 inferior epigastric vein, 8 inferior epigastric artery.

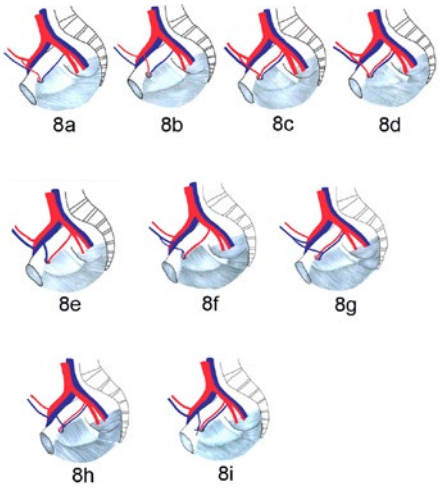

Figure 8 – Schematic representation of our results showing the variable origin obturator artery (8a to 8d) and variable pattern of drainage of obturator vein (8e to 8i).

et al., 1996). Surgical importance of corona mortis has been highlighted by different authors (Tornetta et al., 1996; Sarikcioglu et al., 2003). During pelvic osteotomies for acetabular dysplasia using the medial approach and during acetabular surgery for fractures using ilioinguinal approach, vascular channels crossing superior pubic ramus in a vertical direction are at risk. If cut accidently, they will cause massive uncontrolled bleeding, because retraction of the vessel inferiorly or through the obturator foramen can make hemostasis difficult to achieve (Tornetta et al., 1996; Karakurt et al., 2002) and hence the blood vessel concerned is aptly referred to as corona mortis or crown of death.

In the literature there is no consensus amongst various authors as to what exactly constitutes corona mortis (Sarikcioglu et al., 2003). According to Sarikcioglu et al (2003) only few classical textbooks use the term corona mortis. Various authors use terms like accessory obturator artery, accessory obturator vein, aberrant obturator artery, anomalous origin of obturator artery from external iliac artery (Sarikcioglu et al.,2003), whereas some authors ignore accessory obturator artery or vein and consider only arterial anastomosis between obturator artery or its branches with external iliac artery. In this context we fully agree with Rusu et al (2010) according to whom normal obturator artery takes origin from internal iliac artery and courses through the obturator canal, Accessory obturator artery is an additional artery found in the

Table 1 – Incidences of CMOR as reported by various authors (modified from Rusu et al., 2010).

Sl No.	Author	Year	Total CMOR %	Arterial CMOR %	Venous CMOR %	Both CMOR %	Specimens
1	Missankov et al [10]	1996	-	-	46	-	49 cadaver halves
2	Tornetta et al [20]	1996	84	34	70	20	50 cadaver halves
3	de Kleuver et al [5]	1998	25	-	-	-	24 hemipelvises
4	Berberoglu et al [3]	2001	-	-	100	-	14 cadaver halves
5	Karakurt L et al [9]	2002	--	28.5	-	-	98 patients, angiography
6	Sarikcioglu L et al [18]	2003	-	0	20.37	-	54 cadaver halves
7	Hong et al [7]	2004	72	-	-	-	50 hemipelvises
8	Okcu G et al [12]	2004	61	19	52	9	150 cadaver halves
9	Pungpapong & Thumumnauysuk et al [14]	2005	77.27	-	-	-	66 pelvic halves
10	Malivalaya Namking et al [11]	2005	-	22.5	70.6	17.2	204 pelvic halves
11	Darmanis et al [4]	2007	83	-	-	-	80 hemipelvises
12	Rusu MC et al [15]	2010	80	65	55	-	40 hemipelvises
13	Present study	2016	83.58 [56/67]	10.44 [7/67]	50.74 [34/67]	22.38 [15/67]	67 hemipelvises

presence of obturator artery also coursing through the obturator foramen; an aberrant artery is an extra artery in addition to normal obturator artery but with an aberrant course through the obturator canal. We would like to mention that when the obturator artery takes origin from the external iliac artery or its inferior epigastric branch, its origin is considered as anomalous. Regarding veins, the normal obturator vein drains usually into internal iliac vein or may drain into the external iliac vein or inferior epigastric vein or more commonly there may be an anastomosis between a normal obturator vein and external iliac vein or inferior epigastric vein.

There is wide variation in the reported prevalence of corona mortis as is evident from the Table 1. This could mainly be due to lack of consensus amongst various authors as to what actually constitutes corona mortis as mentioned earlier. According to Okcu et al (2004) the variations could be due to regional differences in the development of vascular system or due to limitations imposed by the size of collapsed vessels. Because of the difficulty in measuring accurate diameter of vessels in the cadaver, we did not attempt to do so. We just identified the vessels as large and small because as pointed out rightly by Rusu et al (2010) the surgeon will not identify the vessels based on the exact calibre but will evaluate them based on appearance, topography and connections

The prevalence of pure arterial corona mortis was relatively less (12.5%) than that of pure venous corona mortis (60.71%). This finding is in agreement with that of other researchers (Tornetta et al., 1996; Berberoglu et al., 2001; Namking et al., 2007etc).

Tornetta et al (1996) observed 70% venous and 34% arterial corona mortis, Berberoglu et al (2001) found a vein behind superior pubic ramus in all the cases of 14 cadaver halves by anatomical examination and in 34/36 cases by laparoscopic examination.

Variations in the venous system being more common than that of arterial could be the reason for the higher prevalence of venous corona mortis. But fewer studies have been done on the prevalence and variations of venous corona mortis in comparison with arterial corona mortis (Berberoglu et al., 2001; Sarikcioglu et al., 2003). The vein behind the superior pubic ramus is referred to by various names by different authors (Tornetta et al., 1996; Berberoglu et al., 2001; Sarikcioglu et al., 2003; Darmanis et al., 2007). A venous connection between obturator vein and external iliac vein was the commonest finding in our cases. Berberoglu et al (2001) found a thick vein between external iliac vein and obturator vein in all the cases he studied. He preferred to use the term communicating vein instead of "unusual", "accessory" or "a pubic branch". He further states that since a venous connection is more probable than arterial, its importance needs to be appreciated by surgeons to prevent venous bleeding. According to him, during repairs of the groin, or procedures involving spermatic cord, dissection of the sac around the origin of this venous connection must be done carefully and meticulously. Though classical text books in Anatomy touch upon the venous connection, they do not mention the risks associated with such cases during surgical procedures (Berberoglu et al., 2001). Angiography can help assess only arterial corona mortis and cannot orient the surgeon on the venous anatomy of the superior pubic ramus.

Both an artery and a vein were observed in 26.78% of our specimens positive for corona mortis, Similar results were obtained by other authors: Tornetta et al. (1966), 20 %; Namking et al. (2007), 17.2% and others.

The commonest source of obturator artery was inferior epigastric artery. This is in agreement with an earlier study carried out in our Department, in which we found the obturator artery to take origin from the inferior epigastric artery in 22% of the cases (Rajive and Pillay, 2015). In literature the origin of the obturator artery from inferior epigastric artery ranges from 6.6 to 44% and from external iliac artery from 0 to 44 % (Rusu et al., 2010). In addition to normal obturator artery, an accessory obturator artery was observed in two specimens and an anastomosis between the pubic branch of inferior epigastric artery and the pubic branch of obturator artery in one case.

The wide spectrum of combined corona mortis is very important in surgical practice and hence while attempting surgical procedures near superior pubic ramus the surgeon must evaluate the vascular pattern of corona mortis free of any prejudgement (Rusu et al., 2010).

The reasons cited for the development of the anomalous arterial pattern of the limbs are based on the ontogenic theory put forth by Sañudo et al (1993), who based their view on the description by Senior (1919, 1925) that arterial pattern of the limbs develop from a primary capillary plexus, through a selection of channels where the most appropriate channels enlarge, while others regress and disappear thus establishing the final arterial pattern. In cases like the present one, long before the obturator artery makes its appearance in the 'rete pelvicum' as an independent blood vessel, the blood flow destined to its territory would derive from source channels different from usual. Instead of arising from the internal iliac artery, that flow would arise

from the inferior epigastric artery or from the external iliac artery. The presence of a dual origin of the obturator artery could be due to the persistence of two source channels for the blood flow, one as usual from the internal iliac artery and the other from the inferior epigastric artery (Sañudo et al., 1993).

Surgical exposure of anterior pubic ring involves lateral dissection on the superior pubic ramus during which a vascular channel crossing the superior pubic ramus is at risk, irrespective of whether it is an artery, a vein or an anastomosis, because severe bleeding would result if accidentally cut and retraction of the cut vessel inferiorly or in to the obturator foramen might complicate the matter further. Laceration of even a small calibre obturator vessel can create a high flow arterial bleed via extrapelvic anastomosis with the circumflex femoral artery (Pick et al., 1942; Tornetta et al.,1996). However, Jenson et al (2015) in a retrospective data base study on 195 patients, who underwent pelvic surgery for acetabular fracture or pelvic ring instability, found the prevalence of corona mortis to be 41.5%; notwithstanding they reported that the high incidence was not associated with bleeding complications or did not affect the mortality significantly.

In the present study, on an average corona mortis was found to be 54.5 mm away from the pubic symphysis, range being 38-79 mm. Various authors have reported a range of 21.4 mm to 96 mm (Rusu et al., 2010). This distance assumes importance as the vascular connections are close to the femoral canal and hence extra caution must be exerted during femoral hernia repair according to Berberoglu et al (2001). However Rusu et al (2010) expressed the opinion that the distance of the above vessels from the bony landmarks are individually variable, related to anthropological types and gender, and hence the knowledge of this distance is of little use and unrelieable.

Though corona mortis could be identified on routine contrast enhanced multidetector CT scans, in one third of the patients in a study conducted by Smith et al (2009), these authors are of the opinion that 1-2.5 mm CT reconstruction demonstrates these variations much more frequently than 5 mm thick images and therefore corona mortis may be prospectively identified on contrast enhanced mutidetector CT in patients with pelvic trauma and will serve as an useful guide in subsequent endovascular embolization. The prevalence of corona mortis is pretty high as is evident in the present study and various other studies (Tornetta et al.,1996; Hong et al., 2004, Pungpapong et al., 2005; Darmanis et al., 2007; Rusu et al., 2010) and hence keeping in mind the high incidence (Smith et al., 2009) this very important but manageable anatomical structure should be handled with caution by surgeons operating on the region especially during delayed open surgery for pelvic trauma.

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The authors wish to declare that there is no conflict of interest.

References

Berberoglu M., Uz A., Ozmen M.M., Bozkurt C., Erkuran C., Taner S., Tekin A., Tekdemir I. (2001) Corona mortis: an anatomic study in seven cadavers and an endoscopic study in 28 patients. Surg. Endosc. 15: 72-75.

Darmanis S., Lewis A., Mansoor A., Bircher M. (2007) Corona mortis: an anatomical study with clinical implications in approaches to the pelvis and acetabulum. Clin. Anat. 20: 433-439.

de Kleuver M., Kooijman M.A., Kauer J.M., Veth R.P. (1998) Pelvic osteotomies: anatomic pitfalls at the pubic bone. A cadaver study. Arch. Orthop. Trauma Surg. 117: 270-272.

Hong H.X., Pan Z.J., Chen X., Huang Z.J. (2004) An anatomical study of corona mortis and its clinical significance. Chin. J. Traumatol. 17: 165-169.

Jensen K.O., Sprengel K., Mica L., Somlyay L., Jentzsch T., Werner C.M.L. (2015) Surgical relevance of corona mortis and clinical outcome in pelvic trauma. Austin J. Anat. 2: 1033.

Karakurt L., Karaca I., Yilmaz E., Burma O., Serin E. (2002) Corona mortis: incidence and location. Arch. Orthop. Trauma Surg. 122: 163-164.

Missankov A.A., Asvat R., Maoba K.I. (1996) Variations of the pubic vascular anastomoses in black South Africans. Acta Anat. (Basel) 155: 212-214.

Namking M., Woraputtaporn W., Buranarugsa M., Kerdkoonchorn M., Chaijarookhanarak W. (2007) Variation in the origin of the obturator artery and corona mortis in Thai. Siriraj Med. J. 59: 12-15.

Okcu G., Erkan S., Yercan H.S., Ozic U. (2004) The incidence and location of corona mortis: a study on 75 cadavers. Acta Orthop. Scand. 75: 53-55.

Pick J.W., Anson B.J., Ashley F.L. (1942) The origin of the obturator artery: a study of 640 body halves. Am. J. Anat 70: 317-343.

Pungpapong S.U., Thum-Umnauysuk S. (2005) Incidence of corona mortis; preperitoneal anatomy for laparoscopic hernia repair. J. Med . Assoc. Thail. 88: S51-S53.

Rajive A.V., Pillay M. (2015) A study of variations in the origin of obturator artery and its clinical significance. J. Clin. Diagn. Res. 8: AC12-AC15.

Rusu M.C., Cergan R., Motoc A.G., Folescu R., Pop E. (2010) Anatomical considerations on the corona mortis. Surg. Radiol. Anat. 32: 17-24.

Sakthivelavan S., Sendiladibban S.D., Aristotle S., Sivanandan A.V. (2010) Corona mortis - a case report with surgical implications. Int. J. Anat. Var. 3: 103-105.

Sañudo J. R., Roig M., Rodriguez A., Ferreria B., Domenech J.M. (1993) Rare origin of the obturator, inferior epigastric and medial circumflex femoral arteries from a common trunk. J. Anat. 183: 161-163.

Sarikcioglu L., Sindel M., Akyildiz F., Gur S. (2003) Anastomotic vessels in the retropubic region: corona mortis. Folia. Morphol. (Warsz) 62: 179-182.

Senior H.D. (1919) An interpretation of the recorded arterial anomalies of the human pelvis and thigh. Am. J. Anat. 25: 55-96.

Senior H.D. (1925) An interpretation of the recorded arterial anomalies of the human pelvis and thigh. Am. J. Anat. 36: 1-45.

Smith J.C., Gregorius J.C., Breazeale B.H., Watkins G.E. (2009) The corona mortis, a frequent vascular variant susceptible to blunt pelvic trauma: identification at routine multidetector CT. J. Vasc. Interv. Radiol. 20: 455-460.

Tornetta P.III, Hochwald N., Levine R. (1996) Corona mortis: incidence and location. Clin. Orthop. 329: 97-101.