A review of the corona mortis with clinical and surgical applications to orthopedics

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ABSTRACT

The corona mortis (crown of death) is usually considered as the anastomosis between the external iliac vessels and internal iliac vessels over the superior pubic ramus, although there is no consensus regarding its definition. It possesses a variable prevalence among different studies and its presence is of surgical significance to numerous procedures. Some of these surgeries are routinely performed by the orthopedist, thus, awareness of the corona mortis is crucial. The present work aimed to perform a comprehensive review to evaluate the prevalence of the corona mortis and to address its anatomical, surgical and clinical aspects in respect to orthopedics. It is known that iatrogenic rupture of this vessel during surgery may cause significant hemorrhage with difficulty in hemostasis. This vessel can also be the source of hemorrhage in pubic fractures, hence, when evaluating pubic fractures one must check the presence of bleeding and its source. Thus, the orthopedist must remember this vessel during procedures such as osteotomies and whilst using accesses such as the ilioinguinal and modified Stoppa.

Keywords: corona mortis, obturator artery, inferior epigastric artery, osteotomy, pubic fracture, ilioinguinal access

INTRODUCTION

The corona mortis (CM) is characterized as an anastomotic channel between the external iliac vessels and the obturator vessels over the superior pubic ramus (SPR). The CM can be both arterial (aCM) (Figure 1) or venous (vCM) [1-4].

Despite its regular definition, some authors debate that any form of anastomosis over the SPR should be labeled as CM, as it can be caused by an aberrant origin of the obturator artery (OA) or from an anastomosis with the inferior epigastric artery (IEA) [1, 2, 5].

The CM is subject to study due to its clinical significance: it can be ruptured in low-energy or high-energy pelvic fractures and be a source of significant hemorrhage [5].

Furthermore, procedures that are commonly used to treat femoral/inguinal hernias, pelvic and acetabular fractures, total hip arthroplasties, and other widely performed surgical accesses (e. g. Stoppa, ilioinguinal) are among surgeries that may lead to iatrogenic injury of this vessel [5-7].

However, the incidence of the CM among the general population is not clear, since numerous studies possess different results, thus, in some studies the presence of CM is common, while in others it is rare [1, 3, 8, 9].

Hence, the review presented herein aims to compile the available data to summarize the anatomical and surgical aspects of the CM in respect to orthopedics.
REVIEW

Corona Mortis

Multiple variations of the OA and IEA have been described in the literature [5, 10-14]. Anatomical textbooks emphasize a variation in which the OA arises from the IEA, as it usually courses over the SPR in order to reach the obturator foramen and has close relation to the lacunar ligament - albeit its significance was only attributed in hernia procedures [10, 11]. However, these textbooks and clinically oriented anatomy textbooks barely mention the relevance of this anastomosis, much less use the term "corona mortis" [10, 11].

The term CM is derived from the Latin (corona, meaning crown; mort, meaning death) [2, 14]. It possesses a confusing definition: some authors believe that any vessel coursing over the superior pubic ramus should be labeled as CM [8, 15, 16], while others restrict this definition to an anastomosis between the external iliac vessels and the internal iliac vessels (anastomotic branch of the OA and IEA) [1, 4, 9, 16-20].

This ample definition creates confusion among anatomists and surgeons. As a result, multiple authors tried to classify the numerous forms CM [1, 21]: (1) whenever the OA originated from the IEA; (2) whenever the OA originated from the EIA; (3) whenever the pubic branch of the OA and the IEA anastomosed over the SPR; (4) whenever the OA diverted from its usual course and passed over the SPR.

The first two cases are well documented in the classic anatomical textbooks and are appreciated by several recent studies [5, 10-12, 14], furthermore, the OA in these two situations is commonly labeled as “aberrant obturator artery” [1, 14, 15, 22-24], although we believe that this term should not be used, as it is not precise and may lead to confusion regarding the fourth situation, since an OA that diverts from its usual trajectory may be labeled as aberrant without necessarily passing over the SPR.

The surgical risk, however, should be attributed to any vessel that courses over the SPR, as it may be injured in this particular area, thus, a more practical way to define what truly is a CM is simply the position of any vessel regarding the SPR [15].

The other issue in this nomenclature lies with the venous portion of the CM. It is known that venous channels are more prone to vary and are more random than arterial ones [11, 25]. There are several reports of multiple obturator veins, and some of them may or may not pass over the SPR whilst draining to the EIV, IIV and IEV [5, 17, 18].

Clinical and surgical significance to orthopedics

The CM can be ruptured in multiple types of fractures, albeit related to the pubic bone. These fractures (caused by high or low energy) have the capacity to injure this vessel and produce significant hemorrhage [31-33]. Furthermore, the fracture can cause spasms on the CM, which can increase the difficulty of the surgical treatment [18]. Thus, patients with pubic bone fractures should not be discharged with analgesics without further evaluation of possible CM rupture [31-33]. This should be of significant concern to the clinician, as the rates of CM are high, according to an aforementioned meta-analysis [20].

Numerous orthopedic procedures are associated with CM injury [6, 18, 28, 34].

Despite the higher risk of iatrogenic injury to neurovascular bundle, the ilioinguinal approach is
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widely used among surgeons to treat anterior wall and column fractures. In order to safely conduct this procedure, one must visualize the CM and the IEA before the adjacent structures are retracted [35-37]. A meta-analysis revealed that the CM is 59.90 mm away from the pubic symphysis [20], however, some papers observed even closer ranges, such as 49.62 mm [14], while its caliber is around 2.6 and 3 mm [14, 38] – the range and caliber of this vessel further adds to the necessity of care when operating on this region, as one of the main concerns of CM injury is the difficulty to achieve hemostasis after its rupture [9, 14, 18, 39, 40]

In addition, pelvic and acetabular osteotomies are among the first choice of treatment for acetabular retroversion, hip deformities and acetabular dysplasia. These procedures are also used to treat hip osteoarthritis. When the medial approach is used, the surgeon must consider the presence of the CM, as there are high rates of iatrogenic injury. The CM is not exposed or handled in other types of approaches [3, 35, 39, 41, 42].

Periacetabular, and pelvic osteotomies poses a great danger to the OA, especially during the anterior approach as there is limited field of vision and the tip of the chisel blade may press or lacerate these vessels [39, 41, 43]. A study performed in cadavers showed that some landmarks are useful during these procedures, such as the distance of the OA (or CM) to the ischial osteotomy site [39].

A systematic review performed by Alshameeri, Bajekal [44] revealed that the OA is in danger during total hip arthroplasties, and that most of these injuries involved laceration of the artery or pseudoaneurysm formation.

Another access that is widely performed is the Stoppa’s to treat medial displacement of the acetabular columns or the quadrilateral surface [45, 46]. Despite that, the modified Stoppa approach has been gaining certain popularity, as it does not involve the femoral neurovascular bundle. However, the obturator neurovascular bundle is still in danger, although it can be easily identified and exposed [45].

In contrast to these data, a study performed by Jensen, Sprengel [47] stated that the presence of the CM was not associated with increased hemorrhage complications or higher mortality. We believe that this was due previous knowledge of this anastomosis, since the surgeon tried to locate it in all situations. Whenever an individual operates blindly or with limited field of vision the CM is more prone to be injured.

CONCLUSIONS

This review can be appreciated in the sense of updating the literature regarding the anatomy of the CM and reviewing the clinical and surgical aspects of this vessel.

In conclusion, the CM is fairly common among the general population, and has a close relation to the SPR and the pubic symphysis. This vessel can be the source of hemorrhage in a great number of surgical procedures (e.g. osteotomies) and accesses (e.g. ilioinguinal, modified Stoppa) or pubic fractures.

Such anatomical threat must be reminded by orthopedicians and surgeons alike in order to prevent iatrogenic injury or aiding in the early diagnosis of hemorrhage in pubic fractures.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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RESUMO

_Uma revisão da corona mortis e suas aplicações clínicas e cirúrgicas voltadas à ortopedia_

A _corona mortis_ (coroa da morte) é usualmente caracterizada como a anastomose entre os vasos ilíacos externos e os vasos ilíacos internos sobre o ramo púbrico superior, embora não seja consenso quanto à sua definição. Possui prevalência variável entre os diferentes estudos e sua presença é de importância cirúrgica para inúmeros procedimentos. Algumas dessas cirurgias são rotineiramente realizadas pelo ortopedista, portanto, conhecimento sobre corona mortis é crucial. O presente trabalho teve como objetivo realizar uma revisão para avaliar a prevalência da corona mortis e abordar seus aspectos anatômicos, cirúrgicos e clínicos em relação à ortopedia. Sabe-se que a ruptura iatrogênica desse vaso durante a cirurgia pode causar hemorragia importante com dificuldade de hemostasia. Esse vaso também pode ser a fonte de hemorragia nas fraturas púbricas, portanto, ao avaliar as fraturas púbricas, deve-se verificar a presença de sangramento e sua origem. Dessa forma, o ortopedista deve lembrar desse vaso durante procedimentos como osteomias e enquanto utiliza acessos como o Stoppa ilioinguinal e modificado.

**Palavras-chave:** corona mortis, artéria obturatória, artéria epigástrica inferior, osteotomia, fratura púbrica, acesso ilioinguinal