

Morphological Evidence for a Minimally Traumatic Method of Epididymal Local Anesthesia

Kodirov M. D.^{1,*}, Khasanova D. A.²

¹PhD Student, Bukhara State Medical Institute, Bukhara, Uzbekistan

²DSc., Professor, Bukhara State Medical Institute, Bukhara, Uzbekistan

Abstract This article presents a morphological rationale for selecting the least traumatic method of local anesthesia for the epididymis based on a comparative evaluation of tissue reactions to different administration routes of local anesthetics. The experimental study was conducted on 90 white outbred male rats (250–300 g) randomly assigned to six groups: control; intratesticular lidocaine; lidocaine conduction anesthesia; intratesticular novocaine; novocaine conduction anesthesia; and a combined technique (intratesticular novocaine with additional lidocaine conduction block). Epididymal tissue samples were obtained at 24 hours, 7 days, and 14 days after anesthetic exposure. Morphological analysis was performed using hematoxylin and eosin staining and Van Gieson staining, with assessment of the convoluted tubule epithelium, interstitial components, microcirculatory bed, and the severity of connective tissue remodeling. The findings demonstrated that intratesticular administration of anesthetics leads to more evident degenerative alterations and fibrotic transformation in epididymal tissues, whereas conduction anesthesia with lidocaine is associated with the least structural impairment. Notably, the combined technique contributed to a reduction in the intensity of morphological abnormalities, suggesting its potential value as a functionally sparing approach, particularly relevant for interventions in subjects with reproductive system disorders.

Keywords Local anesthesia, Intratesticular injection, Conduction anesthesia, Lidocaine, Novocaine, Morphological alterations, Histology, Fibrosis, Van Gieson staining

1. Introduction

Local anesthesia is an important component of pain relief during procedures on the scrotum and male reproductive system. The choice of anesthetic administration route (intratesticular, conduction, or combined) influences not only the intensity of analgesia but also the nature of the tissue reaction. The epididymis is a functionally significant organ involved in sperm maturation and transport; therefore, even moderate morphological disturbances in its architecture can be accompanied by a decrease in reproductive potential and the development of chronic alterations [1–3].

According to the literature, intratesticular lidocaine administration is widely used in surgical practice and experimental models; however, it may be accompanied by local inflammatory changes and immune activation of tissues. For example, differences in immune response have been demonstrated depending on the technique of regional anesthesia during testicular procedures, including changes in inflammatory markers and regulatory cytokines [4].

Furthermore, experimental animal studies have demonstrated that intratesticular anesthesia can influence tissue reactivity and subsequent healing processes, especially with repeated procedures [5,6]. Therefore, an assessment of the morphological consequences of this method is necessary to substantiate its safety.

At the same time, conduction anesthesia (spermatic cord block) is considered a more gentle method of pain relief, minimizing the direct effect of the drug on the parenchyma and interstitial components of the organ. The efficacy and safety of the spermatic cord anesthetic block as an independent method of anesthesia for scrotal surgery has been proven in clinical settings [7], and more recent studies confirm the advantages of the spermatic cord block in reducing intraoperative adverse reactions and improving the course of interventions [8]. However, despite the clinical appeal of this approach, morphological comparison of the routes of anesthetic administration in the context of structural damage to the epididymal tissue remains limited.

Morphological assessment of connective tissue remodeling and fibrotic changes is particularly important. Chronic inflammation and tissue damage in the structures of the male reproductive system are known to lead to remodeling and the development of fibrosis [9], which is considered an unfavorable factor in terms of maintaining function.

* Corresponding author:

Kokkadirov2109@gmail.com (Kodirov M. D.)

Received: Jan. 5, 2026; Accepted: Jan. 27, 2026; Published: Feb. 7, 2026

Published online at <http://journal.sapub.org/ajmms>

Furthermore, the issue of tissue toxicity of local anesthetics and their potential damaging effects on various structures of the body is actively discussed in the scientific literature [10]. Therefore, a comparative morphological study of epididymal tissue after intratesticular and conduction administration of local anesthetics represents a relevant scientific and practical task and allows for the morphological justification of the choice of the most gentle method of local anesthesia.

Purpose of the study. To conduct a comparative morphological analysis of the epididymis tissue after intratesticular, conduction and combined administration of local anesthetics with an assessment of the degree of epithelial damage, interstitial changes, vascular disorders and connective tissue restructuring to substantiate the gentlest method of local anesthesia.

2. Materials and Methods

The study was performed as an experimental controlled randomized trial on 90 white outbred male rats weighing 250-300 g. The animals were divided into 6 groups of 15 individuals: control; intratesticular administration of 1% lidocaine (L-IT); conduction anesthesia with 1% lidocaine (L-CB); intratesticular administration of 1% novocaine (N-IT); conduction anesthesia with 1% novocaine (N-CB); combined technique (N-IT + L-CB).

Epididymal tissue samples were collected 24 hours, 7 days, and 14 days after the procedure (five animals at each time point). Morphological examination was performed on 4-5 μm thick paraffin sections stained with hematoxylin and eosin to assess overall histoarchitecture and using van Gieson staining to analyze connective tissue remodeling and

the degree of fibrotic changes.

The condition of the convoluted tubule epithelium, interstitial tissue, and microcirculation was assessed. Morphological changes were quantified on a 0–3 point scale (edema, epithelial dystrophy/desquamation, vascular abnormalities, foci of necrosis/dystrophy) with the calculation of an integral damage index (0–12 points). Statistical analysis was performed using Student's t-test, χ^2 , and Pearson's correlation analysis; differences were considered statistically significant at $p < 0.05$.

3. Results and Discussion

After intratesticular injection of lidocaine into the tissues of the epididymis, signs of severe epithelial damage and an inflammatory reaction are formed (Fig. 1).

The morphometric parameters of the convoluted tubules of the epididymis are shown.

1. Focal desquamation of the tubular epithelium and areas of necrosis.
2. Small focal lympho-leukocyte infiltration in the stromal tissue and perivascular zone.
3. Decreased number of spermatozoa in the lumen of the tubules.

Focal epithelial desquamation and areas of necrosis are observed in the convoluted tubules, indicating a direct damaging effect of the procedure. Small focal lymphocytic and leukocyte infiltration is detected in the stroma and particularly in the perivascular zones, reflecting an inflammatory response. Additionally, a decrease in sperm count is noted within the tubular lumen, indicating a functional decline in tissue activity.

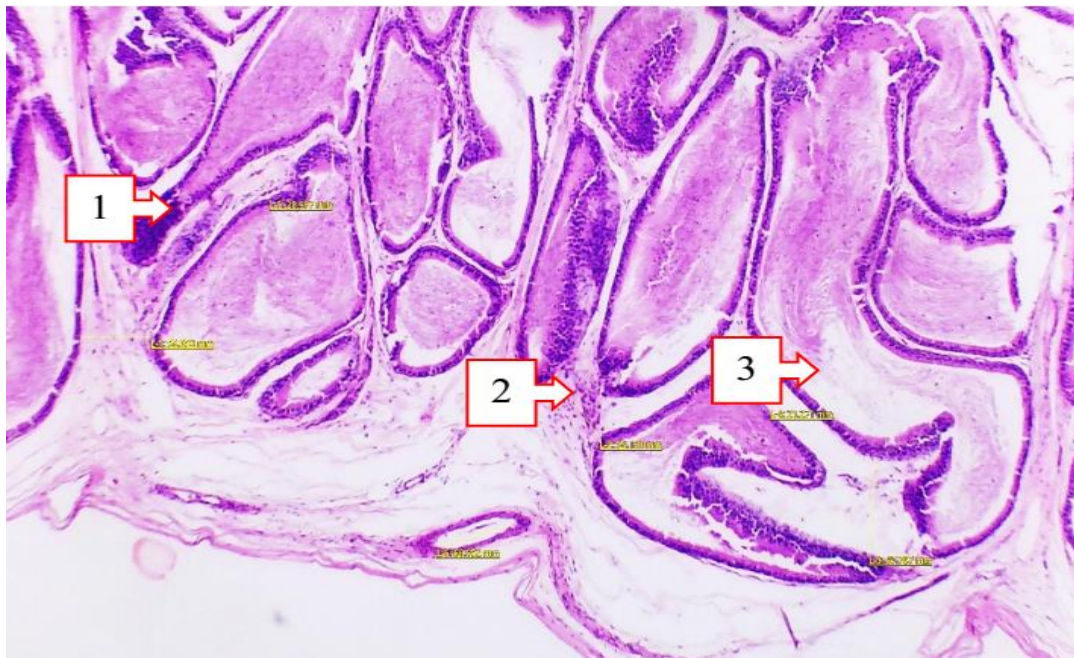


Figure 1. Epididymis after intratesticular injection of lidocaine. Hematoxylin and eosin staining, 4x20 ml

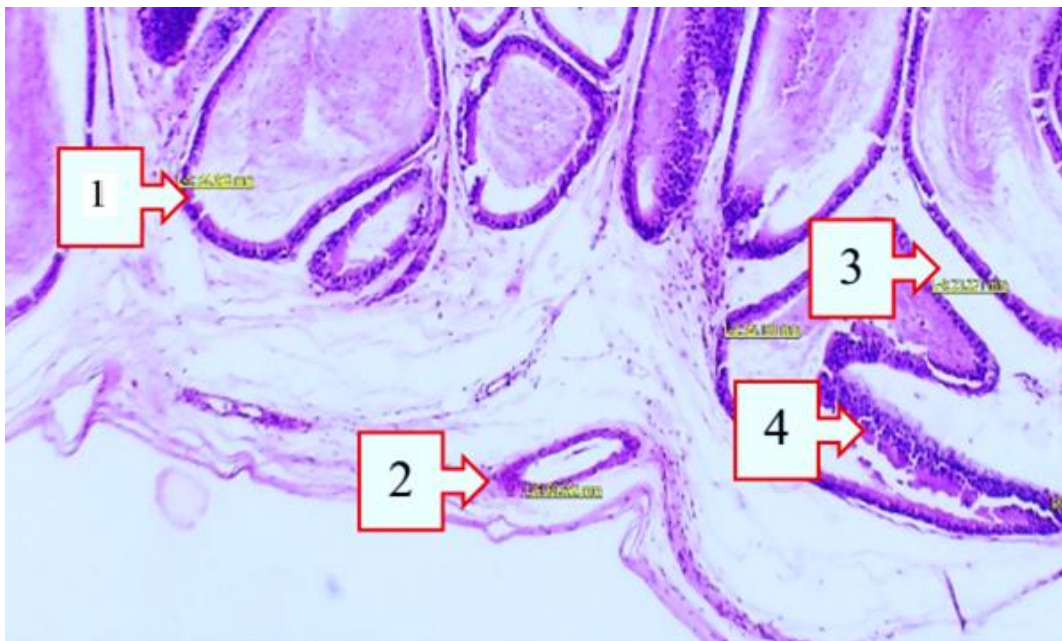


Figure 2. Epididymis after intratesticular injection of novocaine. Hematoxylin and eosin staining, Ok. 10xOb.20

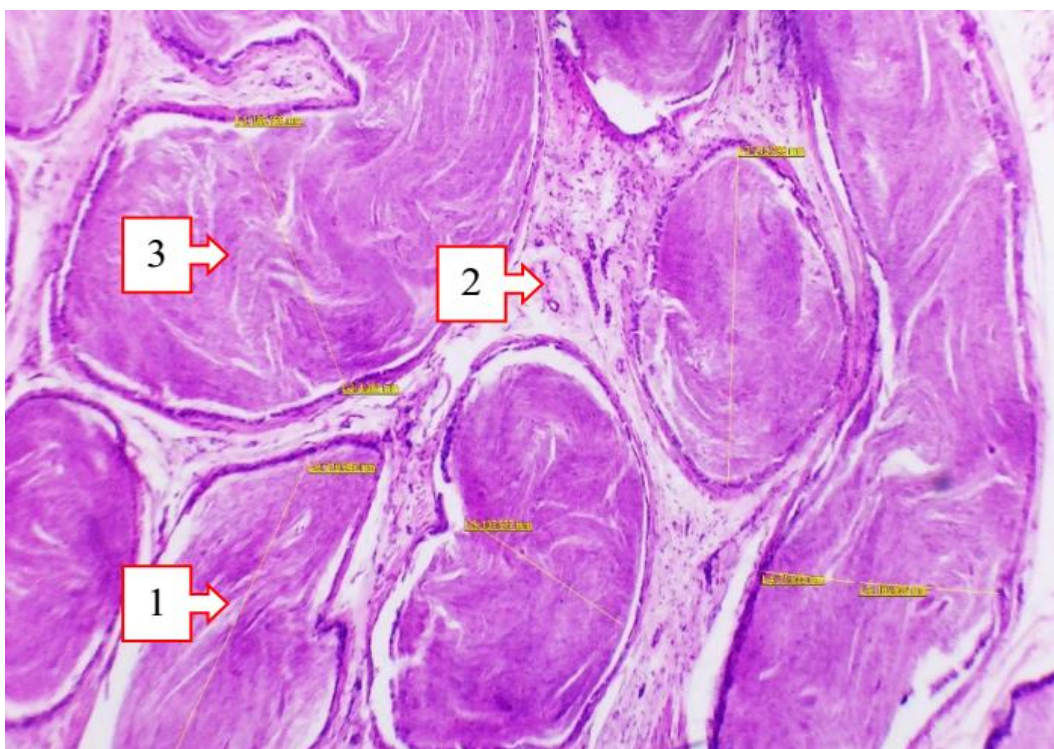


Figure 3. Epididymis after conductive administration of lidocaine. Hematoxylin and eosin staining, 10% x 20% volume

Intratesticular administration of novocaine is accompanied by the most severe morphological changes, affecting both the epithelial structures and the stromal-vascular component (Fig. 2).

The morphometric parameters of the convoluted tubules of the epididymis are shown.

1. Hypertrophy of smooth muscle fibers in the tubular wall (basophilic staining).
2. Thickening of the walls of blood vessels and narrowing

of their lumen.

3. Thickening of elastic fibers in the intertubular septum, edema.
4. Focal necrosis of the tubular epithelium.

Smooth muscle hypertrophy with basophilic staining is observed in the tubular walls. The microvasculature reveals thickening of the vascular wall and narrowing of the lumen, indicating significant vascular abnormalities. Elastic fiber thickening and edema are observed in the intertubular

septum, as well as focal necrosis of the tubular epithelium. These findings, taken together, indicate significant structural damage to the epididymal tissue with this technique.

Conduction anesthesia with lidocaine is characterized by the most gentle morphological profile with a tendency to restore tissue architecture (Fig. 3).

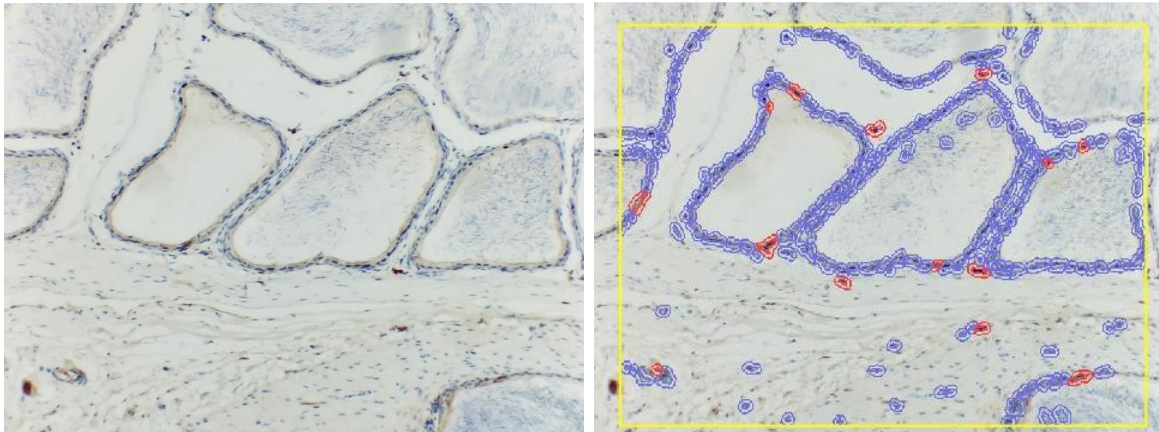
The morphometric parameters of the convoluted tubules of the epididymis are shown.

1. Expansion of the lumen of the tubules, rarefaction of the elastic fibers of the wall.
2. Disappearance of inflammatory infiltrate and edema in the stroma and perivascular zone.

3. The lumen of the tubules is filled with mature spermatozoa.

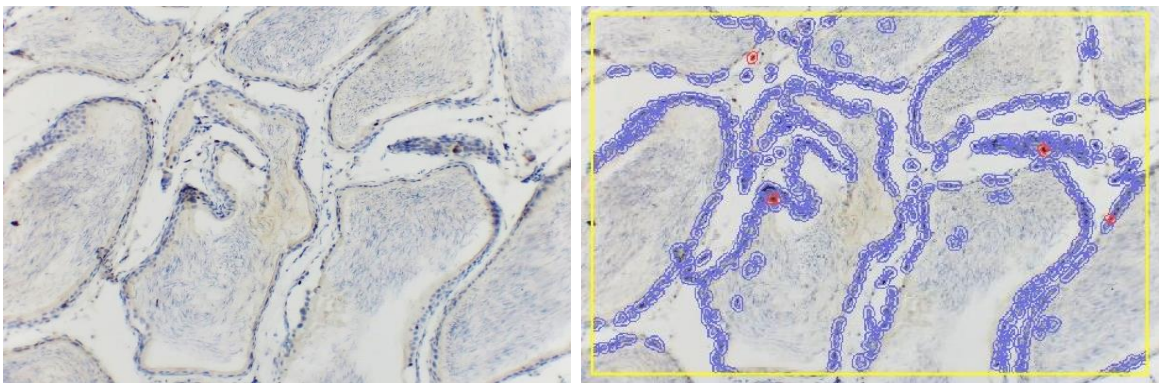
The lumen of the tubules is dilated, and the elastic fibers of the wall appear sparse, reflecting a reduction in the severity of pathological changes. Signs of inflammatory infiltrate and edema in the stroma and perivascular areas have disappeared. An important sign of functional viability is that the tubules are filled with mature spermatozoa, indicating the preserved functional activity of the epididymis.

The combined method demonstrates moderate expression of CD56, which reflects a satisfactory level of tissue reparative /regenerative potential (Fig. 4).



Total number of identified cells	237
Positive cells	14
Negative cells	223
Positive expression	5.90%
Total area	327080 px ²

Figure 4. CD56 expression after combined use of novocaine and lidocaine. DAB, ×400



Total number of identified cells	351
Positive cells	4
Negative cells	347
Positive expression	1.14%
Total area	327120 px ²

Figure 5. CD45 expression after combined use of novocaine and lidocaine. DAB, ×400

Of the 237 identified cells, 14 were CD56-positive, with a positive expression rate of 5.90%. Thus, the combined approach is characterized by relatively favorable dynamics of reparative processes using the CD56 marker.

After the combined use of novocaine and lidocaine, extremely low expression of CD45 is observed, indicating minimal inflammatory tissue infiltration (Fig. 5).

Of the 351 identified cells, only 4 were CD45-positive, representing a 1.14% positive expression rate. Therefore, the combined method ensures minimal levels of the inflammatory component for CD45.

4. Conclusions

1. Intratesticular administration of anesthetics causes the most pronounced morphological damage to epididymal tissue. This is manifested by focal epithelial desquamation, necrosis, and inflammatory infiltration, as well as a decrease in sperm count within the lumen of the testicular tubules.
2. Intratesticular administration of novocaine is accompanied by the most severe stromal-vascular disorders, including hypertrophy of smooth muscle fibers, thickening of the vascular wall and narrowing of the lumen, edema and increased connective tissue remodeling.
3. Conduction anesthesia with lidocaine is the most gentle method, as it ensures the preservation of the tubular structure, the absence of severe inflammation and edema, and the preserved presence of mature spermatozoa.

REFERENCES

- [1] Turner, T. T. (1995). On the epididymis and its role in the development of the fertile ejaculate. *Human Reproduction Update*.
- [2] NIEHS/NTP. (2024). Epididymis – Inflammation – Nonneoplastic Lesion Atlas.
- [3] WebPathology. (n.d.). Chronic epididymitis: marked chronic inflammation and fibrosis with distortion of tubules.
- [4] Vullo, C., et al. (2022). Intratesticular versus intrafunicular lidocaine to reduce perioperative nociception and immunological response in ponies undergoing field castration.
- [5] Haga, H. A., & Ranheim, B. (2006). Effect of intratesticular injection of lidocaine on cardiovascular responses and cremaster muscle relaxation in the anesthetized dog. *American Journal of Veterinary Research*, 67(3), 403–410.
- [6] Serpieri, M., et al. (2024). Effects of intratesticular lidocaine in pet rabbits undergoing orchietomy. *Animals*, 14(4), 551.
- [7] Issa, M. M., et al. (2004). Spermatic cord anesthetic block for scrotal procedures in outpatient clinic setting. *The Journal of Urology*.
- [8] Gao, Q.-Q., & Wu, N. (2024). The effect of spermatic cord block on reducing the risk caused by pulling the spermatic cord during surgery. *Heliyon*.
- [9] Xu, Y., et al. (2024). Testicular fibrosis: pathology, diagnosis, pathogenesis, and clinical implications. *Andrology*.
- [10] Hussain, N., et al. (2018). Local anaesthetic-induced myotoxicity in regional anaesthesia: A systematic review. *British Journal of Anaesthesia*.