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Can the effect of adhesion barriers and/or intravesical balloon inflation improve bladder autoaugmentation outcomes in a rabbit model?

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Summary

Introduction
Bladder augmentation is used for the treatment of bladder dysfunction in order to minimize intravesical pressure and increase bladder capacity. However, less-invasive procedures, such as autoaugmentation, have been proposed due to several complications that have occurred using bowel and gastric segments. The technique of autoaugmentation involves wide excision of the detrusor by leaving the bladder mucosa intact and has shown increased bladder capacity and compliance. An additional step to keep the achieved surface area of this non-contractible bladder segment and, thus, bladder capacity, was reported by using an intravesical balloon to prevent shrinkage of the surgically achieved diverticulum during autoaugmentation. On the other hand, adhesion barriers (AB) with absorbable hydrogel, which can spare tissue and organ plans, are used to prevent postsurgical adhesions. The efficacy of sprayable AB has been demonstrated in animal models and it is now mostly used in laparoscopic surgeries.

Objective
The present study aimed to compare the efficacy of AB and/or intravesical balloon insertion, which might potentially improve the urodynamic and histopathological outcomes of autoaugmentation in a rabbit model.

Methods
A total of 25 New Zealand rabbits were included in the study. Following the surgical reduction to form a low-capacity bladder model (35–40% of the initial volume), standard detrusorotomy was performed in all groups except the sham group. Group 2 had only autoaugmentation as the control group. The bladders in Group 3 were supported with an intravesical balloon. An Adhesion Barrier System (CUI Tissue Expander) was used for all bladders in Group 4, without balloon inflation. In Group 5, both intravesical balloon inflation and adhesion barrier application were performed following autoaugmentation. Urodynamic evaluations were performed at day 0 before reduction, day 0 after reduction, and the 90th postoperative day. Capacity and compliance measurements were noted. Bladders were histopathologically evaluated. Expression of CD31 (microvessel density) and fibrosis were noted.

Results
Autoaugmentation does not result in a reliable increase in bladder capacity and compliance when compared to a sham group. Urodynamic measurements were similar in balloon-inflated groups (Group 3 and Group 5), showing a statistically significant improvement. Sprayable AB system alone revealed a slight, but not statistically significant, increase (Table). No significant differences between all five groups were detected regarding microvessel density (CD31 expression) and fibrosis.

Discussion
In the present study, the intravesical balloon application (IVBA) efficiency was investigated alone and in combination with AB. The main basis of this study were the previous findings, which demonstrated prevention or decrease in the contraction of diverticula by IVBA. The role of AB alone or within a combination was also evaluated. Adhesion barriers are mostly used in laparoscopic gynecologic and colorectal operations. They decrease the postoperative adhesions by forming a physical barrier. In the present study, it was thought that AB might reduce postoperative adhesions and enhance the outcome of autoaugmentation. One of the most important outcomes was the inconsistency of fibrosis density with final bladder capacity and compliance values; this finding did not support the role of fibrosis prevention with IVBA. The present study had some limitations: the partial cystectomy method, which was used to form a low-compliance bladder, is a different clinical condition to neurogenic bladder, and a rectal catheter was not used during urodynamic evaluation. General anesthesia and muscle relaxant were performed during urodynamy and abdominal contractions were not seen.

Conclusion
Bladder autoaugmentation in a rabbit model, followed by intravesical balloon inflation offers improvement in bladder capacity and compliance. The use of sprayable adhesion barrier hydrogel technology may facilitate tissue healing and result in it being easier to maintain the success achieved by surgery when only supported with an intravesical balloon.

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Table Bladder capacity and compliance values of all groups: pre-operative, postoperative and 90 days after surgery.

Groups	Capacity on day 0 (before reduction) Mean ± SD (ml)	Capacity on day 0 (after reduction) Mean ± SD (ml)	Compliance on day 0 (after reduction) Mean ± SD (ml/cm H_2O)	Capacity on day 90, Mean ± SD (ml)	Compliance on day 90, Mean ± SD (ml/cm H_2O)	Δ Capacity Mean ± SD	Δ Compliance Mean ± SD
Group 1 (sham)	23.8 ± 2.1	23.8 ± 2.1	13.5 ± 0.9	23.6 ± 2.0	13.1 ± 1.0	0.2 ± 0.1	0.4 ± 0.3
Group 2 (control)	24.4 ± 1.9	18.6 ± 1.9	3.6 ± 0.2	18.9 ± 1.9	3.9 ± 0.2	0.3 ± 0.1	0.3 ± 0.1
Group 3 (IVBA)	25.3 ± 1.2	19.1 ± 0.7	3.9 ± 0.3	23.4 ± 0.9	13.0 ± 0.3	4.6 ± 0.6*	9.1 ± 0.2*
Group 4 (AB)	24.7 ± 0.8	18.4 ± 1.4	3.3 ± 0.5	18.9 ± 1.3	3.9 ± 0.5	0.4 ± 0.2	0.6 ± 0.1
Group 5 (IVBA + AB)	24.1 ± 1.3	18.1 ± 0.8	3.4 ± 0.2	22.8 ± 1.0	12.5 ± 0.4	4.6 ± 0.5*	9.2 ± 0.2*

*$P < 0.05$.
AB, adhesion barrier; IVBA, intravesical balloon application.
The mean increase in bladder capacity and compliance between day 0 (after reduction) and day 90.

Introduction

Bladder augmentation is an effective and reliable method of minimizing intravesical pressure and increasing bladder capacity in patients with refractory, severe bladder dysfunction. The most common augmentation cystoplasty methods are performed by the detubularization of gastrointestinal organs. However, these are associated with different absorption and secretion complications. To overcome these difficulties, less-invasive techniques have been proposed such as autoaugmentation, ureterocystoplasty and tissue engineering.

Autoaugmentation is the excision of the detrusor muscle over the urothelium, where the bladder mucosa is left intact. The aim of this operation is to obtain large pseudodiverticula. In long-term follow-up, the main concern is maintaining the acquired high compliance of the bladder due to fibrosis and progressive shrinkage [1]. Replacement of a balloon into the surgically created diverticula during the operation may prevent shrinkage of the diverticula and, therefore, the bladder capacity and compliance can be more durable [2,3]. The wide surgical area is inevitably open to adhesions with the nearby organs.

Adhesion barriers (AB) with absorbable hydrogel, which can spare tissue and organ plans, are used to prevent these postsurgical adhesions. The efficacy of a sprayable AB system has been demonstrated in animal models and is now mostly used in laparoscopic surgeries [4]. In the present study, the aim was to investigate the role of intravesical balloon application (IVBA) and/or sprayable AB in the success of autoaugmentation, in terms of urodynamic and histologic parameters. The efficiency of these two approaches was compared with control and sham groups.

Material and methods

The Animal Research Center Central Ethical Committee approved the present study. Twenty-five male 9—12-month-old New Zealand white rabbits were enrolled; they weighed between 3.4 and 4 kg. Urodynamic studies for initial bladder capacity were performed on all rabbits under general anesthesia. Then they were randomized in to five groups:

In Group 1 (sham group), only laparotomy was performed. After laparotomy, the abdominal wall was repaired without any approach.

In Group 2 (autoaugmentation group), partial cystectomy was performed in order to achieve a 35—40% smaller bladder. Three weeks later, autoaugmentation was performed on all rabbits in this group.

In Group 3 (autoaugmentation + IVBA), the same procedure was performed as Group 2. After autoaugmentation, a silicon tissue expander (CUI™ Tissue Expander) was placed into the diverticulum, which was created during the autoaugmentation, and inflated; it was kept there for 10 days.

In Group 4 (autoaugmentation + AB), autoaugmentation was performed, as described in Group 2, followed by the application of a sprayable AB.

In Group 5 (autoaugmentation + IVBA + AB), the combination of the procedures in Groups 3 and 4 were performed consecutively.

Postoperatively, all rabbits were returned to separate cages and were unrestricted to water and standard food. All rabbits underwent urodynamic studies 90 days later, and then they were all sacrificed. Cystectomy materials were histopathologically evaluated. Organs were fixed in 4% paraformaldehyde and paraffin embedded: 4 mm sections were dew axed, hydrated sections were stained