

Assessment of The Nerve Ending Distributions on Dartos Fascia in Children with Concealed Penises

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Research

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Abstract

Background: The role of nerve ending distribution in dartos fascia in the pathogenesis of concealed penis (CP) is still unclear. Our aim is to compare the histological structure of dartos fascia of both normal and CP tissue to evaluate the importance of nerve ending distribution.

Methods: After degloving, tissue specimens of dartos fascia located at 3-, 6-, 9-, and 12- o'clock of the penile shaft were harvested from the CP. The relatively normal tissues at the periphery after resection of black moles or hemangioma in other parts were considered as control. The distribution of nerve plexuses between these groups was compared using standard hematoxylin and eosin (H&E) staining and S-100 immunohistochemical staining.

Results: The number of nerve plexuses for all cases of CP was abundant but significantly fewer in the normal group. In CP, the number of nerve plexuses in superficial fascia collected at 6 o'clock position of penile shaft was the most abundant among different positions.

Conclusions: Abundant nerve plexuses were presented in dartos fascia in children with CP, especially at the 6 o'clock position, suggesting surgery performed at the preputial frenulum should avoid damage of dartos fascia to preserve the erectile and sexual function of penis in puberty.

Background

Concealed penis (CP) is a relatively rare congenital abnormality in children which the normal sized penis is encompassed by either skin, subcutaneous tissue, and/or fat in the prepubic area [1]. The CP patients commonly show short penis appearance and obvious phimosis [2–4] (Fig. 1), but most of them have normal penile length. The incidence of the CP has not been systematically studied, although a Japanese study reported a prevalence of 3.7% in male newborn infants [5]. In addition to the abnormal appearance, CP might exert symptoms and negative psychological effects, such as anxiety and/or depression, on children and their parents [6]. Spinoit et al. [7] had observed abnormal histology of the dartos fascia in 74% of patients with CP and dartos layer of penises then became nonelastic which prevents forward extension of the penis and entrapped it under the pubis. The CP remained a challenge for urologists and a flexible surgical approach might be required [2]. The common surgical procedures in CP included complete penile degloving, the removal of excess suprapubic fat, the reconstruction of the penile skin with local flaps, and the fixation of the penile skin at the penopubic and penoscrotal angles [2, 7, 8]. The satisfactory outcomes with few complications have been reported in these surgical techniques [9–11].

However, the adequately prepuce degloving might cause postoperative penile retraction, lymphocytic obstruction-induced perioperative edema in the transposed inner prepuce (short-term) and subcutaneous dartos hyperplasia (long-term), which might subsequently lead to a poor cosmetic appearance of the penis in some cases (Fig. 2) [11–13]. Lim et al. described that the resection of abnormal dartos fascia completely removing the redundant dartos tissue during surgery was a simple technique to avoid these

complications [14]. However, the resection of inelastic dartos fascia was present as a versatile surgical approach for correction in patients with CP [1].

Examination of histological nerve ending distribution of dartos fascia is expected to reveal whether nerve damage could occur after resection of the dartos and may assist clinicians with proper techniques for surgical correction of CP in children. Therefore, our goal was to investigate and compare the histological structure of dartos fascia of both normal and concealed penises.

Methods

Ethics statement

From January to July 2017, this prospective study was conducted on children who received the penile reconstructive surgery in our hospital. Children with relatively normal tissues at the periphery after the resection of black moles or hemangioma in other parts of the body were included as the normal group. The dartos fascia specimens from these patients were collected. The study was approved by the Ethics Board of our hospital. The written informed consent was also obtained from the patients' parents or legal guardians for participation in this study. It was harmful to take 4 specimens from some tissues of a child where there were numerous nerve endings in the areas that the specimens were taken; however, the specimen obtained was an abandoned tissue and the informed consent has already mentioned this effect.

Subjects

The inclusion criteria were patients with CP in ASA (the physical status scale of American Society of Anesthesiologists) categories I and II. The exclusion criteria included: 1. patients with micro-penises (a stretched penile length of less than 2 or more standard deviations below the mean) because this condition represented an endocrinological problem; 2. CP due to adiposity in obese patients; 3. patients with atypical concealed penises who did not need the penile reconstruction.

Material and method

After a penile degloving in CP patients, 0.3 × 0.3 cm samples of dartos fascia at 1 cm under coronary sulcus were harvested from at 3-, 6-, 9-, and 12-o'clock position. In the normal group, the sample was mostly taken from relatively normal tissues at the periphery after the resection of black moles or hemangioma in other parts of the body. These dartos fascia samples were examined histologically using routine hematoxylin and eosin (H and E) staining and S-100 immunostaining for nerve changes. Briefly, the dartos fascia samples were fixed in 10% formalin solution for 12 hours. After fixation, specimens were dehydrated and embedded in paraffin, and then cut into 3-4 μm thick sections. The routine hematoxylin and eosin (H & E) staining and S-100 immunoperoxidase staining using S-100 antibody (rabbit polyclonal antibody with 1:1000 dilution; Dako, Santa Clara, United States) were performed. Microscopic examination (50×) in H&E staining had indicated that nuclei were stained blue, whereas the

cytoplasm and extracellular matrix had varying degrees of pink staining. Microscopic examination (50×) in S-100 immunostaining had demonstrated that S100 positive areas of staining were nerve with intact plexuses. The number of nerve plexuses were counted with Image J with manually calibrated and counted.

Statistical analysis

The numbers of the nerve plexuses were summarized as mean±standard deviations (SD) and median (range: min. to max.) at 3-, 6-, 9-, and 12- o'clock position collected from CP and normal patients. The Kolmogorov-smimov test was used to assess whether the data were normal distribution (normality). If the data were non-normal distribution, the Wilcoxon ranks test was used for the analysis of non-normally distributed variables and data would be presented as median. In this study, a non-parametric method, Wilcoxon signed ranks test, was performed for the paired comparison of the nerve plexuses within different locations and between two groups. All statistical assessments were two-tailed and $p < 0.05$ was considered significant. Data were analyzed using the Statistical Product and Service Solutions (SPSS) statistical software version 22 for Windows (IBM Corp., New York, USA).

Results

In this study, 29 patients were in the normal group and 28 patients were in the CP group. The median age was 3.2 years (range 7 months to 4 years) in the normal group and 3.5 years (range 8 months to 5 years) in the CP group. The result of H&E staining had showed that the abundant nerve ending distribution was located on the dartos fascia of the penis in the CP group (Fig. 2A); however, the pattern of nerve distribution on the superficial fascia in the normal group were less abundant (data not shown). The result of S-100 immunostaining had indicated that there were many intact nerve plexuses in the dartos fascia of the penis in the CP group (Fig. 2B) which was the most concentrated in the dartos tissue beneath the ventral region. There were only few S-100 positive areas in the superficial fascia of penises in the normal group (Fig. 2C).

After we conducted the pair-wise comparisons, the numbers of nerve plexuses were significantly higher in the superficial fascia of the penis collected from all different positions in the CP group than the normal group ($P < 0.001$) (Table 1). In addition, the numbers of nerve plexuses in the superficial fascia collected from the 6 o'clock position were significantly greater than that of 3-, 9-, and 12- o'clock positions ($P < 0.05$) (Table 1).

Table 1
Distribution of nerve plexuses (count) in various positions of the penis

Position (o'clock)	Median value	Minimum value	Maximum value	<i>P</i> * value
3	5.50	1.0	11.0	0.017
6	7.25	1.0	24.0	—
9	5.00	2.0	15.0	0.020
1	4.00	1.0	11.0	0.001
Control group	1.07	0.0	3.0	0.000
<i>P</i> * = the <i>P</i> value obtained after comparison with the value at the 6 o'clock position. There were no significant differences among the values at the 3, 9, and 12 o'clock positions. The <i>P</i> values of the black moles and hemangiomas were 0.000 for comparisons with each position of the penis.				

Discussion

Concealed penis is a rare congenital abnormality in the children and has numerous and unclear etiology. Histological features of nerve ending especially dartos fascia in the CP have not been well explored in previous studies.

According to penile anatomy, the penile innervation consists of several branches of the pudendal nerve derived from S2–4, including the dorsal, cavernosal, and perineal nerves of the penis [15]. After branching from the pudendal nerve, the dorsal nerve traversed the dorsum of the penis deep to Buck's fascia. The dorsal nerve was superior to the cavernous bodies and together with the dorsal arteries and veins to supply sensation to penile skin, including the glans penis [16]. The fibers of the dorsal nerve of the penis penetrated the corpus spongiosum to innervate the urethral lumen as afferents and received input and relayed the information during micturition and ejaculation [17]. The perineal nerve also branched off the pudendal nerve and innervated the ventral shaft skin, the frenulum, and corpus cavernosum [18]. The cavernous nerve branched off the autonomic pelvic plexus, accompanying with the neurovascular plexus of the prostate, and carrying sympathetic and parasympathetic nerve fibers to the corpora cavernosa [19]. These nerves spreaded sensory signals to the central nervous system that was critical to achieve an erection and sexual function [20].

Common principles of surgical procedures for CP are complete degloving along Buck's fascia and correcting the deficiency of the penile shaft skin [21, 22] to restore the normal erectile and sexual function. Numerous techniques have been described to correct the CP with various surgical outcomes, reflecting the different perceptions of etiology. In children, the CP is often caused by an inelasticity of the dartos fascia in infancy [23]. A review on comparison with current literature had reported that the dissection of the dartos and Buck's fascia with division of chordee was commonly performed in children with CP [21]. Several studies also maintained that the key to correction in children with the CP was the release of the abnormal dartos attachments and fixation of the penile skin to Buck's fascia [14, 24]. However, in this

study, we had observed that there were the abundant nerve plexuses on the dartos in CP children. Cold et al. [25] had also reported that the resection of dartos to correct CP may cause loss of sexual sensation, due to removal of abundant nerve endings. In addition, Wu, et al [26] had found that the concentration of substance P and calcitonin gene-related peptides on nerve terminals, which were associated with the afferent sensation of penises, were relatively high in the frenulum compared to other positions. Although the resection of the superficial fascia dartos has been proven to improve the cosmetically appearance in children, it may reduce the sensitivity of the penile skin after puberty.

For concealed penis repair, the first step is to make a circumcised incision and followed by degloving the foreskin, that is, releasing abnormal dartos. In this procedure, many surgeons choose to remove the abundant dartos which attached to Buck's fascia to reduce the edema or hyperplasia of dartos which will reveal a poor cosmetic result, postoperatively. The purpose of this study is to find out whether this manipulate is harmless; if not, we have to modify the procedure to preserve the dartos. Also, the number of patients should be as few as possible to minimizing the ethical issues when we investigated if the manipulation was harmful. In this study, we obtained four samples from the children because many surgeons performed a surgical procedure for large-scale resection of the fascia under the penis in order to maintain the aesthetics of the penis after surgery, and reduce postoperative lymphatic drainage disorders and penile scar hyperplasia. We obtained a relative position specimen after the surgical removal of the fascia, without additionally increasing the damage of the child. This study was done for trying to minimize these injuries when the surgeon underwent the surgical removal of a large number of fascia tissue.

In this study, the nerve plexus distribution was more abundant on samples collected at 6 o'clock position than at other positions. The histology of penile anatomy in cross-section has indicated that there was a notable paucity of nerves at the 12 o'clock position while the most sensitive part of penis, the area around the frenulum, was located at the 6 o'clock position[27]. However, the study regarding the placement of sutures in reinforcement at the penoscrotal and penopubic angles had suggested the placement of three sutures at 120 degrees angles were sufficient for penile support and positioning [21], in which might cause the disruption of penile sensation. Liu et al. [22] had reported a surgical technique that the dartos facial bands were attached to the distal or middle shaft of the penis, it might be a better surgical procedure in preserving the nerve plexus in the dartos. The resection of the peripheral dartos, especially at the frenulum, might lead to postoperative complications such as the sexual dysfunction; however, the definite pathological mechanism should be further explored.

In the present study, the sample taken from relatively normal tissues at the periphery after the resection of black moles or hemangioma in other parts of the body was used as a normal control because it is impossible for us to take any samples from normal children. The "other part of the body" is the other regions on the body except penises. When the surgeon needs to remove the black sputum or hemangioma, the subcutaneous fascia tissue in other parts of the body can be obtained. The purpose of this study is to show that the subcutaneous nerves of the penis are richer than other parts, especially at 6 o'clock position, to illustrate the importance of this part of tissue.

For most hypospadias patients, their analgesia won't be complete unless an additional injection is made in the ventral part of the penis if only dorsal penile block is used for distal hypospadias. Patients usually feel pain if we do not make an additional injection to the ventral part. In this study, we have found the same phenomenon from circumcision and usually used caudal block and the phenomenon was not found for the hypospadias repair. Indeed, when doing a nerve block in penile surgery, there would be blockade during penile surgery if we did not take caudal anesthesia instead of simply using the nerve block on the dorsal side of the penis root. However, we usually achieved satisfactory results after undergoing the ventral block. We have not performed this study in children with hypospadias because the anesthesia of our penis surgery basically uses a caudal block. In theory, not only the penis is hidden, but also all penile nerves distribution should have the same condition. The future work for us would be doing further research on children with hypospadias.

Conclusion

In this study, we found that there are abundant nerve plexuses in the superficial fascia in children with CP. Thus, the surgical management of CP in children should consider not only the good cosmetic appearance but also avoiding the damage of superficial fascia dartos, especially at the frenulum, in order to preserve the erectile and sexual function of the penis in the long term. We must be careful in ventral part dissection in CP repair and this result should be generalized for other penile abnormalities. In fact, we have modified the procedure in which almost all dartos underneath foreskin can be preserved. We suggest that preserving the ventral dartos during operation is critical for hypospadias repair.

List Of Abbreviations

CP: concealed penis; H&E staining: hematoxylin and eosin staining; SD: standard deviations

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Board of our hospital.

Consent for publication

The written informed consent was also obtained from the patients' parents or legal guardians for participation in this study.

Availability of data and materials

The datasets used during the current study are available from the corresponding author on reasonable request

Competing interests

The authors declare that they have no competing interests

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None

Authors' contributions

WenFang Huang: guarantor of integrity of the entire study; study concepts; study design; definition of intellectual content; literature research; clinical studies; experimental studies; data acquisition; data analysis; data analysis; statistical analysis; manuscript preparation; manuscript editing

DaXing Tang: guarantor of integrity of the entire study; study concepts; study design; definition of intellectual content; literature research; clinical studies; experimental studies; data analysis; data analysis; statistical analysis; manuscript preparation; manuscript editing; manuscript review

WeiZhong Gu: clinical studies; experimental studies; data acquisition

All authors read and approved the final manuscript

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Figures

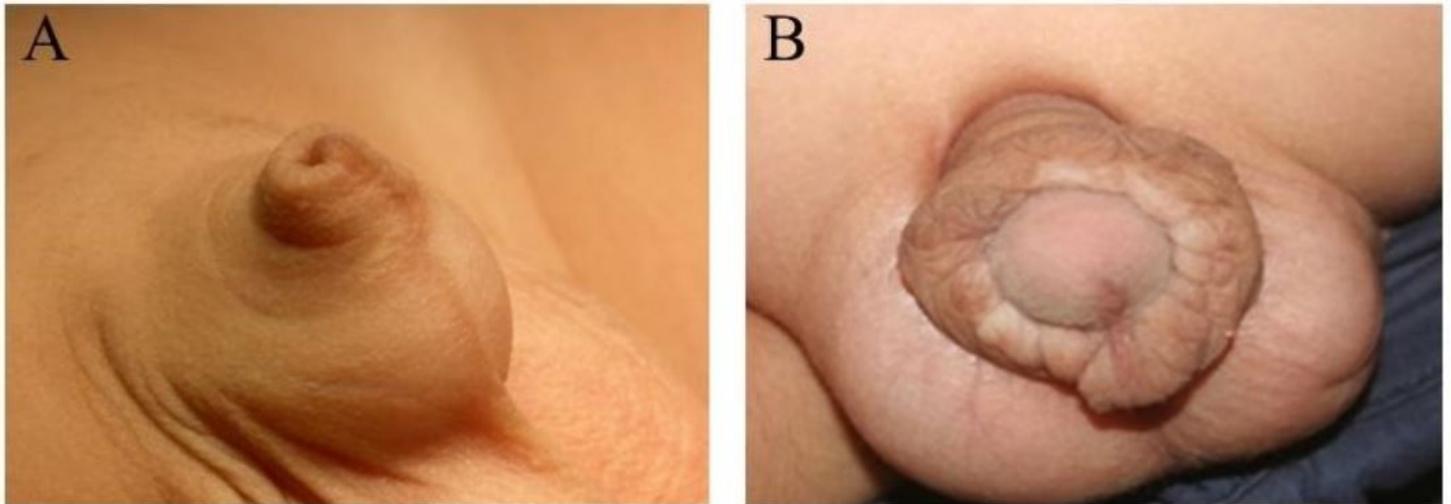


Figure 1

(A) Typical appearance of concealed penis. (B) Proliferation of inner plate of the prepuce after the concealed penis (CP) reconstruction.

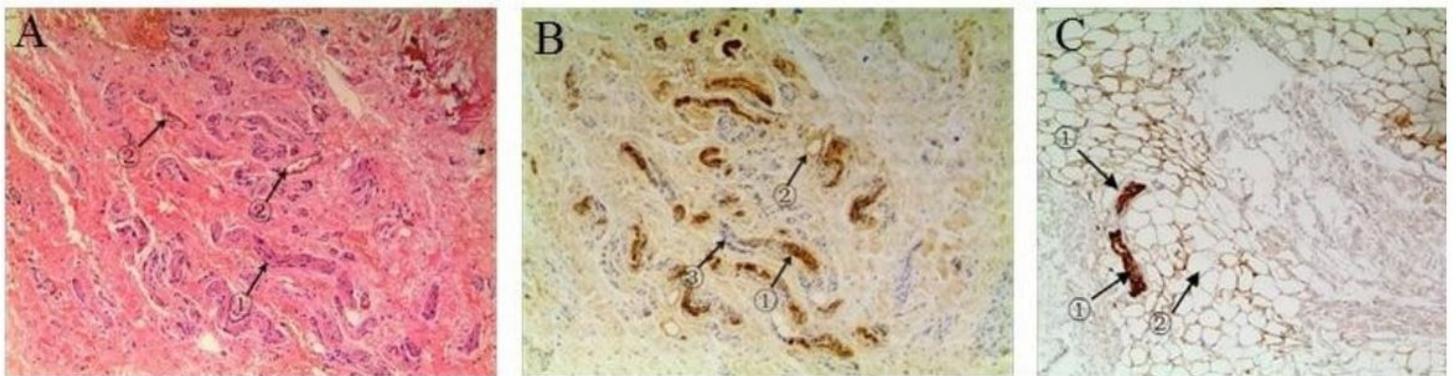


Figure 2

Results of staining for nerve ending distribution in the superficial fascia dartos of the penis. (A) Hematoxylin and eosin (H&E) staining (50×) in a concealed penis (CP) patient: ① Nerve; ② Blood vessels. S-100 positive staining (50×); (B) a CP patient: ① Nerve; ② Adipocyte; ③ Nucleus of vascular smooth muscle; (C) normal control (black moles or hemangioma in other parts of the body). ① Nerve ; ② Adipocyte.