Corpus cavernosum fracture: The ultrasound in the emergency diagnosis

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KEYWORDS
Corpus cavernosum; Emergency; Fracture; Tunica albuginea; Ultrasound

Abstract
Objective: The main objective of this work is to study usefulness of ultrasound (US) for the emergency diagnosis of the penile fracture.

Material and methods: We reviewed all the penile US studies registered in our Emergency Department between July 2007 and August 2009 with suspicion of a corpus cavernosum fracture. We compared US findings (subcutaneous hematoma, peri-albuginea hematoma, albuginea rupture and Buck’s fascia rupture), and the clinical progress, with those of the surgery. We studied sensitivity, specificity, positive predictive value and negative predictive value of US in the diagnosis of rupture of the tunica albuginea. The epidemiological data of all the cases reviewed were collected.

Results: Twelve patients with a mean age of 37.8 years were reviewed. The most common cause of injury was sexual intercourse. A subcutaneous hematoma was found in nine patients, a peri-albuginea hematoma in eleven of the cases, and an albuginea rupture was seen in six of them. We found no Buck’s fascia rupture. Seven patients underwent surgical treatment and in the remaining five patients, treatment was conservative. Clinical progress was good in all cases. US, as an emergency test to diagnose albuginea fracture gave 0.83 sensitivity, 1 specificity, 1 positive predictive value and 0.83 negative predictive value.

Conclusion: We believe that US is a useful procedure in the diagnosis of acute penile fracture and that it could be proposed as the diagnostic method of choice to confirm the clinical suspicion of penile fracture. Identifying the exact site of a tear in the tunica albuginea facilitates the surgical procedure.

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Fractura de cuerpo cavernoso: la ecografía en el diagnóstico de urgencia

Resumen

Objetivo: Valorar la utilidad de los hallazgos ecográficos en la sospecha de fractura de pene.
Material y métodos: Se revisan las ecografías de pene realizadas en urgencias entre julio de 2007 y agosto de 2009 por sospecha clínica de fractura del cuerpo cavernoso, comparando los hallazgos ecográficos (hematoma subcutáneo, hematoma perialbuginosa, rotura de la albugínea y rotura de la fascia de Buck) con losquirúrgicos, y la evolución a mediano plazo. Se calculan sensibilidad (S), especificidad (E), valor predictivo positivo (VPP) y valor predictivo negativo (VPN) de los hallazgos ecográficos para el diagnóstico de fractura del cuerpo cavernoso. Recogemos datos epidemiológicos de los casos revisados.
Resultados: Se estudiaron a 12 pacientes, con edad media de 35,75 años. El origen más frecuente de la lesión es el traumatismo durante el acto sexual. Ecográficamente, presentaron un hematoma subcutáneo 9 pacientes, perialbuginosa 11 sujetos y discontinuidad de la albugínea 6 pacientes. No se visualizaron roturas de la fascia de Buck. Siete fueron operados. En los 5 sujetos restantes se realizó manejo conservador. La evolución fue siempre satisfactoria. La identificación mediante ecografía de la discontinuidad de la albugínea mostró una S de 0,83, E de 1, VPP de 1 y VPN de 0,83.
Conclusión: Consideramos la ecografía como un procedimiento útil para diagnosticar la fractura de cuerpo cavernoso y que se puede proponer como de elección para confirmar la sospecha clínica. La identificación del punto exacto de rotura dirige y facilita la cirugía.

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Introduction

Fracture of the corpus cavernosum refers to the solution of continuity in its surrounding tunica albuginea. The fracture is secondary to trauma to the penis during erection, when the tunica thins from 2 mm to 0.5–0.25 mm. Generally, the fracture occurs in the tunica albuginea of only one corpus cavernosum and in one single site; however, rupture of Buck’s fascia, urethra or both corpora cavernosa may also occur.1

Patients commonly report hearing a “crack” followed by severe pain, detumescence, penile deformity and hematoma. Hematoma extravasation into the perineum may occur in case of rupture of Buck’s fascia. The penis remains flaccid and deviated toward the opposite side of the fracture.

Treatment is usually surgical,2 and this entity truly represents a urological emergency. Closure of the tunica albuginea is used to prevent sequelae3 such as fibrous scarring, which causes the penis to bend, experience painful erections and even urothelial stenosis.4 Early surgery reduces the duration of hospitalization and is associated with faster functional recovery5 and lower risk of complications.1

Regarding the surgical technique, direct incision over the fracture site is recommended when the location of the fracture is well defined, which reduces the duration of surgery and complications. In cases of unclear location of the fracture, presence of a large hematoma or urethral injury, a circumferencial subcoronal incision is recommended since this allows thorough examination, evacuation of the hematoma and closure with absorbable sutures.3

Ultrasound (US), cavernosography and magnetic resonance imaging (MRI) are used as diagnostic modalities,6,7 but there is no standard protocol regarding the first-choice technique. As MRI is not readily available in emergency departments and cavernosography is an invasive procedure, we believe that ultrasound is a valid alternative because it is easily available, fast and safe.

The main objective of this study is to evaluate the usefulness of US findings in patients with suspected corpus cavernosum fracture. Epidemiological data were also recorded and described.

Material and methods

This retrospective study included those patients who underwent an US examination for clinically suspected fracture of the corpus cavernosum at the Emergency Department of our hospital between July 2007 and August 2009. Patients were selected from our database of radiological examinations carried out at the Emergency Department. All the penile US examinations performed during the study period were filtered and those whose reason for consultation was not suspected corpus cavernosum fracture were excluded. In all the cases the clinical evaluation was performed by an on-duty urologist. Since this is a prospective study, informed consent of patients and ethics committee approval were waived. The study was in compliance with the good clinical practice and the Spanish Data Protection Act and confidentiality of the information.

Ultrasound examination technique

A Toshiba Power Vision (Tokio, Japan) US system with a high frequency transducer (7.5–10 MHz) was used for all the examinations.

Patients were imaged in the supine position with the penis on the abdominal wall. The examination started in B mode on the dorsal region of the penis, and continued on the ventral surface. Measurements of flow in the cavernous...
artery and dorsal vein using color duplex Doppler US were not systematically recorded.

All the US examinations were performed by on-call radiologists and were always reviewed by the consultant radiologist in charge.

The following epidemiological data were recorded: age, cause of injury, reason for consultation and clinical presentation.

The US findings evaluated were:

1. Presence and location of hematoma:
   - Peri-albugineal hematoma: hypoechoic area adjacent to the tunica albuginea, seen as a hyperechoic line around the corpora cavernosa in B mode US.
   - Subcutaneous hematoma: seen as a hypoechoic area under the skin, usually in the same site where it is visualized during the physical examination.

2. Visualization of the fracture of the tunica: evaluating the presence of lack of continuity.

3. Solution of continuity in Buck’s fascia (also known as deep fascia of the penis) seen in B mode as rupture of the hyperechoic line immediately superficial to the tunica albuginea that surrounds the two corpora cavernosa, corpus spongiosum and deep dorsal vein.

4. Associated findings (thickening of fascial layers) or complications (urethral rupture, arterial-cavernous fistula, etc.).

The presence (or absence) of each of these US findings was compared with the identification of tunica albuginea fracture during surgical examination and the clinical outcome. In this respect, functional recovery and the presence or absence of complications were evaluated by telephone interview or in-office visit.

The cases of true and false positives and true and false negatives were counted. Sensitivity, specificity, PPV and NPV were also calculated for each US finding.

The results were considered:

1. True positive when the US finding suggestive of corpus cavernosum fracture corresponded to corpus cavernosum rupture during surgical examination (at the indicated site).
2. False positive when the US finding suggestive of corpus cavernosum fracture did not correspond to corpus cavernosum rupture during surgical examination or there was functional recovery in the medium term without surgery.
3. False negative when no US finding suggestive of corpus cavernosum fracture was identified, but the surgical examination revealed the presence of corpus cavernosum rupture or the clinical outcome was adverse.
4. True negative when the absence of the US finding suggestive of corpus cavernosum fracture corresponded to an intact corpus cavernosum. Confirmation of these cases was based on a favorable clinical outcome with functional recovery in the medium term.

### Results

The studies of 12 patients with ages ranging from 23 to 73 years (mean age 35.75 years) were reviewed. Eight of the 12 patients provided a history of trauma to the erect penis. In the rest of the patients, the cause of injury was not specified. All the patients presented to the emergency room for pain and nine of the 12 patients presented with hematoma (Table 1).

US findings were as follows (Table 2): peri-albugineal hematoma in 11 of the twelve cases (91%) (Fig. 1); hematoma extravasation into the penile subcutaneous tissue in 9 cases (75%); no cases of extravasation into the perineum were identified; disruption of the tunica albuginea was found in six cases (50%) (Fig. 2).

In those patients where a solution of continuity was visualized in the tunica, a peri-albugineal hematoma and penile subcutaneous hematoma were also identified.

None of the patients showed rupture of Buck’s fascia or other associated complications.

<table>
<thead>
<tr>
<th>Date</th>
<th>Age</th>
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<th>Clinical presentation and physical examination</th>
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<td>Sexual trauma</td>
<td>Pain</td>
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<tr>
<td>2</td>
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<tr>
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<tr>
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<td>73</td>
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</tr>
<tr>
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<td>32</td>
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<td>Pain</td>
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<tr>
<td>10</td>
<td>29</td>
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<td>36</td>
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<td>Pain and hematoma</td>
</tr>
<tr>
<td>12</td>
<td>23</td>
<td>Sexual trauma</td>
<td>Pain and hematoma</td>
</tr>
</tbody>
</table>

* Mean age.

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**Table 1** Epidemiological data from the 12 patients studied for suspected corpus cavernosum rupture between July 2007 and August 2009.
Table 2  Ultrasonic findings of the 12 cases reviewed.

<table>
<thead>
<tr>
<th></th>
<th>Perialbugineal hematoma</th>
<th>Subcutaneous hematoma</th>
<th>Buck's fascia rupture</th>
<th>Tunica albuginea rupture</th>
<th>Surgical confirmation of the fracture</th>
<th>Adequate functional recovery in the medium term</th>
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</thead>
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<tr>
<td>3</td>
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<td>4</td>
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<td>6</td>
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<td>No surgery</td>
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<tr>
<td>7</td>
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<tr>
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</tr>
<tr>
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<tr>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Adequate</td>
</tr>
<tr>
<td>12</td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Adequate</td>
</tr>
<tr>
<td>Frequency</td>
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<td>0.75</td>
<td>0</td>
<td>0.50</td>
<td>0.58</td>
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</tbody>
</table>

Figure 1  Ultrasound of the body of the penis shows perialbugineal hematoma (1). Transverse (a) and longitudinal (b) images.

Figure 2  Ultrasound shows a solution of continuity in the tunica albuginea (delimited by cursors 1 and 2) in a transverse view of the body of the penis.

Seven patients underwent surgery. The six patients in whom a disruption of the tunica albuginea was visualized at US underwent surgery, and in all the cases, the presence of the disruption in the location determined by US was surgically confirmed. In addition, one patient in whom the US examination demonstrated a perialbugineal hematoma but no disruption also underwent exploratory surgery because of the high clinical suspicion, and surgery confirmed rupture of the corpus cavernosum at the hematoma site.

The surgical procedures were performed on an urgent basis and no complications were detected. All the patients who underwent surgery were discharged and scheduled for in-office follow-up.

Fracture of the corpus cavernosum was confirmed in six of the nine patients with subcutaneous hematoma (true positives) but it was not confirmed in the remaining three patients (false positives). Two of the three patients where no subcutaneous hematoma was found showed no rupture and had a favorable outcome, with normal
function in the medium term (true negatives). The third patient underwent surgery and surgery revealed the presence of a rupture of the corpus cavernosum (false negative). There were therefore six true positives, three false positives, two true negatives, and one false negative. Sensitivity, specificity, PPV and NPV were 0.85, 0.40, 0.66, and 0.66, respectively.

Peralbugineal hematoma (Fig. 1) was observed in 11 of the 12 patients. In seven of the 11 patients, surgery confirmed the diagnosis of fracture of the corpus cavernosum (true positives). The remaining four patients had no fracture and a favorable outcome without undergoing surgery (false positive). The only patient with no peralbugineal hematoma did not have fracture of the corpus cavernosum either (true negative). There were therefore seven true positives, four false positives, one true negative, and no false negatives. Sensitivity, specificity, PPV and NPV were 1, 0.25, 0.63, and 1, respectively.

In six patients the disruption of the tunica was directly visualized (Fig. 2) (true positives). Of the six patients in whom no disruption of the tunica albuginea was identified, all but one (false negative) did not have rupture of the corpus cavernosum either. There were therefore six true positives, no false positives, five true negatives, and one false negative. Sensitivity, specificity, PPV and NPV were 0.85, 1, 1, and 0.83, respectively.

Fracture of Buck’s fascia or other associated findings were not detected in any of the patients.

The presence or absence of thickened fascial layers was not recorded in many of the reviewed US reports, and the results concerning this variable were considered not assessable. Doppler US recordings were available in seven of the 12 studies, with normal flow in cavernous arteries and dorsal vein reported in all cases.

Functional recovery was achieved in all the patients who had no post-operative or post-traumatic complications. After discharge, none of the patients reported having needed additional medical consultation for the fracture, been diagnosed with fracture of the corpus cavernosum in a different center, or having functional sequelae.

Rupture of the corpus cavernosum was confirmed in seven (58%) of the 12 patients with suspected rupture at clinical examination. The remaining five cases were false positives.

Discussion

Fracture of the corpus cavernosum is a rare entity and it is usually seen in young adults secondary to blunt trauma to the erect penis. A mean age of 35.75 years and a history of traumatic intercourse in our series (8 out of the 12 patients in our series) are in agreement with the findings of the reviewed literature.1,4,8

For us, the most useful US finding is direct visualization of the ruptured tunica albuginea because of its high sensitivity (0.85), specificity (1), PPV (1), and NPV (0.83).

The presence of a peralbugineal hematoma has a high sensitivity, but a very low specificity. However, in the only case where the disruption of the tunica was not directly visualized, the hematoma location aided the surgery by indicating the most likely site of rupture. On the other hand, the absence of peralbugineal hematoma, with low clinical suspicion, can reliably rule out fracture of the corpus cavernosum according to our results (NPV), unlike the absence of subcutaneous hematoma.

Sensitivity, specificity, PPV and NPV of the presence of subcutaneous hematoma for the diagnosis of corpus cavernosum fracture were very low in our series. Thus, we believe that this US finding alone is not of value for confirming or ruling out a clinically suspected penile fracture.

Many authors think that the diagnosis of suspected fracture of the corpus cavernosum is usually based on the patient history and physical examination, and that radiological examination is not required.9 In our series, however, only 58% of the clinically suspected fractures were actually fractures. Therefore, it seems imperative or, at the least, justified to confirm the presence of rupture before subjecting the patient to a surgical procedure that could be otherwise avoided. In six of the seven cases with fracture of corpus cavernosum, US helped determine the location of the fracture before surgery. In five patients, US avoided a negative exploratory surgery by ruling out the presence of fracture. This fact supports the opinion of those who recommend performing a diagnostic imaging procedure to determine the exact location of the fracture, provide a correct differential diagnosis and rule out the presence of complications. The following imaging techniques can aid in the diagnosis of a corpus cavernosum fracture: ultrasound, cavernosography and MRI.7,9 Cavernosography involves ionizing radiation, is invasive and involves intracavernous injection of contrast. In addition, MRI is not readily available at emergency departments. The six cases where disruption of the albuginea was identified underwent surgery, with confirmation of the rupture in all of them. This is in agreement with published studies reporting the high specificity and accuracy of US to determine the exact location of the fracture, as well as its ability to make a differential diagnosis with other entities or rule out complications such as arterial-sinusoidal fistulas or injury to the dorsal vein of the penis.10 Ultrasound is an inexpensive and readily accessible imaging technique. Its main drawback is that it is an operator-dependent technique, where the lack of trained personnel may result in a higher number of false negatives.1 Its availability, simplicity, absence of adverse effects and good diagnostic accuracy render ultrasound, as opposed to cavernosography and MRI, the most commonly used technique for diagnosis of corpus cavernosum fracture.

Regarding the surgical technique, in the six patients with US diagnosis of rupture of the tunica albuginea, the previous determination of the exact location of the fracture guided the surgical technique, thus reducing the duration of the procedure. The location of the hematoma, in the only case where the disruption of the tunica was not visualized, also facilitated the procedure because the fracture was located adjacent to the hematoma. The sensitivity, specificity, PPV and NPV of the visualization of subcutaneous and peralbugineal hematoma are not enough to be used as reliable indicators of corpus cavernosum fracture. However, the lack of visualization can reliably rule out fracture. No significant complications occurred during or after surgery, with favorable outcomes at the scheduled follow-up.

This study has some limitations. First, it is a retrospective study, which has prevented the exploitation of some US data that would have been of interest. Doppler US recordings
were available only in seven of the 12 studies, although they reported normal flow in the cavernous arteries and dorsal vein in all cases. In addition, the small size of the series limited the statistical power of the results. Nonetheless, it is worth pointing out that this is one of the largest series described in the literature, since most publications are single-case studies. Finally, since the studies were carried out in the emergency department by different radiologists during on-call periods, another limitation is that no information could be obtained regarding inter-observer variability.

In conclusion, we believe that the high sensitivity and specificity of US in the identification of disruption of the tunica albuginea render it a useful technique for confirmation of clinically suspected corpus cavernosum fractures. US should be considered as the technique of choice because it can also be used to guide surgery and avoids unnecessary surgical procedures.

Authorship

1. Responsible for the integrity of the study: IM, MM.
2. Conception of the study: MM, IM, JPGF.
3. Design of the study: MM, IM, IP.
4. Acquisition of data: IM, HRR, AM.
5. Analysis and interpretation of data: IM, JPGF, AM.
6. Statistical analysis: IM, JPGF, HRR, AM.
7. Bibliographic search: IM, AM.
8. Writing of the paper: IM, MM.
9. Critical review with intellectually relevant contributions: MM, IM, IP.
10. Approval of the final version: MM, IM, JPGF, HRR, AM, IP.

Conflict of interest

The authors declare not having any conflicts of interest.

References