

## Corona mortis

### An anatomic study in seven cadavers and an endoscopic study in 28 patients

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#### Abstract

**Background:** The corona mortis is defined as the vascular connections between the obturator and external iliac systems. While detailed information on the arterial anastomoses in corona mortis is available, a complete description of the venous system is lacking. Although the tiny anastomoses behind the pubic symphysis between the obturator and external iliac arteries have been described in classical anatomy textbooks, these texts neglect to mention that these anastomoses can be life threatening. Attention needs to be paid to these anastomoses between the arterial and the venous system located over the superior pubic ramus during laparoscopic procedures.

**Methods:** Fifty retroinguinal regions were dissected in seven cadavers and 28 patients.

**Results:** During the dissections, a venous anastomosis on the superior pubic ramus was a consistent finding in 96% of cases. This vein coursed vertically to the inferior border of the superior pubic ramus and connected to the obturator vein. Accessory branches of the obturator artery were observed in only 8% of the dissections. The tiny connections between the obturator and external iliac arteries are less important, since their diameter is <1 mm.

**Conclusions:** We have termed the venous connection between the external iliac and obturator veins over the superior pubic ramus “the communicating vein”. This structure forms the corona mortis. Surgeons dealing with direct, indirect, femoral, or obturator hernias need to be aware of these anastomoses and their close proximity to the femoral ring. In classical anatomy textbooks, a description of the veins that form corona mortis is found less often than descriptions of the arteries. Since a venous connection is more probable than an arterial one, its importance must be appreciated by surgeons in order to avoid venous bleeding.

**Key words:** Anatomy — Corona mortis — Hernia repair — Extraperitoneoscopy

The corona mortis is defined as the vascular connections between the obturator and external iliac systems [4, 8, 11, 13, 17, 21]. Although classical anatomy textbooks provide detailed information about the arterial anastomoses in corona mortis, they do not give a thorough description of the venous system. The tiny anastomoses behind the pubic symphysis between the obturator and external iliac arteries have been described, but the investigators neglected to mention that these anastomoses can be life threatening [3, 4, 9, 11, 12]. In laparoscopic procedures, attention needs to be paid to the anastomoses located over the superior pubic ramus between the arterial and venous systems.

Now that interest in the laparoscopic anatomy of the pelvic region is increasing, the confusion over the anatomy of that region needs to be cleared up. Therefore, we set out to evaluate the anastomoses that form the corona mortis in order to determine whether they are arterial, venous, or both.

#### Materials and methods

Fifty retroinguinal regions (14 halves in seven cadavers and 36 hernias in 28 patients) were dissected either anatomically or laparoscopically. In the cadaver group, all findings were recorded during dissections; both drawings and photographs were made. In the laparoscopic group, a totally extraperitoneoscopic video surgery technique was chosen; video recording and drawings were used to record the findings.

#### Laparoscopic technique

All patients were operated on under general anesthesia. A balloon dissection technique was used to achieve a wide retropubic area. The laparoscope



**Fig. 1.** The communicating vein is situated between the external iliac and obturator vein. Left side, upper view. EIA: external iliac artery, EIV: external iliac vein, ON: obturator nerve, OA: obturator artery, CoV: communicating vein, OV: obturator vein, OF: obturator foramen.



**Fig. 2.** Accessory obturator artery originating from the inferior epigastric artery and two tributaries of the communicating vein (Cov1 and CoV2). Right side, upper view. EIA: external iliac artery, EIV: external iliac vein, IEA: inferior epigastric artery, AOA: accessory obturator artery, CoV: communicating vein, Cov1: branch of the communicating vein, CoV2: branch of the communicating vein, OV: obturator vein, OF: obturator foramen.



**Fig. 3.** Accessory obturator artery originating from the external iliac artery. Left side, upper view. EIA: external iliac artery, EIV: external iliac vein, CoV: communicating vein, AOA: accessory obturator artery, RP: pubic branch, ON: obturator nerve, OF: obturator foramen.

was introduced into the Retzius space through the structural balloon (Origin Medsystems, Menlo Park, CA, USA). During the manipulations required for hernia repair, the corona mortis was gently dissected, and the vascular structures were clearly determined. All of the operations were recorded, and the findings were evaluated by the authors.

## Results

### Anatomical findings

During the dissections, a venous anastomosis on the superior pubic ramus was found in all cases. The venous connections between the external iliac and obturator veins are shown in Fig. 1. The diameter of this vein ("the communicating vein") was 3.3 mm (range, 2.2–4.9). This vein coursed vertically to the inferior border of the superior pubic ramus and connected to the obturator vein. This connection was located in the obturator foramen in some cases and was outside the foramen in others (Figs. 1, 2).

In 12 of the cadavers, the obturator artery arose from the internal iliac artery, which forms a branch known as the "pubic ramus" before entering the obturator foramen. This branch coursed behind the pubic bone, creating anastomoses with the pubic ramus of the inferior epigastric artery. The average diameter at these connecting vascular structures was 0.98 mm (range, 0.6–1.2).

In two of the samples, the obturator artery originating from the internal iliac artery could not be found. Instead, there was an extension from the external iliac artery in one

case and an accessory obturator branch from the inferior epigastric artery in the other (Figs. 2, 3). This artery coursed from the superior pubic ramus vertically to enter the obturator foramen. The diameters of those vessels were 2.4 and 2.2 mm, respectively. In the case with the accessory obturator artery, there was an obturator vein (Fig. 2), which was not seen in the other case (Fig. 3).

The average distance from the back of the pubis to the arterial or venous anastomoses was 40.4 mm (range, 33.2–52.7 mm). We observed that the venous arch over the superior pubic ramus was in close relation with the femoral ring and lacunar ligament (Fig. 4).

### Laparoscopic findings

A venous connection between the external iliac and obturator veins was found in 34 of our 36 pelvic dissections (Fig. 5). In 31 patients, the obturator arteries branched before entering the obturator foramen, which forms an anastomosis with the pubic ramus of the inferior epigastric artery retro-pubically. Their diameter was <1 mm, as for the anatomic findings. An accessory obturator branch from the inferior epigastric artery was observed in three cases; it coursed over the superior pubic ramus vertically to enter the obturator foramen. In these cases, no obturator artery was seen. We also noted that the venous arch over the superior pubic ramus was in close proximity to the femoral ring and lacunar ligament in all of our laparoscopic dissections.



**Fig. 4.** Close relationship between the lacunar ligament and the communicating vein. Right side, upper view. EIV: external iliac vein, L. Lig: lacunar ligament, CoV: communicating vein, ON: obturator nerve, OA: obturator artery, OV: obturator vein, OF: obturator foramen.

**Fig. 5.** Laparoscopic view of right communicating vein. EIV: epigastric inferior vein, CoV: communicating vein, VD & SV: vas deferens and spermatic vessels, OV: obturator vein.

## Discussion

In much of the surgical literature, corona mortis is mainly described as an arterial anastomosis. Nyhus referred to the pubic branch of obturator artery as “the corona mortis” [14]. Condon defined it as the anastomosis between the obturator artery and the pubic branch of the inferior epigastric artery and also described the relatively larger venous connections accompanying them [6]. Skandalakis et al. warned of possible bleeding during incision of the lacunar ligament while freeing the femoral sac. According to them, the artery can be damaged if it is positioned medial to the sac instead of between the sac and the iliac external vein [16]. In the drawings that illustrate his textbook on surgical anatomy, McVay shows an aberrant obturator artery that originates from the external iliac artery and enters the obturator foramen, but it is not mentioned in the text [10]. Bendavid described a venous circular network formed by the inferior epigastric, iliopubic, rectus, retro pubic, and communicating rectusopubic veins but did not mention the corona mortis [5]. In another anatomical text, Ellis also shows an artery located between the inferior epigastric and the obturator arteries; in this case, it is referred to as “the pubic artery”

[7]. Mainland concluded that the pubic branches between the inferior epigastric artery and the obturator artery are surgically significant and may represent a hazard when they are thick [11]. Odar noted that the anastomoses between the obturator branch of the inferior epigastric artery and the pubic branch of the obturator artery are sometimes thick and that injury to this connection may occur during femoral hernia repairs [15].

The anatomic atlases of McMinn and Grant also describe the accessory obturator artery on the superior pubic ramus [1, 2]. In the absence of an obturator artery, several authors have documented an unusual accessory artery originating from the inferior epigastric artery or a thickened portion of the inferior epigastric artery and known as “the obturator artery” [2, 4, 9, 13, 21]. According to Moore, the incidence of this unusual or accessory vessel is ~20% [13]. The textbooks indicate that surgery in this region may be risky if the anastomosis is formed by a thick branch, but they never mention the tiny anastomoses behind the pubic symphysis [2, 4, 9, 13, 17, 20]. Only Mainland, Odar, and Yıldırım considered these tiny structures to be part of the corona mortis [11, 15, 21].

We found tiny connections between the obturator and external iliac arteries; however, they may be regarded as less important because their average diameter is only ~0.98 mm and they are located away from the surgical field. On the other hand, surgical risk is probable in the presence of an accessory obturator artery, which takes the place of the obturator artery. The diameter of this accessory artery, which is located on the superior pubic ramus, was 2.88 mm in one case and 2.24 in the other.

The classical anatomy texts pay less attention to the veins that form the corona mortis than its arteries. Moore referred to the venous connection as “the accessory obturator vein,” and *Gray’s Anatomy* mentions a thick vessel that connects the obturator and external iliac veins [13, 20], but neither text mentions the risks associated with such cases during surgical operations. Von Lanz and Wachsmuth called the vein that originates from the external iliac vein and runs through the obturator canal “the vv. comitantes” [19]. Tornetta et al. reported that the anastomoses described as corona mortis consisted of 34% arterial, 70% venous, and 20% both vascular structures in a review of previous studies [17]. In their study of on South African blacks, Missankov et al. found that 12% of cadavers had arterial, 26% of cadavers had venous, and 12% of cadavers had both vascular structures [12]. But in their work with 55 cadaver dissections, Gilroy et al. noted a relatively high incidence of obturator artery variations (~70–80%) [8]. In these studies, the incidence of venous anastomoses was greater than that of arterial anastomoses.

In our study, we found a thick vein (an average of 3.3 mm in diameter) between the external iliac and obturator veins in all cases. The important finding here is that there is always a thick vein on the superior pubic ramus, whether it is called an “unusual”, an “accessory”, or a “pubic” branch. We prefer to use the term “communicating vein” for these structures, which were observed with the obturator vein in one of two cases. Because a venous connection is more probable than an arterial one, its importance needs to be appreciated by surgeons in order to avoid venous bleeding. During groin hernia repairs, manipulation of the spermatic

cord and dissection of the sac around the origin of this vein must be done carefully and meticulously.

Tornetta et al. gave a morphometric measurement of 60.2 mm (range, 30–90) from the pubic symphysis to the anastomoses in 50 pelvic halves [17]. Our average measurement was 40.5 mm (range, 33.2–52.7). The distance between the anastomoses known as “the corona mortis” and the pubic symphysis should be taken into consideration during hernia repairs [18], in addition, the unstable pelvic fractures need to be fixed in order to avoid unexpected complications. It is also important to remember that these connections are in very close relation to the femoral hernial sac. Therefore, dissection of this area must be done with extra caution during femoral hernia repair.

### Conclusion

We found a consistent venous connection between the external iliac and obturator veins over the superior pubic ramus. We have termed it “the communicating vein” that forms the corona mortis. Thus, the corona mortis is not an arterial connection, as had been previously thought. If the obturator artery is missing, an accessory obturator artery joins to the corona mortis (20–30%). This artery or vein reaches the obturator foramen by passing by or over the femoral ring on the superior pubic ramus. Here it is in close relationship with the loose edge of the lacunar ligament and the neck of the femoral hernial sac. Therefore, any surgeon dealing with direct, indirect, femoral, or obturator hernias needs to be aware of these anastomoses and their close proximity to the femoral ring.

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