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ORIGINAL ARTICLE

The venous drainage of the corpora cavernosa in the human penis

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KEYWORDS

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Cadaver

ABBREVIATIONS

DDV, deep dorsal vein;
CVs, cavernous veins;
PAVs, para-arterial

Abstract ***Objective:*** To study the drainage proportions from the corpora cavernosa in defrosted human cadavers, as the veins related to penile erection were recently depicted to comprise the deep dorsal vein (DDV), a pair of cavernous veins (CVs) and two pairs of para-arterial veins (PAVs), as opposed to a single DDV between Buck's fascia and the tunica albuginea of the human penis.

Materials and methods: With no formalin fixation, 10 defrosted male human cadavers were used for this study. After injecting a 10% solution of colloid, and with the intracavernous pressure (ICP) fixed at 90 mmHg, the perfusion rate was recorded before and after the DDV, CVs and PAVs were removed, respectively. Finally, measurements were again recorded after penile arterial ligation. Cavernosography was used if required.

Results: The mean (range) perfusion rate for maintaining the ICP at 90 mmHg was 30.2 (15.5–90.8) mL/min, whereas the arterial perfusion rate was 2.8 (0.3–

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veins;
ICP, intracavernous pressure;
ED, erectile dysfunction

3.9) mL/min. The mean (range) drainage proportion of the corpora cavernosa was 60.5 (50.3–69.7)%, 11.9 (5.8–22.9)% and 11.4 (5.2–15.0)% via the DDV, CVs and PAVs, respectively. The remaining drainage proportion was 15.6 (14.1–18.1)%. This study shows the separate drainage contributions of the DDV, CVs and PAVs to the corpora cavernosa of the human penis.

Conclusion: We conclude that the venous drainage system of the corpora cavernosa is much more complex than the previous depictions of it, and the consequent focus on a single DDV. This also shows the independent role of each venous system.

Introduction

The venous system of the human penis has been widely studied, and it is generally accepted that a single deep dorsal vein (DDV), accompanied by a pair of dorsal arteries positioned between the Buck's fascia and the tunica albuginea, facilitates venous drainage [1,2]. However, a recent study [3] showed a more complex venous anatomy in which a DDV, a pair of cavernous veins (CVs) and two pairs of para-arterial veins (PAVs) are shown between Buck's fascia and the tunica albuginea. The DDV, consistently located in a median position, receives the blood of the emissary veins from the corpora cavernosa and of the circumflex vein from the corpus spongiosum. It is sandwiched by a pair of CVs, although these lie in a deeper position. Bilaterally, each dorsal artery is sandwiched by its corresponding medial and lateral PAVs, respectively. These veins are independently responsible for draining the sinusoidal blood of the corpora cavernosa into the systemic circulation.

The concept of DDV varicosity was first introduced in the 19th century [4], and the first surgery on the DDV to treat atonic impotence reported in 1902 [5]. Similar attempts were not reported on a larger scale for a further five decades [6], and the surgery did not achieve popularity until 1985 [7]. Penile venous surgery was unfortunately almost abandoned because the general consensus on it as a treatment for erectile dysfunction (ED) was that it only resulted in temporary success, i.e. of 1–2 years. Accordingly, in 1996 and after a meta-analysis of the literature, the clinical guidelines panel of the AUA supported this view and declared that venous surgery was not justified for routine use in treating ED [8]. In hindsight, the eventual recurrence of ED in men treated by venous surgery seemed unavoidable given that knowledge of the venous anatomy remained limited to the traditional understanding [9,10], and given that electrocauterisation was so often used [11,12]. It seems that more accurate knowledge of tunical and venous anatomy is crucial in achieving a favourable surgical outcome [13]. This new insight inspired us to further explore the respective contribution of venous drainage in the corpora cavernosa.

Materials and methods

The study was approved by the institutional review board of China Medical University, conducted from November 2009 to May 2012, and included 10 male defrosted human cadavers, obtained in the previous 3 months, that were frozen with no formalin fixation and within 10 h of death, and in which the penises were intact. To facilitate venous access, a semi-circumferential incision, followed by a median longitudinal incision (Fig. 1) was made superficial to Colles' fascia, from the retrocoronal sulcus along the penile shaft to the upper margin of the symphysis pubis. Two 19-G scalp needles were inserted and firmly fixed in place, with 5–0 Nylon sutures at the 3 and 9 o'clock positions, respectively.

One needle was connected to an infusion pump (ML172 peristaltic pump and ML 175 STH pump controller, AD Instruments Pty Ltd., Bella Vista, NSW, Australia) and was used to inject a 10% colloid solution (Haes-steril, Fresenius-Klinik, Bad Homburg, Germany) into the corpora cavernosa, whereas the other needle was used to monitor the intracavernous pressure (ICP) via an intravenous set connected to a negative-feedback pressure-monitoring system. The perfusion rate was recorded (Fig. 2) while the ICP was set at 90 mmHg before (overall intact reading) and after the DDV, CVs and PAVs were meticulously removed, in sequential order, until they were absent from the corpora cavernosa. Cavernosography was used when required (Fig. 3).

The new insight into the penile venous anatomy was used as a blueprint for venous removal in this study (Fig. 4A). Initially, the DDV was thoroughly stripped and ligated, closest to the tunica albuginea, with 5–0 Nylon sutures, distal to the level of the retrocoronal sulcus, where the number of veinlets can be several dozen, and laterally as close as possible to the junction between the corpus spongiosum and the corpora cavernosa. Further dissection was performed with the aid of two 8.0×1.6-cm right-angled retractors that were sufficiently long to reach the deep-rooted vessels, which were at least 7-cm deep (Fig. 4B), until the infrapubic angle was encountered. Similarly, the CVs were resected and ligated, and then the PAVs were segmentally ligated only (Fig. 4C). Finally, the penile shaft was further