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Brief Report

A Cadaveric Study of the Deep and Superficial Dorsal Veins for Penile Transplant

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Abstract

Objective: It is crucial to know the lengths of the neurovasculature proximal to a penile allograft to allow for better viability of a penile transplant. We performed a cadaveric exploration focused on the deep and superficial dorsal veins as identified in a microsurgical dissection of the penis to help expand the anatomical knowledge for such a procedure.

Methods: We examined 18 cadavers and measured the (1) vertical distance from the pubic symphysis to the point at which the superficial dorsal vein is no longer on the erectile tissue; (2) point at which the superficial dorsal vein is no longer on the erectile tissue to where its tributary meets the great saphenous vein; and (3) point at which the deep dorsal vein is no longer on the external erectile tissue to its contribution into the prostatic plexus near the prostate. Moreover, we noted the variations of the deep and superficial veins of the penis. We used IBM SPSS in all statistical analyses.

Results: The average length of the superficial dorsal vein when no longer on the external penis to its tributary was 84.9 ± 10.4 mm. The average length of the deep dorsal vein was 72.9 ± 6.43 mm. Three different drain patterns were observed for the superficial dorsal vein, whereas the deep dorsal vein was consistently midline. No statistically significant correlations were identified between cadaveric demographic data and lengths of venous structures.

Conclusions: Further studies regarding the anatomy and dissection of penile allografts would be helpful. More research regarding donor and recipient anatomy and vasculature is needed to establish surgical guidelines.

Keywords

superficial dorsal vein, deep dorsal vein, anatomical variation, penile transplant, allograft, penile reconstruction

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Introduction

Penile transplant presents an emerging option with the potential to provide the desired goals of intact sensation, urination, and sexual function that are otherwise limited by other penile reconstruction options[1,2]. With only a few attempts in different countries, surgical guidelines for complex penile transplants have yet to be developed, and current investigations include explorative dissections, case reports, and anatomical studies[3,4]. Tiftikcioglu et al.[5] conducted a cadaveric study concluding that the level of penile dissection should be determined according to the extent of the defect, where a cis-male patient with a proximal penile defect and a transgender patient will receive a partial shaft and a total allograft, respectively. A study conducted by Selvaggi et al.[6] found that an en bloc dissection of the penis with its associated neurovasculature structures and urethra is a potential option for penile transplant from a male cadaver to a female recipient[6]. Other highlighted structures include the internal pudendal arteries, dorsal nerve of the penis, and venous structures to be anastomosed with the recipient's vessels[5,7].

An important consideration of graft survival is microvascular anastomosis to ensure adequate blood flow and minimize venous congestion[8]. Several case reports on penile replants demonstrated the need for increased venous outflow to prevent skin necrosis and edema[8,9]. In a review of attempted transplants to date, Lake et al.[3] highlight the importance of venous anastomosis for reducing postoperative complications. The penile venous system consists of the superficial dorsal vein (SDV) and deep dorsal vein (DDV) that

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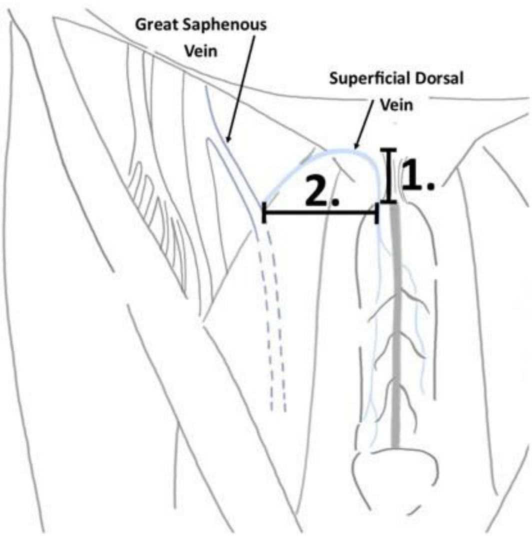

Figure 1. A schematic drawing of superficial dorsal vein measurements including Measurements 1 and 2.

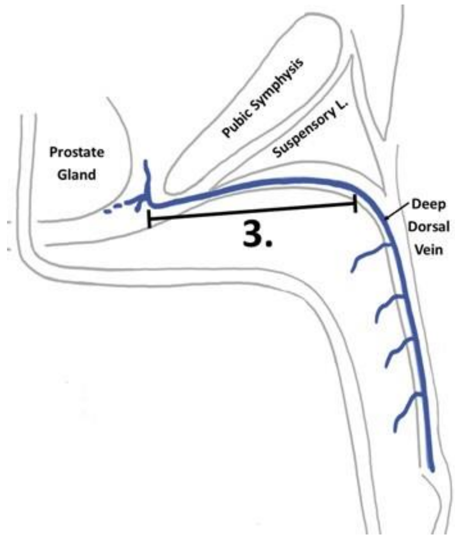

Figure 2. A schematic drawing of deep dorsal vein measurements, indicated as Measurement 3.

drain the skin, cavernous bodies, and glans of the penis. An en bloc dissection for total penile allograft requires harvesting a long vascular pedicle, but current literature lacks sufficient anatomical details of the venous structures needed for transplant. Therefore, the lengths of the neurovasculature proximal to the transplant are worth considering to allow for better viability.

To help expand the anatomical knowledge for penile transplant, we performed a cadaveric exploration focused on DDV and SDV as identified in a microsurgical dissection of the penis[10].

Methods

We examined 18 male, formalin-embalmed cadavers from the Kansas City University and University of Nebraska Medical Center laboratories. The donors were between 50 and 98 years old, and no cadaveric specimen was excluded from the study based on any inclusion or exclusion criteria. Data regarding age, height, and weight were recorded, but comorbidities were not noted.

Dissection started with a midline incision on the dorsal aspect of the penis, separating the skin and dartos fascia to expose the SDV. Careful dissection of the SDV involved leaving the fascia surrounding the vein intact so as not to disturb its original position. Dissections were performed to the left and right of the pubic symphysis to ensure localization of the SDV. The second phase involved reflecting the deep (Buck's) fascia to expose the DDV, and a hemisection of the male pelvis was performed to visualize the vein distally to its diversion to the prostatic venous plexus. The focus of the measurements for both venous structures involved the consideration of an en bloc dissection of the penis as proposed by Selvaggi et al.[6] Therefore, the lengths measured reflected the pedicle length for penile transplant, excluding any part of the vein resting on the external part of the penis.

The measurements included lengths of (Measurement 1) the vertical distance from the pubic symphysis to the point at which the SDV is no longer on the erectile tissue; (Measurement 2) the point at which the SDV is no longer on the erectile tissue to where its tributary meets the great saphenous vein; and (Measurement 3) the point at which the DDV is no longer on the external erectile tissue to its contribution into the prostatic plexus near the prostate (**Figure 1 and 2**). Measurement 1 was included as a reference point to help localize the SDV. All lengths were measured by one author using Mitutoyo DIGIMATIC length calipers.

Data were analyzed using IBM SPSS v. 23 for Windows. The analysis included descriptive statistics for all data collected, independent *t*-tests, and Spearman's correlations between demographic data and lengths measured. Variations in draining patterns were calculated in percentages.

Results

In the study, a total of 18 DDVs and 21 SDVs were assessed. The mean cadaveric age, height, and weight were 78.8 years, 68.9 inches, and 71.4 kg, respectively. The average length of the SDV (Measurement 1) where it is no longer on the external penis to the pubic symphysis was 45.2 ± 8.0 mm. An independent *t*-test was conducted to establish any difference in means for Measurement 2 of the SDV, which was found draining to the right or left via its tributary into the great saphenous vein. There was no statistically significant difference in the lengths of SDV draining to the right or left into the great saphenous vein; therefore, the data points for Measurement 2 were averaged together to run descriptive statistics. The means for Measurements 2 and 3 were 84.7 ± 10.4 mm and 72.9 ± 6.4 mm, respectively (**Table 1**).

Table 1. Descriptive Statistics for Vein Measurements and Cadaveric Demographic Data.

	Age (years)	Height (inches)	Weight (kg)	BMI (m/kg)	SDV to pubic symphysis (Measurement 1) (mm)	SDV to great saphenous length (Measurement 2) (mm)	DDV to prostatic plexus (Measurement 3) (mm)
N	18	16	16	16	18	18	18
Mean	78.8	68.9	71.4	23.2	45.2	84.7	72.9
Median	82.0	69.5	75.0	24.3	44.2	83.3	73.9
Standard deviation	10.7	2.57	14.8	4.92	8.0	10.4	6.4

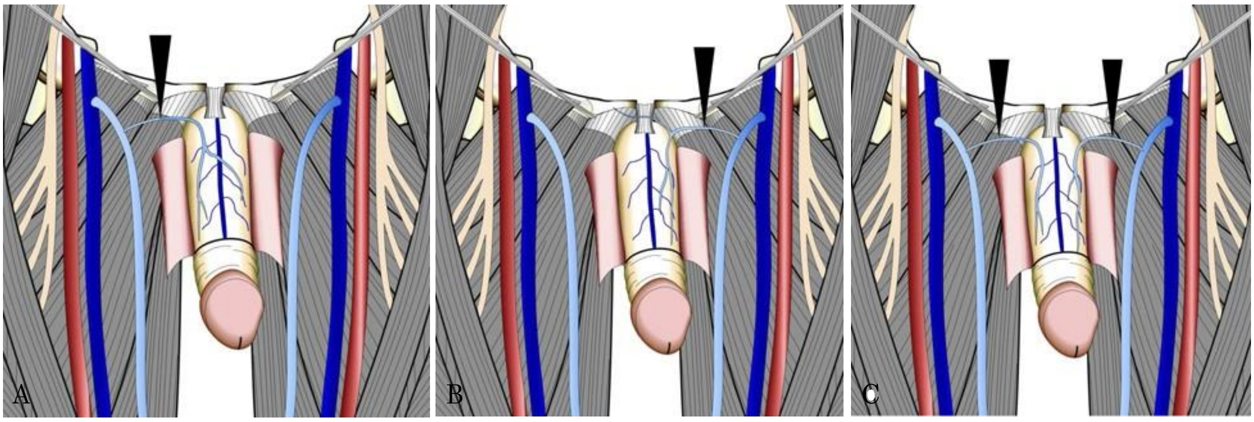

Figure 3 A–C. A visual representation of the anatomical variation observed during cadaveric dissection. The superficial dorsal vein (black arrow) was found to have right, left, and bilateral drainage to the great saphenous vein.

Table 2. Correlations between Cadaveric Demographic Data and Lengths of the Superficial and Deep Dorsal Veins.

Correlations to SDV lengths (Measurement 2)			Correlations to DDV lengths (Measurement 3)		
	Spearman's correlation	P-value		Spearman's correlation	P-value
Age (years)	−.099	.697	Age (years)	.020	.929
Height (inches)	−.081	.767	Height (inches)	.363	.167
Weight (kg)	.377	.150	Weight (kg)	−.174	.519
BMI (kg/m^2)	.480	.060	BMI (kg/m^2)	.275	.201

Anatomical Variation

The findings of our study showed that among the observed SDVs, it was noted to drain to the right (44%; **Figure 3A**) and left (38%; **Figure 3B**) and bilaterally (16%; **Figure 3C**) to its tributary to the great saphenous vein of the leg. The DDV was consistently midline, running as a single trunk between the corpora and diving deep to the periprostatic plexus after entering the pelvis through the suspensory ligaments.

Correlations to Cadaveric Demographic Data

Information collected for the cadaveric specimens included BMI, age, height, and weight. This information was used to run Spearman's correlations with venous lengths from Measurements 2 and 3 (**Table 2**), to elucidate any venous length variation across the cadavers with different demographic information. These correlations could potentially offer more information to consider when selecting an optimal donor for penile transplantation. Age and height and BMI and weight were negatively and positively correlated to the SDV lengths, respectively. Positive correlations were noted for age and height to the DDV lengths. Weight and BMI were negatively correlated to DDV lengths. All the observed trends were not statistically significant.

Discussion

In a novel procedure such as total penile allografts, the establishment of surgical guidelines can be aided by focusing on studies involving the anatomical structures of the transplant. There are previous studies on the anatomy of the SDV and DDV, but the landmarks and measurements used in this study explored the venous structures of the penis for an en bloc dissection and transplantation.

Unlike procedures involving men with genitourinary injuries, where there may be a partial stump to work with, cases of female-to-male gender affirmative surgery require a complete penile allograft for the success of the procedure[10]. Arteries, including the dorsal and internal pudendal, are highlighted as important for the vascularization of the transplant, whereas venous structures have been emphasized to help with the draining[3]. This study focused on the DDV and SDV lengths and variations to elucidate the anatomy available for potential anastomosis. Our anatomical findings were consistent with what have been stated in the literature in which Breza et al.[11] noted the dorsolateral position of the SDV draining into the great saphenous vein and a variation in which the SDV formed a trunk and drained bilaterally. Surgeons should be aware of venous variation when harvesting the pedicle for transplantation to be aware, for example, that the SDV can drain to the left or right or bilaterally. If the SDV is present bilaterally, as found in this study, it could facilitate for the surgeon to potentially use both veins to improve viability.

Because of the novelty of this procedure, donor inclusion criteria currently include consideration of screening for a healthy penis free of vascular or sexually transmitted diseases and physical attributes that align with recipient preference[3]. It may be helpful in the future to screen available donor penises more carefully, specifically the vasculature, to help optimize the success of the procedure. However, because our findings were insignificant, further investigation with a much larger sample size should be explored to justify the use of age, height, or BMI in donor inclusion criteria. Further research is needed to establish donor age criteria for penile transplant, and therefore, the higher mean age of the cadavers in this study may not reflect the target population for the procedure.

With increasing interest in penile transplants, the results of this study can contribute to the anatomical knowledge base and help inform surgeons of variability. Future studies can focus on exploring the diameters of the vasculature structures using Computed Tomography (CT) or MRI, a parameter that was not investigated in this study.

Conclusions

As penile transplants continue to be investigated as a future surgical option for the transgender male population, understanding the lengths and variations of the DDV and SDV is of increasing importance. Further research regarding donor and recipient anatomy and vasculature is needed to establish surgical guidelines.

Author Contributions: S.R. and D.B. designed the study; S.R., N.B., A.K., and R.S. performed the experiments and analyzed the data; A.O. and N.B. supervised the experiments; and S.R. and A.O. wrote the manuscript.

Conflicts of Interest: There are no conflicts of interest.

Ethical Approval: This study was approved by the Institutional Biosafety Committee at Kansas City University (ID # 1,837,056-5).

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