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# Anatomical features of venous and arterial corona mortis in fresh cadavers in the Turkish population and anatomical landmarks to be used during surgical procedures

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## Abstract

**Objectives:** The aim of this study is to determine the topographic position of the corona mortis on fresh cadavers and also to determine anatomical landmarks that will facilitate surgeons to consider to this structure during operations by clarifying the relationship of the corona mortis with the surrounding anatomical structures.

**Methods:** A total of 50 autopsy cases of 31 men and 19 women, all examined within 24 hours post-mortem, were evaluated bilaterally for the presence of corona mortis. When identified, the vascular characteristics (arterial/venous) of the corona mortis were documented. The topographic position of the corona mortis was determined by measuring the distances to the pubic symphysis, promontory, obturator nerve and anterior superior iliac spine. The study also investigated whether some anthropometric measurements affect these distances.

**Results:** Out of the 100 hemipelves examined, corona mortis were observed in 50 cases. Among these, 34% were arterial (n=17), and 66% were venous (n=33). Anastomoses were identified in the hemipelves of 22 women and 28 men, with no significant gender difference (p>0.05). The average distances to anatomical landmarks were as follows: 5.43 cm to the pubic symphysis, 1.77 cm to the obturator nerve, 9.87 cm to the promontory, and 10.56 cm to the anterior superior iliac spine.

**Conclusion:** Corona mortis poses a significant risk in surgical procedures. Knowing the vascular anatomy of the pelvis is vital for gynecological, urological and orthopedic interventions, while investigating deaths caused by pelvic trauma is important for forensic practice. This anatomical study contributes to a better understanding of the complex and intricate pelvic structure.

**Keywords:** autopsy study; corona mortis; pelvis; variant obturator artery

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## Introduction

The term "corona mortis" (CM), meaning as the 'crown of death,' denotes a crucial anatomical variant within the pelvic vascular system.[1] The obturator artery can occasionally be replaced by an expanded pubic branch of the inferior epigastric artery that descends into the obturator foramen, according to Gray's Anatomy.[2] An enlarged pubic vein that connects to the external iliac vein can also take the place of the obturator vein. Venous and arterial anastomoses, as well as auxiliary obturator vessels derived from the external iliac systems, may be involved in the formation of CM. Moreover, in cases where arterial CM connection is present, it helps pelvic nutrition by providing anastomosis between the internal iliac artery and external iliac artery.[1–3] Pieroh et al.[4] showed that the corona mortis supplies the upper part of the symphysis pubis.

Previous studies have shown that many patients have variable obturator vessels. It is a structure of great clinical importance due to the possibility of diameters greater than 3 mm.[5] Regardless of whether the anastomosis is arterial or venous, it is known as a formation that should be considered in urological inguinal hernia repairs, gynecological

interventions and orthopedic interventions due to pelvic fractures because of its localization.[6–8] Recently, laparoscopic interventions involving this region have been preferred with increasing frequency. In these procedures, damage to the anastomotic structure may occur and complications such as hemorrhage may be observed. This situation causes the patient to turn to open surgery.[9–11] Today, minimally invasive interventions are performed in many fields. CM appears as a structure to be considered for new surgical techniques used in the field of urogynecology.[6,7]

With the classical definition, CM is the anastomosis between the pubic branch of the obturator artery, a branch of the internal iliac artery, and the pubic branch of the inferior epigastric artery, a branch of the external iliac artery.[3] However, there are comments in the literature that this definition is incomplete because of the complex structure of the pelvis and the variety of vascular structures.[12–14] Even studies and meta-analysis have revealed that venous connection is more common than arterial connection.[5,15–16] The venous anastomosis structure is challenging for surgeons in surgical applications to this region as the venous anastomosis is difficult to see and is easily injured. In case of injury, provide hemostasis becomes more complicated for the surgeon.[11,17]

Notably, literature reviews indicate a scarcity of fresh cadaver studies focusing on CM.[5,18–19] The aim of this study is to determine the topographic position of the corona mortis on fresh cadavers and also to determine anatomical landmarks that will facilitate surgeons to consider to this structure during operations by clarifying the relationship of the corona mortis with the surrounding anatomical structures.

## Materials and Methods

In 2019–2020, 50 forensic cases autopsied at the Ankara Group Presidency of the Forensic Medicine Institution were included in the study. All cases were examined within 24 hours of death, showed no signs of decomposition, maintained pelvic stability, and were in the age range of 18–70 years. The overall mean age of cases with CM was 46.97 (range: 19–70) years. The mean age of females was 42.92 (range: 23–70) years and 50.06 (range: 19–70) years in males.

Height was measured as head-to-heel distance from the cadaver lying in the supine position. To ensure precision and preserve anterior abdominal wall structures, an inverted V-shaped incision below the umbilicus was made, deviating from the routine vertical incision in standard autopsies.

A digital caliper with a precision of 0.01 mm was used for pelvic measurements. The measurements were performed by ZGK, the single author. The intersection of the corona mortis with the inner surface of the upper pubic ramus was determined. The midpoint of the bone distance of the anastomosis was used as the measurement point. The vertical distances from this midpoint to the promontory (P) and anterior superior iliac spine (ASIS) were recorded. In addition, the bony distance from the midpoint to the pubic symphysis (SP) and the nearest point of intersection with the ON were measured (**Figure 1**).

The data were analyzed using the SPSS (Statistical Package for Social Science for Windows, IBM SPSS 24.0 Corp.; Armonk, NY, USA). Descriptive statistics such as frequency, percentage, mean and standard deviation were used. Mann-Whitney U test was used for pairwise comparisons, and Chi-square test was used for the comparison of descriptive characteristics. Spearman correlation test was used to determine the relationship between variables. $p<0.05$ level was considered statistically significant.

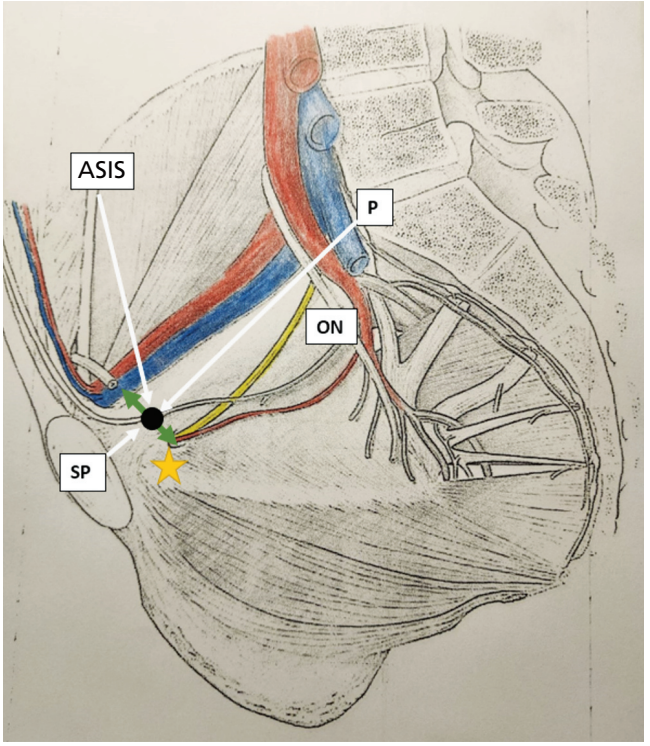


**Figure 1.** Corona mortis coursing across the medial surface of the superior ramus of the pubic bone (**yellow star**). The measurement point of corona mortis is shown as a black point. **ASIS:** anterior superior iliac spine; **ON:** obturator nerve; **P:** promontorium; **SP:** pubic symphysis.

## Results

Corona mortis was observed in fifty (50%) of the hundred hemipelvis analyzed (**Figures 2** and **3**). Of these, 22 (44%) were female and 28 (56%) were male. Gender did not show a statistically significant difference in CM anastomosis formation ($p>0.05$). The vascular distribution of the 50 CM cases was arterial in 17 (34%) and venous in 33 (66%). Arterial and venous anastomosis were not detected together. Of the 50 CM cases, 22 (44%) were located on the right side and 28 (56%) on the left side and there was no statistically significant difference between the right and left sides ($p>0.05$).

The average distances of CM to SP was 5.43 (range: 4.14–7.30) cm and to ON 1.77 (range: 0–2.88) cm. On the other hand; the average distances of CM to P was 9.87 (range: 7.70–14.70) cm and to ASIS 10.56 (range: 7.50–14.00) cm (**Table 1**).

The study revealed that there were statistically significant differences between males and females in SP, ON and ASIS distances and these distances were higher in males ($p<0.05$). On the other hand, there was no statistically significant difference between men and women in terms of P-CM distance ($p>0.05$).

A strong negative correlation was observed between height and SP ($r=-0.568$, $p<0.01$), indicating that as height increases, the SP distance shortens. Height

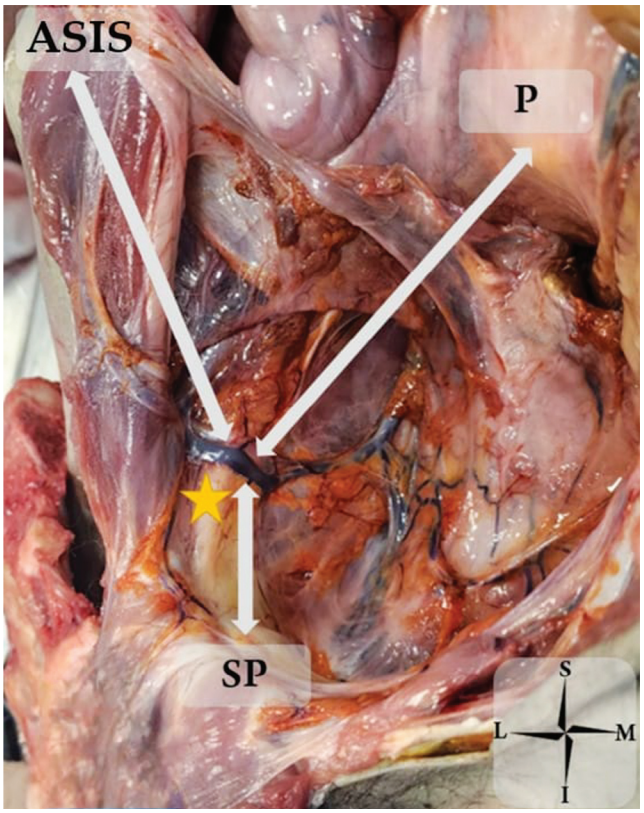


**Figure 2.** Corona mortis anastomosis crossing the bone on the inner surface of the superior pubic ramus (**yellow star**). **ASIS:** anterior superior iliac spine; **P:** promontorium; **SP:** pubic symphysis.

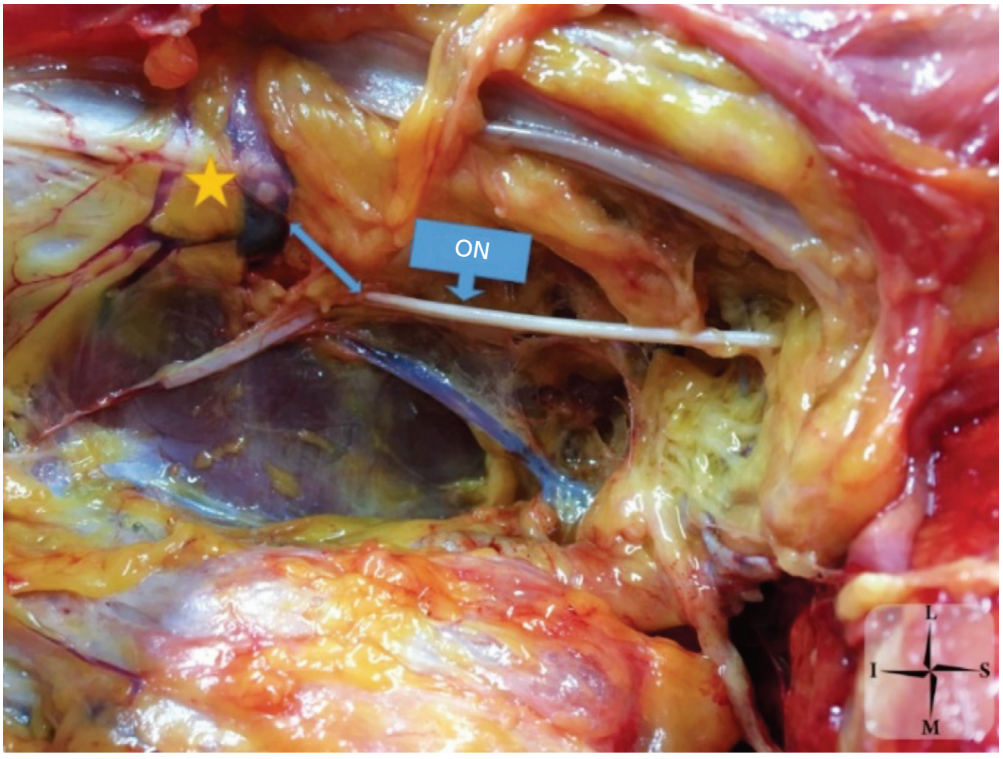


**Figure 3.** Corona mortis anastomosis crossing the bone on the inner surface of the superior pubic ramus (**yellow star**). The closest crossing point between obturator nerve (**ON**) and corona mortis is shown with a **blue arrow**.

**Table 1**
Distance of corona mortis to various landmarks by gender.

| Gender | | SP (cm) | ON (cm) | P (cm) | ASIS (cm) |
|---|---|---|---|---|---|
| Women | Mean±SD | 5.73±0.86 | 1.36±0.38 | 9.48±0.77 | 9.94±1.2 |
| | Median | 5.77 | 1.42 | 9.50 | 9.50 |
| | Minimum | 4.20 | .00 | 8.00 | 8.50 |
| | Maximum | 7.30 | 1.93 | 10.50 | 12.50 |
| Men | Mean±SD | 5.2±0.78 | 2.1±0.45 | 10.18±1.85 | 11.05±1.54 |
| | Median | 5.03 | 2.17 | 9.50 | 11.00 |
| | Minimum | 4.14 | 1.05 | 7.70 | 7.50 |
| | Maximum | 7.20 | 2.88 | 14.70 | 14.00 |

**ASIS:** anterior superior iliac spine; **ON:** obturator nerve; **P:** promontorium; **SD:** standard deviation; **SP:** pubic symphysis.

demonstrated a moderate positive correlation with both ON and ASIS (r=0.391, p<0.01, and r=0.324, p<0.05, respectively), suggesting that as height increases, ON and ASIS distances also increase. However, no correlation was found between height and P value.

Furthermore, the study identified a strong negative correlation between SP distance and ON distance (r=-0.513, p<0.01), signifying that as the SP distance increases, the ON distance decreases. SP and ON distances showed no correlation with P and ASIS values (p>0.05). Notably, a moderate positive correlation was established between P distance and ASIS (r=0.339, p<0.05).

## Discussion

Any vascular structure (arterial, venous or both) crossing the super pubic ramus can be considered as "corona mortis".[8,15] Many studies have attempted to classify corona mortis. It is complicated because of the variant the obturator artery origin.[5,18,20]

Surgical interventions within the pelvic region pose significant challenges to surgeons owing to the intricate anatomy of this area. Given the vital importance of understanding the vascular structures in the pelvic region, identifying topographically safe areas becomes imperative for guiding surgeons.[6,7,17]

Most of the studies conducted on the pelvic region are studies performed on embalmed cadavers.[5,20] There are some limitations in the study conducted by Ateş et al.,[21] which examined laparoscopic inguinal hernia surgeries. The pelvis was not examined bilaterally in all cases included in the study. In addition, venous anastomoses could not be seen at the standard 14 mmHg $CO_2$ pressure given to the patients, but were detected when the pressure was reduced to 10 mmHg. This means that fresh cadaver studies, as we did in our study, have specific advantages such as preservation of tissue integrity, absence of intraoperative variables, and the potential for more accurate anatomical evaluation. In this respect, autopsy studies conducted in our country provide important data.

Pelvic region trauma is an area that requires attention in forensic medicine practice.[22] If traumas occurring in this area result in death, autopsy is the gold standard to investigate the accuracy of medical practices applied after the injury and to determine the cause of death. Studies have shown that demonstrating pelvic vascular injuries by autopsy gives better results than tomography.[23] Pelvic region vascular structures are a subject that must be mastered not only by surgeons but also by forensic experts in postmortem studies.

In the meta-analysis conducted by Cardoso et al.[18] in 2021; a total of 3107 hemipelves were examined in 18 articles included in the study, and the incidence of CM regardless of the vessel type was found to be 63%±20% (min: 20%, max: 96%). Similar to this high incidence of finding, our study identified CM in 50 out of 100 hemipelves. Studies have revealed that the incidence of corona mortis is more common in Asia (59.3%) compared to Europe (42.8%) and North America (44.3%).[24] Based on the similar detection rates in our study, the high incidence of CM in our country also ensures that the anatomy of this region is known and preoperative preparations become even more important in terms of pelvic surgery.

Although CM was presented as an arterial anastomosis when it was first discovered, studies conducted in later years showed that it was more commonly found as a venous anastomosis.[15,18,25] In the meta-analysis conduct-

ed by Marvanova and Kachlik [5] in 2024; data on venous variations of the corona mortis were reported in 27 investigations (n= 2877 hemipelves), with an average incidence of 54.57% (ranging from 17.14% to 100%) (5). In our study, consistent with the literature, 34% of the anastomosis was found to be arterial (n=17) and 66% was venous (n=33). Venous anastomosis is an important situation for surgeons in surgical procedures to this area. In case of venous injury in this region, the surgery becomes more complicated for surgeons.[11,17,21] Thus, pre-operative knowledge of the locations of venous anastomoses, as highlighted in this study, can contribute to safer surgical approaches.

One of the bone measurement points used for laparoscopic studies is the pubic symphysis.[10] The distance of the CM to the SP, which becomes a clear measurement point after entering the retroperitoneal space, was measured as 33.4 (range: 21.4–41) mm in 98 right hemipelves conducted by Karakurt et al.[26] In another study examining 50 hemipelves, it was found to be 6.2 (range: 3–9) cm.[22] Our study is also compatible with the literature information[5] and the average SP distance of the CM anastomosis was determined as 5.43±0.85 cm. It has been observed that this distance is longer in men than in women. It is thought that this difference may be due to the difference in pelvic structure between men and women in the Turkish population.[27] Furthermore, a substantial negative association was noted between height and SP and a somewhat positive correlation with ON and ASIS were noted, despite the fact that no link was identified between height and P value. This underscores the potential significance of anthropometric measurements, often overlooked in practice, as a valuable noninvasive method in corona mortis examinations.

ON which is a branch of the lumbar plexus and is formed by the union of the branches coming from the L2–4 lumbar nerves, emerges from underneath the medial margin of the psoas major muscle, progresses to the pelvis and enters the obturator canal together with the homonymous vessels. ON is the most commonly encountered nerve in radical hysterectomy. The course of ON is important because it establishes the boundaries of pelvic lymph node dissection. It is necessary to dissect the lymph nodes until the ON is visible.[28] Protecting the ON itself and the surrounding anatomical structures used for oncogynecological surgery is also a priority for the surgeon. CM localization is closely related to ON, and in the literature review, no study showing the relationship between these two structures could be found. The midpoint of the superior ramus of the pubic bone distance, or the midpoint of the CM's bone transition, served as the measurement site for this investigation (**Figure 1**). The average distance from the CM to the ON was 1.77 (range: 0–2.88) cm. In one instance, the obturator nerve's pelvic route intersected the CM. Therefore, the findings obtained can make an important contribution to developing safer and more effective methods in medical practices by filling the gap in knowledge about the distance between these two structures.

There are many orthopedic interventions for the pelvic region, especially pelvic fractures. The biggest cause of death in the first 24 hours of pelvic fractures is bleeding.[29] The plates used during the treatment of these fractures with the intrapelvic approach also extend to the superior ramus of the pubic bone. For this reason, the vascular structures in this region are at risk both from the trauma itself and from the surgical intervention performed.[30] In this study, we measured the distances of P and ASIS, two points commonly utilized as guides in open pelvic surgeries, from the CM. The utilization of these landmarks and neurovascular data may mitigate the risks associated with intraoperative approaches.

In summary, what we found in our study, the significance of SP and ON distances is noteworthy for laparoscopic surgeries, while P and ASIS distances serve as crucial landmarks in open surgery. Given the challenges in identifying veins during surgery, and the potential for serious bleeding from vein injuries, specifying the locations of CM before the operation, elucidating their relationships with surrounding structures, and detailing the landmarks of these variations on the bone are expected to facilitate the surgeon's tasks.

In future studies, it is important to adopt multidisciplinary approaches to more clearly understand the effects of anatomical details in the pelvic region on various surgical practices and to integrate this knowledge into clinical practice. In this way, it is thought that it will contribute to making surgical interventions safer, more effective and patient-oriented.

The limitations of the study are that all cadavers included in our study were forensic autopsy cases. Due to forensic processes and security reasons, measurements could only be performed by the author within a limited time. Due to the limited autopsy time, the structures in the dissected area could not be revealed and photographed as in fixed anatomy cadaver studies. Another limitation was the difference in the number of cases between males and females since the majority of deaths in forensic cases were male.

## Conclusion

The pelvic region is of vital importance for many medical specialties. This study stands out as a step that encourages cooperation between different surgical disciplines and increases the knowledge in this field. In gynecological, urological and orthopedic surgical applications, anatomical knowledge of the corona mortis plays a critical role in surgical planning and safe performance of procedures. This study provides guidance not only for surgeons but also for forensic medicine specialists.

### Conflict of Interest

There is no conflict of interest.

### Author Contributions

ZGK: concept, design, literature search, data collection, processing, analysis and interpretation of the results, writing the manuscript; AU: design, literature search, writing the manuscript.

### Ethics Approval

Approval for the study was received from the Scientific Research Board of the Istanbul Forensic Medicine Institute (Number: 21589509/2019/373, date: 20.05.2019).

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