

Rethinking dogma: Can urinary catheters be filled with air? A feasibility study

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1. Introduction

Although, surgical dogma dictates that foley catheter balloons must be filled with fluid there has been no investigation if air-filled catheter balloons will result in adverse outcomes for patients. Informal surveys of practicing urologists indicate that surgical maneuverability may be improved if foley catheter balloons can be filled with air postoperatively.

Dr Frederick Foley invented the foley catheter to be a self-retaining bladder drainage device used postoperatively.^[1] Catheter balloons are inflated with saline through a one-way valve, through which the saline is drained from at the time of removal. Urinary catheters can be utilized short- or long-term (indwelling) and indicated in patients with urinary retention or perioperatively for certain surgeries.^[2] Spontaneous balloon rupture and saline crystallization are rare but serious causes of catheter balloon malfunction.^[3] Although filling catheter balloons with fluid allows for confirmation that the balloon is empty prior to removal, there is limited evidence to suggest that air-filled balloons are dangerous. Additionally, for short-term catheterization the avoidance of fluid-filled balloons could potentially reduce balloon rupture on filling or deflation failure during trial-of-void. As there is limited literature surrounding air-filled catheters,^[4] in this report we sought to evaluate whether air-filled catheter balloons had more complications than saline-filled catheter balloons.

2. Materials and methods

Forty-six patients undergoing posturologic surgery short-term catheterisation - defined as planned catheter duration less than 24 hours - at our tertiary care center were randomly assigned 1:1 to one of two groups: air-filled vs. saline-filled catheter balloons. After the procedure, a standard 16–18F catheter was placed and the balloons were filled with either 10 mL of air or 10 mL of sterile 0.9% saline. Patients undergoing holmium laser enucleation of the prostate had a 22F three-way catheter placed with 60 mL of air or saline. Catheters were placed postprocedurally, while the patient was under general anesthesia. Patients were monitored

postoperatively in the postanesthesia care unit. Catheters were checked regularly by nursing staff to ensure they remained in place, and at removal were evaluated for rupture. Any balloon ruptures or complications relating to the urinary catheter were recorded.

Fisher's exact tests were performed to compare rates of balloon rupture and complications related to foley catheter using R v3.6.3 (R, Vienna, Austria).

3. Results

The study included a total of 46 patients, 42 males (91%), and 4 females (9%). The average indwelling catheter time was 8:32 (hours: minutes) for the air-filled group and 11:14 for the saline-filled group. There were 7 distinct surgical procedures performed (Table 1). The number of balloon ruptures was 0 in the air-filled group (0.0%), and in the saline-filled group (0.0%). There was 1 (4.3%) continuous bladder irrigation complication in the air-filled balloon group and 0 (0.0%) in the saline-filled balloon group (Table 2). There were no significant differences in the balloon rupture rate ($p=1.00$; 95% CI: 0.0–999.9), and in complications related to foley catheters ($p=1.00$; 95% CI: 0.026–999.9) in both groups.

4. Discussion

To the best of our knowledge, no study has compared the differences in balloon rupture rates and complications related to foley catheters for air- and saline-filled catheter balloons. Since an

Table 1
Demographics.

Variables	Air-filled (n=23)	Saline-filled (n=23)
Median age (IQR), yr	68 (61–71)	72 (61.5–74)
Gender		
Female	2	2
Male	21	21
Multiple procedures performed		
Yes	5	6
No	18	17
Procedures performed		
HoLEP	18	18
Cystolitholapaxy	3	3
URS, RPG	3	1
Laser lithotripsy	0	1
Percutaneous nephrolithotomy	3	6
Botox injection	1	0
Calyceal ablation	0	1

HoLEP = holmium laser enucleation of prostate; IQR = interquartile range; URS = ureteroscopy; RPG = retrograde pyelogram.

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Table 2
Complication rate.

	Balloon ruptures	Complications	p
Air-filled	0	1	1.00
Saline-filled	0	0	1.00

informal survey of practicing urologists revealed that filling catheters with air is not uncommon, we designed a controlled feasibility study to explore this practice. We found no significant difference in the balloon rupture or complications with air-filled short-term catheter balloons. The one incidence of irrigation issues in the air-filled group was statistically insignificant and may be attributed to a defective catheter.

Latex urinary catheters are commonly used postoperatively for 86% of patients undergoing major operations. Approximately 50% of catheters stay in for less than 2 days.^[5] As this study has shown the safety of air-filled catheter balloons, we predict that routinely filling short-term catheters with air instead of saline could result in cost-savings. At the time of catheter insertion in the operating room, individually packaged catheters are chosen by surgeons based on individualized patient need. As this is the case, standardized prefilled catheters are not routinely used postoperatively and we observed that a new 1-L saline bottle is opened for each catheter inserted. We utilized 3789 operating room catheters over a 6-month period in the Urology Department. Thus, based on available catalogue costs of \$2.10 per bottle, the total annual cost for urinary catheter saline is \$15,913.80. While prefilled syringe kits can be utilized, they would cost \$7805.34 more annually, an underestimate when considering that holmium laser enucleation of prostate patients require 60 mL of saline for catheter placement, necessitating more saline syringes. As this cost is only limited to the urology department, total hospital savings would be greater if other departments utilized air-filled balloons for short-term perioperative catheters.

There are a few limitations to this study that should be considered when evaluating these findings. Study patients received endoscopic procedures for which they were planned for a trial-of-void within 24 hours. Thus, air-filled balloons should only be tested in short-term catheters. As outcomes can differ based on time of catheter removal,^[6] further investigation is necessary to determine if air-filled balloons are safe for indwelling catheters. Additionally, our study is limited by the small sample size. However, the study is intended to be a proof of concept for air-filled catheters. As we have demonstrated that adverse events are unlikely in short-term catheterizations, a larger controlled study should be conducted to inform practice recommendations.

5. Conclusion

Filling short-term foley catheter balloons with air could be a cost-effective, safe alternative to saline.

Acknowledgments

None.

Statement of ethics

This study was approved by the Northwestern Institutional Review Board, with an approval number: STU00213284. The participants have provided written informed consent to this study. All procedures performed in study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest statement

The authors declare no conflicts of interest.

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Author contributions

AEK: Conceptualization, investigation, writing-revising, and editing;
 MAA: Conceptualization, investigation, data analysis, writing-revising, and editing;
 MBG: Conceptualization, data analysis, investigation, writing-original draft, writing-revising, and editing;
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