

Histomorphological characteristics of the wall of an acutely developed cyst of the spermatic cord in children under one year of age

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Acutely developed cysts of the spermatic cord (ADCSC) is one of the most common and controversial pathologies in children. There is still no unified approach or consensus among pediatric surgeons regarding the treatment of patients with this condition, which underscores the need for further study of the problem.^[1,7] Therefore, even though surgeons are trending towards minimally invasive surgical techniques, the development of improved treatment methods to prevent postoperative complications is considered an area requiring further refinement.

There is disagreement in the existing literature regarding the specific type of treatment for ADCSC. Authors' views differ on both the timing of surgery and the methods of intervention. Most authors consider surgery to be the primary method for treating ADCSC. Surgery is recommended for

Abstract

Objectives: The objective of this study was to examine the histomorphological characteristics of spermatic cord cysts in infants and young children.

Patients and methods: This retrospective study was conducted at the Specialized Pediatric Surgery Clinic of Samarkand State Medical University. Medical records of 355 male pediatric patients aged 18 days to 12 months who underwent treatment for acute developed cysts of the spermatic cord (ADCSC) between 1994 and 2021 were retrospectively reviewed. Of the 92 operated children from both groups, 88 patients underwent histomorphological examinations of the seminal canal cyst walls to confirm the effectiveness of the developed treatment method in our clinic.

Results: A total of 355 male pediatric patients (range, 18 days to 12 months) met the criteria. The patients were divided into two groups based on treatment strategy and period: the control group (n = 160, 45.1%), comprising patients who received conventional blind puncture aspiration between 1994 and 2007. The main group (n = 195, 54.9%) consisted of patients with ADCSC treated using a method developed at the clinic: ultrasound-guided cyst puncture under real-time sonographic visualization between 2008 and 2021. The results show that the thinnest cyst walls are observed in patients aged 1.5 to 3.5 months. In contrast, children aged 3.5 to 12 months have thicker cyst walls compared to the younger age group.

Conclusion: The outcomes of puncture treatment for acute spermatic cord cysts in newborns and young children demonstrate a significant advantage of this minimally invasive treatment, especially in infants under three months of age.

Keywords: Children, cyst, puncture treatment, spermatic cord.

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children older than 1-1.5 years within their first two years of life, provided there is no tense or acute presentation.^[2,4,6] However, in children under six months of age, needle aspiration is a possible

treatment if a large amount of fluid causes tension in the tunics of the spermatic cord, accompanied by restlessness in the child and testicular compression. In this case, after the hydrocele fluid is evacuated, a suspensory bandage is applied, and a repeat aspiration is performed if the fluid reaccumulates. Aspiration treatment can be performed multiple times.^[3,5]

The term “acutely developed cyst of the spermatic cord” was introduced to describe a cyst that appears *de novo* or enlarges rapidly in neonates and infants, presenting with clinical features of acute scrotal pathology: sudden scrotal swelling, skin erythema, restlessness, and transillumination positivity.^[5] This term is used by our group and is grounded in the clinical observation that these cysts differ from chronic hydroceles of the processus vaginalis by their acute onset, rapidly increasing tension, and the age-specific structural characteristics of their walls. To our knowledge, no published study has systematically examined the histomorphological features of ADCSC walls across infant age groups nor linked these structural differences to treatment outcomes. We hypothesized that age-related differences in cyst wall thickness, epithelial architecture, and connective tissue composition underlie the higher efficacy of minimally invasive puncture in younger infants (under 3 months) and that characterizing these structural features would provide an evidence-based rationale for treatment strategy selection. The aim of this study was therefore to compare the histomorphological characteristics of ADCSC walls in children under three months versus those aged 3-12 months, and to correlate these findings with clinical treatment outcomes.

PATIENTS AND METHODS

This retrospective study was conducted at the Specialized Pediatric Surgery Clinic of Samarkand State Medical University. Medical records of 355 male pediatric patients aged 18 days to 12 months who underwent treatment for ADCSC between 1994 and 2021 were retrospectively reviewed. Inclusion criteria were male sex, age 18 days to 12 months, scrotal swelling with transillumination positivity, and ultrasound confirmation of a fluid-filled cyst of the spermatic cord. Exclusion criteria were concomitant inguinal

hernia, testicular torsion, epididymo-orchitis, or solid scrotal mass. The parents of all patients gave written informed consent to the processing of the children's personal data included in the study, as shown in Table 1. The study protocol was approved by the Ethics Committee of Samarkand State Medical University (Date: August 12, 2023, IRB protocol no: 2023-0001). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Treatment selection was not randomized; the decision to perform aspiration or surgery was based on the following criteria: aspiration was the first-line treatment for all eligible patients under three months of age and for older patients with small-to-moderate cysts without signs of secondary infection. Surgical excision was performed when aspiration failed (cyst refilled within four weeks after two aspiration attempts), when the cyst was very large (diameter > 4 cm) with marked testicular compression, or when the child was older than three months and aspiration had not been attempted or had failed.

An analysis of treatment outcomes showed that out of 160 children in the control group (CG), 36 (22.5%) underwent scheduled surgery, while the remaining 124 (77.5%) underwent aspiration. Of the 124 children who underwent aspiration of an ADCSC, 107 (86.3%) achieved a complete cure. For children under three months of age in the CG, conventional blind puncture was performed in 114 patients (107 puncture only + 7 puncture then surgery), with a primary success rate of 107/114 (93.9%). In the main group (MG), aspiration proved effective in 148/149 (99.3%) of patients under three months of age. Statistical comparison demonstrated a statistically significant difference (Fisher's exact test, $p = 0.014$), confirming the superiority of ultrasound-guided aspiration over conventional blind aspiration in this age group.

The observation results indicated a correlation between the outcomes of ADCSC aspiration treatment and the patient's age. This finding prompted us to conduct histomorphological studies of ADCSC wall samples obtained during surgery.

The material for the histomorphological studies consisted of ADCSC wall fragment samples obtained from 88 patients, aged two to 12 months, who had undergone surgical excision of the ADCSC. To perform a comparative analysis,

TABLE 1								
Treatment methods for ADCSC in the compared groups								
	Age of patients in the groups							
	Control group				Main group			
	Under 3 months		Over 3 months		Under 3 months		Over 3 months	
Treatment method	n	%	n	%	n	%	n	%
Puncture	107	66.9	-	-	148	76	-	-
Puncture + surgery	7	4.4	10	6.3	1	0.5	5	2.6
Surgery	133	8.1	23	14.4	-	-	41	21
ADCSC: Acutely developed cysts of the spermatic cord.								

TABLE 2				
Distribution of children by age group				
Age groups	Number of patients		Number of samples	
	n	%	n	%
Up to 3 months	17	19.3	51	12.2
3-12 months	71	80.7	366	87.8
Total	88	100	417	100

all 88 patients were divided into two age groups, as shown in Table 2.

Statistical analysis

Statistical analysis was performed using Microsoft Office Excel 2021 and IBM SPSS v.26 (IBM Corp., Armonk, NY, USA). Categorical data are presented as absolute counts and percentages. Between-group differences in treatment outcomes were evaluated using Fisher's exact test. Histomorphological measurements were obtained from 417 specimens using calibrated ocular micrometry at ×100 magnification. Between-group comparisons of layer thickness were performed using the Mann-Whitney U test. A two-tailed *p*-value of < 0.05 was considered statistically significant.

RESULTS

A total of 355 male pediatric patients (range, 18 days to 12 months) who underwent treatment for ADCSC were included in the study. The patients were divided into two groups based on treatment strategy and period: the CG (n = 160, 45.1%), comprising patients who received conventional blind puncture aspiration (without ultrasound

guidance) between 1994 and 2007. In cases of tense cysts, large cyst size, or when punctures were ineffective, radical surgery was performed. The MG (n = 195, 54.9%) consisted of patients with ADCSC treated using a method developed at the clinic: ultrasound-guided cyst puncture under real-time sonographic visualization between 2008 and 2021. The key distinction between groups is therefore both temporal (CG: 1994-2007; MG: 2008-2021) and methodological (CG: blind aspiration; MG: ultrasound-guided aspiration).

Light microscopy and scanning electron microscopy (SEM) revealed clear age-dependent differences in the histomorphological architecture of ADCSC walls. The key findings are summarized by age group in Table 3 and illustrated in Figures 1 and 2.

Age group < 3 months

In infants under three months of age, cyst walls were uniformly thin. Light microscopy demonstrated a single-layered epithelium of flat cells with elongated hyperchromatic nuclei and weak basement membrane attachment, resulting in minimal desquamation. The lamina propria contained loose connective tissue with fine fibers,

TABLE 3
Summary of histomorphological findings in ADCSC walls by age group

Histomorphological feature	Age < 3 months (n = 17 patients; 51 specimens)	Age 3-12 months (n = 71 patients; 366 specimens)
Wall thickness (overall)	Thin; adventitia is the thickest layer (= mucosal + muscular layers combined)	Significantly thicker than in younger group; all layers enlarged
Epithelial lining (light microscopy)	Single layer of flat cells with elongated hyperchromatic nuclei	One to two layers of cuboidal cells; round hyperchromatic nuclei; bilayered epithelium in some areas
Epithelial desquamation	Minimal; occasional cells shed; basement membrane remains intact	Pronounced; large clusters of desquamated cells; exposed basement membrane in places
Basement membrane	Swollen, oxyphilic, without distinct contours; weak epithelial attachment	More clearly defined and moderately pronounced
Connective tissue (lamina propria)	Loose, with fine fibers; numerous fat cells; large mesothelial cells with hypochromatic nuclei	Denser; coarser collagen fibers; more fibroblasts; loose and dense fibrous structures alternate
Muscular layer	Relatively thin; single distinct fiber layer	Slightly thicker; fibers more prominent; two orientations (longitudinal and circular)
Adventitia	Thickest layer; loose connective tissue with fat deposits; numerous veins, often forming venous sinuses	Thicker than in < 3 months group; blood vessel content relatively less dominant
Vascularity	Abundant lymphatic and blood capillaries directly beneath basement membrane; vascular plexuses at mucosal-muscular border	Numerous thin-walled microvessels and wide, branching capillaries in lamina propria; larger vessels at mucosal-muscular border
Inner surface relief (SEM)	Smooth, wavy surface without deep grooves; ridges and depressions uniformly covered with flat cells	Pronounced folded relief with deeper troughs; more complex 3D topography
Epithelial cell morphology (SEM)	Flat, irregularly polygonal; wrinkled surface; no microvilli; wide intercellular spaces	Rounded cells with distinct borders, tightly adherent; desquamated cells resemble fallen leaves; dome-shaped apical surface in older infants; cell polymorphism increases with age
Clinical correlation	Thin, pliable wall; well-developed subepithelial drainage network → complete collapse after puncture; high aspiration success (99.3% at < 3 months in MG)	Structural rigidity prevents complete wall collapse; denser stroma impairs reabsorption → higher rate of aspiration failure and recurrence

ADCSC: Acutely developed cysts of the spermatic cord.

fat cells, and an abundance of lymphatic and blood capillaries forming a drainage network directly beneath the basement membrane. The adventitia was the dominant layer, consisting of loose connective tissue with fat deposits and numerous veins, frequently forming venous sinuses. SEM confirmed a smooth, wavy inner surface without deep grooves or fissures, as shown in Figure 1.

Age group 3-12 months

In children aged 3-12 months, all wall layers were significantly thicker. The mucosa was 1.5-2 times thicker, consisting of one or two layers of cuboidal cells with round hyperchromatic nuclei

and a more clearly defined basement membrane. The lamina propria was denser, with coarser collagen fibers and more fibroblasts. Desquamation was markedly more pronounced than in younger infants, with large clusters of shed cells and focal exposure of the basement membrane. The muscular layer showed two distinct fiber orientations (longitudinal and circular). SEM revealed a more complex folded inner surface with deeper troughs, increased epithelial polymorphism, and dome-shaped apical cell surfaces; the degree of topographic irregularity increased progressively with age, as shown in Figure 2.

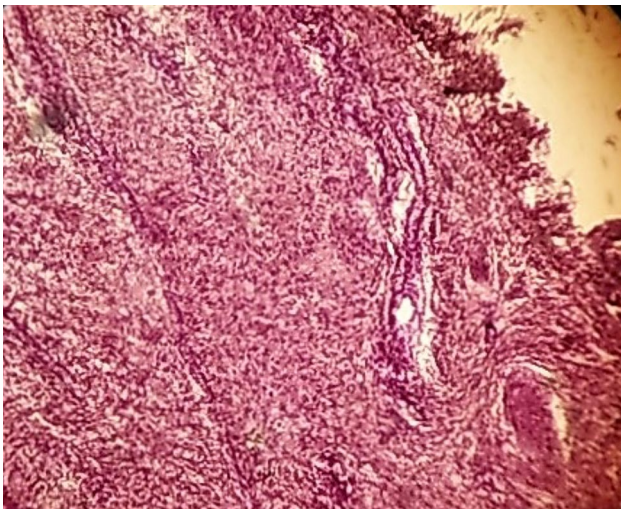


Figure 1. Single-layered epithelium of ADCSC wall in a two-month-old infant. Single-layered flat epithelium, numerous blood vessels in connective tissue (H&E $\times 100$).

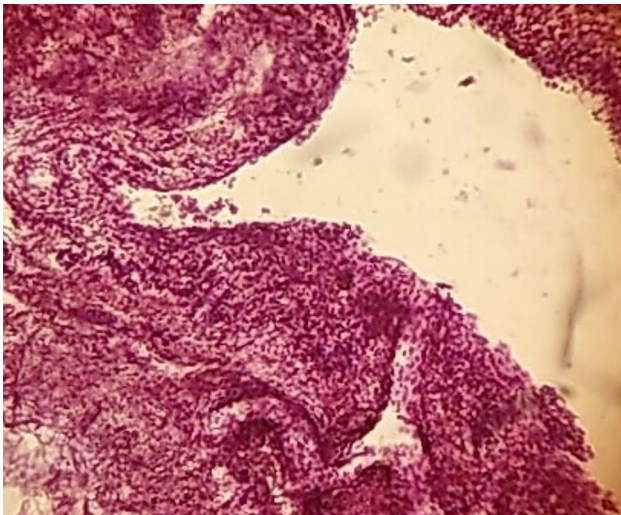


Figure 2. Significant thickness of cyst mucosa in a 3.5-month-old infant. Dense connective tissue layer; pronounced mucosal fold (H&E $\times 200$).

A comparative analysis identified common structural features across all age groups (three-layer organization: mucosa, muscularis, adventitia) alongside significant age-related differences. The most pronounced inter-group differences involved the epithelial lining, overall wall thickness, and the degree of desquamation. These structural features, particularly the thin, pliable wall and well-developed subepithelial drainage network in infants under three months,

provide a mechanistic explanation for the significantly higher aspiration success rate observed in this age group (99.3% vs. 93.9%, $p = 0.014$).

DISCUSSION

To our knowledge, this is the largest published series specifically examining the histomorphological features of ADCSC walls in children under 12 months of age, comprising 88 operated patients and 417 biopsy specimens. The principal finding is a clear age-dependent difference in cyst wall architecture that is clinically correlated with treatment outcomes: thinner, smoother-walled cysts in infants under three months respond reliably to minimally invasive puncture, whereas thicker, structurally more complex cysts in older infants are more likely to require surgical excision.

The clinical relevance of our histomorphological findings can be summarized as follows. In infants under three months, the cyst wall is thin and its epithelial lining consists of a single layer of flat cells with minimal desquamation and relatively weak attachment to the basement membrane. The lamina propria contains abundant lymphatic and blood capillaries that are structurally capable of reabsorbing evacuated cyst fluid residues. These features explain why complete drainage by a single puncture is achievable in the vast majority of younger infants: once the fluid is evacuated, the thin, pliable wall collapses and the well-developed subepithelial drainage network facilitates resolution. In contrast, in children aged 3-12 months, the mucosa is 1.5-2 times thicker, the connective tissue is denser with coarser collagen fibers, and epithelial desquamation is more pronounced. The SEM data demonstrated progressively more complex surface topography with deeper clefts and greater polymorphism. This structural rigidity likely prevents complete wall collapse after aspiration, explaining the higher rate of aspiration failure in older infants.

These findings are consistent with existing literature on age-related differences in the processus vaginalis. Chang et al.^[4] noted that spermatic cord hydroceles in infants differ pathophysiologically from those in older children, with a higher spontaneous resolution rate in the first months of life attributed to the structural immaturity of the cyst wall. Kogan et al.^[2] and Davidov and Dyabkina^[1] similarly

emphasized that the timing of intervention should be individualized by age. The present study provides the histomorphological basis for these clinical observations. The statistically significant superiority of ultrasound-guided aspiration over blind aspiration (99.3% vs. 93.9%, $p = 0.014$) additionally demonstrates that real-time sonographic guidance improves procedural precision and reduces the risk of incomplete drainage.

Several limitations of this study should be acknowledged. First, the study is retrospective and non-randomized; the CG and MG differ not only in technique but also in time period, so improvements in outcomes may partly reflect general advances in neonatal care. Second, quantitative data on absolute layer thicknesses would further strengthen the correlation with aspiration outcomes. Third, long-term follow-up data on recurrence rates and fertility outcomes are not yet available for the full MG cohort. Despite these limitations, the coherence of histomorphological and clinical findings across a large patient series spanning 27 years provides a strong basis for the conclusions drawn.

In conclusion, a retrospective analysis of treatment outcomes for ADCSC in the CG, along with histomorphological examinations, data from instrumental studies implemented in the MG, and long-term follow-up studies, allowed us to develop a minimally invasive puncture treatment method and propose a new, evidence-based approach to treating ADCSC in children. The patient's age is the determining factor in selecting the surgical treatment approach for ADCSC. It is advisable to treat children under the age of three using the minimally invasive puncture method developed in our clinic. This method achieves complete drainage of the cyst contents and guarantees the prevention of trauma to surrounding soft tissues, blood vessels, elements of the spermatic cord, and other anatomical structures.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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