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ANTERIOR INTRA-PELVIC APPROACH AND CORONA MORTIS VASCULAR ANASTOMOSES CAUTION: A CLINICAL ANATOMICAL STUDY SHOWS HIGH FREQUENCY

Yunus Güzel*, Nuh Mehmet Elmadağ†, Mehmet Arazi‡, Kemal Emre Özen§, Aynur Emine Çiçekibaşı††

* Yunus Güzel MD, Associate Professor of Orthopedic Surgery, Department of Orthopedics and Traumatology, Faculty of Medicine, Ordu University, Ordu, Turkey. dryg@windowslive.com
† Nuh Mehmet Elmadağ MD, Orthopedic Surgeon, Department of Orthopedics and Traumatology, Faculty of Medicine, Bezmialem Vakif University, İstanbul, Turkey. drelmadag@hotmail.com
‡ Mehmet Arazi MD, Professor of Orthopedic Surgery, Department of Orthopedics and Traumatology, Private Farabi Hospital, Konya, Turkey. mehmet.arazi@gmail.com
§ Kemal Emre Özen MD, PhD, Assistant Professor of Anatomy, Department of Anatomy, Faculty of Medicine, İzmir Kâtip Çelebi University, İzmir, Turkey. kemalemre9870@yahoo.com
†† Aynur Emine Çiçekibaşı MD, Professor of Anatomy, Department of Anatomy, Meram Faculty of Medicine, Necmettin Erbakan University, Konya, Turkey. aynurciçekibaşı@yahoo.com.tr

Correspondence: Kemal Emre Özen, MD, Ph.D.
Address: İzmir Kâtip Çelebi Üniversitesi Çiğli Ana Yerleşkesi, Tıp Fakültesi, Anatomi AD. Balatçık Mh., Havaalanı Şosesi Cd., Nu: 33/2 35620 Çiğli/İzmir/Turkey
Fax: +903322236181
Mobile: +905332503397
E-mail: kemalemre9870@yahoo.com
Abstract

Background/Aim. This study aimed to answer the following questions: 1) What is the clinical frequency observed of Corona Mortis Vascular Anastomosis? 2) In clinical cases, what is the composition of Corona Mortis Vascular Anastomosis; arterial, venous or a combination? Methods. A retrospective review was made of 31 patients (24 males, 7 females; mean age 43.5 years) who underwent surgery for acetabular fractures between 2011 and 2015. The anterior intra-pelvic (AIP) approach had been applied to all patients. By examination of the intraoperative Corona Mortis Vascular Anastomosis compositions, the frequency of Corona Mortis Vascular Anastomosis was determined together with identification of venous or arterial formation and distance from the pubic symphysis. Results: A Corona Mortis Vascular Anastomosis was determined during dissection in 94% (n=29) and was ligated. In 14 cases (45%) the Corona Mortis Vascular Anastomosis was recorded as venous, in 7 cases (23%) as arterial and in 8 cases (26%) as both. The mean distance of the Corona Mortis Vascular Anastomosis from the pubic symphysis was 35.9 mm (range, 21.6 – 48.7 mm). Conclusion. The results showed the frequency of Corona Mortis Vascular Anastomosis in AIP approach is very high than previously reported in the English literature. Therefore, orthopedic surgeons should be aware about Corona Mortis Vascular Anastomosis while doing the approach.

Key Words: corona mortis, crown of death, Stoppa approach, obturator vessels, venous communications

Introduction

Surgical treatment is the gold standard treatment method for displaced acetabular fractures and successful clinical results have been reported in the long-term following internal fixation where anatomic reduction has been achieved. The most frequently used surgical approaches are the Kocher-Langenbeck and ilioinguinal approaches. The extended iliofemoral approach is recommended for complex fractures, but this approach also has high rates of complications and morbidity. In the last few decades, the anterior intra-pelvic (AIP) approach has become known as a relatively less invasive approach for complex fractures, especially those involving the load-bearing roof and medial wall. There has continued to be increasing popularity of the technique due to highly encouraging studies.

In the AIP and ilioinguinal approaches, vascular anastomoses which provide the connection between the external and internal iliac vascular system on the posterior side of the superior pubic ramus, may be the cause of significant bleeding. Obturator vessels and nerves are the most important structures requiring attention because of their direct contact with the quadrilateral surface. These vessels, which are known as the corona mortis vascular anastomoses (CMVA), must be located during surgical exposure and appropriately tied or cauterized. First described by Albrecht von Haller (1708-1777), various studies have been conducted on the frequency of observation of these vessels, the anatomic variations and structural properties. The rate of frequency of observation has been reported as ranging from 1% to 100%.

The aim of this study was to answer the following questions: 1) What is the clinical frequency observed of CMVA? 2) In the clinical cases, what is the composition of CMVA; arterial, venous or a combination?
Methods

A retrospective evaluation was made of the records patients who had been treated for acetabular fractures with an AIP approach, between 2011 and 2015 in two different centers. Children fractures and geriatric age patients were excluded and a total of 31 patients’ records were included to the study. The AIP approach had been applied to all patients and the operations were performed by two surgeons experienced in the field of trauma and pelvic surgery. Approval for the study was granted by the Local Ethics Committee and the study performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and all subsequent revisions.

Preoperatively anteroposterior (AP), iliac and obturator oblique pelvic radiographs and computed tomography (CT) images were taken. The fractures were classified according to the Judet and Letournel classification. All the fractures were evaluated clinically and radiologically as unstable and the decision was taken for surgery. In 3 patients, the fractures were bilateral and extended to both hemipelvis. In 4 patients, there was acetabulum fracture together with a displaced pelvic fracture. Demographic data of the included patients are shown in Table 1.

Surgical Technique

The AIP approach technique was applied as defined in detail in the articles of Cole and Bolhofner and Hirvensalo, Lindahl et al. The patient was placed supine on the operating table to allow adequate visualization on AP and Judet radiographs. Prophylactic antibiotic (1gr i.v. Cefazolin – Bilim, Istanbul/Turkey) was routinely administered. The presence of CMVA was investigated during exposure in all cases. In this process, the anatomic properties of CMVA were recorded (placement, distance from the pubic symphysis, arterial, venous or both). Then the vessels were appropriately tied.

Results

The patients were operated on at mean 3.9 days, range: 1 to 9 days (Figures 1 A-D). Before the reduction of the particular fracture any CMVA was found and ligated to prevent extensive bleeding. A CMVA was determined during dissection in 29 patients (n=29/31, 94%). In respect of vascular composition of the CMVA, 3 types were identified (Figures 2 A-C): type I, a purely arterial CMVA (n=7/31, 23%); type II, a purely venous CMVA (n=14/31, 45%) and type III, a combination of both arterial and venous connections located on the behind of superior ramus of the pubic bone (n=8/31, 26%). The average distance of the CMVA from the pubic symphysis was 35.9 mm (range, 21.6 – 48.7 mm).

Postoperative foot drop was observed in 1 patient, obturator nerve palsy in 2, partial iliac vein damage in 1 and external femoral vein damage in one patient. All vascular injuries were treated with primary sutures during the surgery. Drop foot was resolved after six months and all obturator nerve palsies resolved within 3 months after the index surgeries.

Discussion

While corona mortis has a place in some studies as an anatomic variation, other researchers have stated that there are anatomic variations within CMVA. In this study, the AIP approach was applied to 31 patients and CMVA was identified in the majority of the
patients (n=29, 94%). There was some form of anastomosis in almost all the hemi pelvises. The thickness varied but nearly all were large enough to be a cause of bleeding.

Very different rates related to CMVA visualization have been reported in cadaver and endoscopic studies (Table 2). In studies of 50 cadaver halves by Tornetta, Hochwald et al. 20, anastomosis was determined between the obturator and external iliac system vessels at the rate of 84%. In these cases, the arterial type was determined together with corona mortis at 34%, venous at 70% and a combination of both types at 20%. In dissections of 7 cadavers by Berberoğlu, Uz et al. 12, and in additional endoscopic evaluations of 28 cases, venous anastomosis was seen in 96% and in 8% accessory branches of the obturator artery. In the endoscopic examination of 141 hemi pelvises of 121 patients by Lau and Lee 21, corona mortis was encountered as arterial in 22%, aberrant obturator vein in 27%, and as arterial or venous in 40%. Sarıkıncıoğlu, Sindel et al. 17 determined venous anastomosis at a rate of 20% in 27 cadavers (54 cadaver halves) and the obturator artery was seen to originate from the inferior epigastric artery in 14%. In dissections of 150 cadaver halves of 75 cadavers, Okcu, Erkan et al. 22 determined vascular anastomoses between the obturator and external iliac systems in 91 of 150 sides (61%), and anastomotic veins in 78 of 150 exposures (52%), arterial connections were seen in 29 of the exposures (19%).

Rusu, Cergan et al. 16 noticed the differences and systematically recorded the possibilities of CMVA, thereby determining in a study of 40 hemi pelvis dissections from 20 cadavers, 32 (80%) CMVA, of which 10 (31%) were arterial, 16 (53%) arterial and venous and 6 (18%) venous. In the dissection of 10 hemi pelvis cadavers, Kacra, Arazı et al. determined 4 (40%) venous CMVA. In the dissection of 20 hemi pelvis of 10 cadavers by Stavropoulou-Deli and Anagnostopoulou 23. 8 arterial and 10 venous CMVA were determined. In the current study, CMVA was present in 94% and determined as venous in 45% (n=14/31), arterial in 23% (n=7/31) and a combination of both in 26% (n=8/31). Darmanis, Lewis et al. 13 in the examination of the hemipelvis of 80 cadavers, in 83% any vessel was determined crossing the superior pubic ramus and arterial anastomosis was determined at 36% and venous anastomosis at 60% but in 492 operations applied with an anterior approach (ilioinguinal or AIP), corona mortis was encountered in only 5 cases. Findings in the operational group could be interpreted in complete contrast to those of the current study. However, there are few studies in literature presenting data supporting this.

When clinical studies are examined, Elmadağ, Güzel et al. 9 determined CMVA in all of 17 acetabular fractures operated on with the AIP approach, 70.6% of which were reported as venous and 29.4% as arterial CMVA. In a series of 55 cases, Cole and Bolhofner 3, who first defined the AIP approach, first reported that anatomic vascular blockage related to the technique was anastomosis between the obturator vessels and the inferior epigastric artery and these anastomoses are often to be found but they are sometimes of different dimensions. From clinical studies, Cole and Bolhofner 3, who first described the technique and Elmadağ, Güzel et al. 9 determined CMVA in every case at rates similar to those of the current study. There are angiographic studies of corona mortis in literature, but angiographic studies only evaluate arterial anastomoses and do not give information about venous connections 16, 24. Advanced radiological techniques and fine slice thicknesses can provide the determination of higher incidence of corona mortis.

When examined anatomically, CMVA is immediately behind the superior pubic ramus and lateral of the pubic symphysis. In various studies in literature there are a series of findings about the thickness of CMVA and the distance to the pubic symphysis (Table 3). Rusu, Cergan et al. 16 classified CMVA into 4 arterial subtypes, 3 venous subtypes and
the combined type of arterial and venous anastomosis together. In studies by Sakthivelavan, Aristotle et al. in which the origin of the obturator artery was examined in 116 hemi pelvis, the obturator artery was determined to originate from the internal iliac system in 60.3% and from the external iliac system in 39.7%. It was determined that, in 90% of the hemi pelvises, the superior pubic ramus was crossed by various shapes and numbers of veins, to be drained from external iliac vein to obturator foramen. Similarly, Pai, Krishnamurthy et al. reported that in the majority of cases, the superior pubic ramus was traversed by multiple venous vessels but a percentage was not reported, whereas the rate of obturator artery crossing the superior pubic ramus was stated as 21% in total (19% originating from the external iliac system and 2% of dual origin, n=98). There are studies in literature stating that the condition is less important when vascular diameter is <1mm. The high incidence of CMVA obtained in the current study and that these vessels were of a thickness which could lead to bleeding, raises the question of whether very small diameter CMVA (<1mm) have been disregarded by many researchers or could not be determined. The importance of this question is further increased in studies which do not reflect the findings of vessels below 2mm.

The area of this study offering enlightenment can be considered to be not the presence of CMVA but that there may be variations in the origins and thickness of the veins which comprise the CMVA. In addition, that the CMVA is not seen in some cases in clinical studies may be due to injury during trauma and that it is not visualized in some cases in cadaver studies may be due to vascular collapse occurring due to the lack of blood circulation in the veins which form the CMVA or because of the fixation technique and time elapsed since the fixation. Examination of fresh cadavers in anatomic studies in this area would raise the rates of CMVA encountered by researchers. One of the strengths giving importance to the current study is that CMVA could be seen in the majority of the cases in a living population. In this respect, it is necessary to make a careful surgery is essential for the approach.

Limitations of this study can be said to be that the number of cases was low, that the vascular diameters were not measured quantitatively, and the detailed origins of the vessels were not determined. As the incision did not allow for it during the operation and because of the inherent risk, the vessel origins were not determined. However, the strong aspects of the study are that by drawing attention to the high presence of CMVA. In addition, showing live CMVA which has not collapsed during the operation is strength of this study compared to previous cadaver and angiographic studies.

As this study is the clinical study with the very high observed frequency of CMVA in English literature, it can be considered necessary to take great care with these vessels during surgical exposure. Anastomoses are a different anatomic structure and include variations in size and origin.
Table 1.

Demographic data

<table>
<thead>
<tr>
<th>Included patients</th>
<th>31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years (range)</td>
<td>43.5 (21-65)</td>
</tr>
<tr>
<td>Male:female (%)</td>
<td>24:7 (77.4:22.6)</td>
</tr>
</tbody>
</table>

Letournel classification
- Anterior column: n:15
- Both columns: n:2
- Anterior column plus posterior hemitransverse: n:6
- Transverse: n:6
- T shaped: n:2

Table 2.

Incidence of various connections (vascular, arterial and venous) from the references and the present study, AIP: Anterior intra-pelvic

<table>
<thead>
<tr>
<th>Study</th>
<th>Corona mortis (%)</th>
<th>Arterial connections (%)</th>
<th>Venous connections (%)</th>
<th>Arterial and venous connections (%)</th>
<th>Specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berberoğlu, Uz et al. 22</td>
<td>-</td>
<td>8</td>
<td>96</td>
<td>-</td>
<td>7 cadaver dissection and 28 patients endoscopic</td>
</tr>
<tr>
<td>Karakurt, Karaca et al. 38</td>
<td>-</td>
<td>28.5</td>
<td>-</td>
<td>-</td>
<td>98 patients, angiography</td>
</tr>
<tr>
<td>Sarikcioglu, Sindel et al. 37</td>
<td>-</td>
<td>20</td>
<td>14</td>
<td>-</td>
<td>54 cadaver halves</td>
</tr>
<tr>
<td>Okcu, Erkan et al. 22</td>
<td>61</td>
<td>19</td>
<td>52</td>
<td>-</td>
<td>150 cadaver halves</td>
</tr>
<tr>
<td>Hong, Pan et al. 38</td>
<td>72</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>50 cadaver halves</td>
</tr>
<tr>
<td>Pungpapong and Thum-umnauysuk 20</td>
<td>77.27</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>66 pelvic halves</td>
</tr>
</tbody>
</table>


Table 3.

The distance between the corona mortis and the pubic symphysis

<table>
<thead>
<tr>
<th>Study</th>
<th>Arterial corona mortis</th>
<th>Venous corona mortis</th>
<th>Arterial or venous connecting vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diameter (mm)</td>
<td>Distance from pubic symphysis (mm)</td>
<td>Diameter (mm)</td>
</tr>
<tr>
<td>Berberoğlu, Uz et al.</td>
<td>0.98 (0.6 – 1.2)</td>
<td>3.3 (2.2 – 4.9)</td>
<td>-</td>
</tr>
<tr>
<td>Hong, Pan et al.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Karakurt, Karaca et al.</td>
<td>-</td>
<td>33.4 (21.4 – 41)</td>
<td>-</td>
</tr>
<tr>
<td>Okcu, Erkan et al.</td>
<td>-</td>
<td>64 (45 – 90)</td>
<td>56 (37 – 80)</td>
</tr>
<tr>
<td>Tornetta, Hochwald et al.</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Darmanis, Lewis et al.</td>
<td>-</td>
<td>71 (42 – 88)</td>
<td>65 (39 – 82)</td>
</tr>
<tr>
<td>Stavropoulou-Deli and Anagnostopoulou</td>
<td>3</td>
<td>52.4</td>
<td>3.13</td>
</tr>
<tr>
<td>Current study</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure Legends:
Figures 1A, B, C, D: A 65-year-old male patient suffered with an acetabular fracture of the left hip after a simple fall (A). Tomography scans show dome impaction and displaced anterior column fracture on the left acetabular bone (B, C). Anatomic surgical reduction of the fracture and restoration of the dome impaction can be seen on the postoperative pelvic x-ray (D).

Figures 2A, B, C: Surgical exploration of the CMVA, it can be arterial (A), venous (B) or both (C).