

REVIEW ARTICLE

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How Long Is a Transurethral Catheter Necessary in Patients Undergoing Thoracotomy and Receiving Thoracic Epidural Analgesia? Literature Review

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DESPITE THE AGING POPULATION and new lung cancer cases being on the rise, clinicians are forced to be more efficient and more productive without additional resources. Fast-track pathways have been described showing outstanding results, such as a faster recovery process and shorter length of hospital stay, but mainly for abdominal^{1,2} and orthopedic³ surgeries. Although enhanced recovery paths might seem to be an excellent option to solve this problem, there is a scarcity of trials in thoracic surgery in general on this subject.⁴ Therefore, it is essential to implement recovery pathway programs for patients undergoing thoracic surgery. Thoracic epidural analgesia (TEA) is the gold standard to relieve pain after thoracotomy because of its association with severe pain.⁵ Thus, a crucial point to implement a fast-track pathway in thoracic surgery is to offer TEA. It reduces significantly the incidence of postoperative morbidity compared with other types of analgesia.⁶ In contrast, TEA encompasses important side effects. Postoperative urinary retention (POUR) is one of the most frequent, with an average incidence of 26%.⁷ To avoid this complication, it is a common practice to place a transurethral catheter, as long as the epidural is in situ and functioning well.^{8,9} Nevertheless, a urinary bladder catheter impedes early ambulation and can lead to urinary tract infection (UTI), which increases patients' hospital length of stay and governmental costs.

Recent studies have reported that transurethral catheters can be removed earlier safely in thoracic surgery patients.^{8–11} Hence, the goal of the present review was to determine when is the most appropriate timing to remove the bladder catheter in patients undergoing thoracic surgery receiving TEA. This paper reviews the literature to provide recommendations from experts' opinions for both the appropriate removal period of the indwelling bladder catheter and the management of POUR for patients scheduled for thoracotomy receiving working TEA. This review aims to contribute to the building of a fast-track pathway for patients undergoing thoracotomy.

METHODS

A systematic search of the PubMed database was conducted in April 2014, examining the literature during the past 10 years (from August 2003 to December 2013). The search was conducted using the medical subject heading (MeSH) on the topics of "urinary catheter removal" or "indwelling bladder catheter removal" or "transurethral catheter removal". Then those terms were combined with the MeSH words "thoracic surgery" and "postoperative urinary retention" and "thoracic epidural analgesia" or "thoracic epidural catheters". The present review highlights the evidence from published data in the English language excluding animal models and pediatric surgeries. Considering the small numbers of investigations related to the present innovative topic, the current query was designed to encompass randomized clinical trials and observational

studies. In addition, the authors intended to amplify the search using relevant articles selected by cross-referencing. The studies obtained from the MeSH were screened subsequently to identify the abstract trials that were conducted in patients undergoing thoracotomy and receiving a thoracic epidural with an early removal of the indwelling catheter. The latter is defined as a removal of the urinary catheter within 48 hours from the surgery while the TEA was still in situ and functioning. In contrast, a later removal was considered the common practice, which keeps the transurethral catheter until TEA is in place. A template specifically designed to incorporate data of relevance from the articles of interest included: Number of patients, level of epidural insertion, anesthetic solution mixtures injected into the epidural space, type of epidural infusion technique, infusion rate of anesthetic solution administered into the epidural space, volume of the bolus injected associated with continuous infusion and what was the definition of POUR employed in each study. In addition, UTI and average time to first micturition and post-void residual (PVR) data were recorded when reported. Finally, length of bladder catheterization and incidences of POUR in the presence of a running TEA were grouped to calculate their average time and the overall incidences, respectively. When the data of interest were missing in the manuscript, an email was sent to the corresponding author.

RESULTS

This MeSH research identified 123 studies of relevance. Sixty-six studies were rejected from the analysis because they were not written in English, not conducted in human or adult studies, or the abstract was not available. After this first screening, a thorough reading of the remaining 57 abstracts was completed. Finally, only 4 investigations were included for analysis (Fig 1), involving a total of 203 patients who had their transurethral bladder catheter removed in the presence of a working TEA. From the studies selected, 3 were published in 2009 and 1 was published in 2013. From those studies, 2 were randomized controlled trials and 2 were prospective observational

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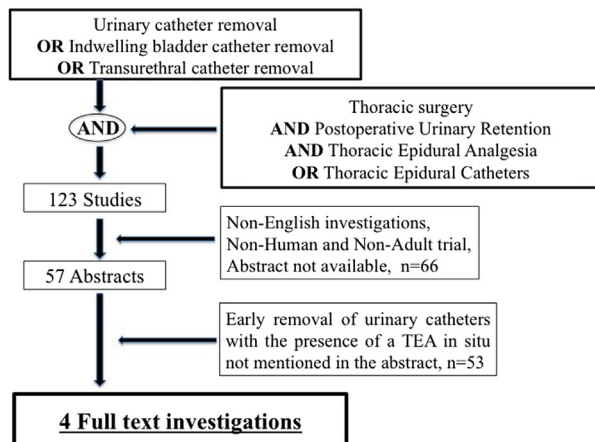


Fig 1. Flowchart of screened, excluded, and included studies.
Abbreviation: TEA, thoracic epidural analgesia.

studies. From the studies included, POUR was the primary outcome in 3 and was the secondary outcome in 1. This latter had as primary outcome the incidence of UTIs. Ladak et al⁹ removed the indwelling catheter in a time frame ranging from 18 to 48 hours. Thus, it was assumed that they discontinued the urinary catheterization, on average, 33 hours after surgery. Similarly, Tripepi-Bova et al¹¹ removed the transurethral catheter in a period ranging from 24 to 48 hours. Again, it was assumed that in this study it was removed, on average, 36 hours after the surgical procedure. The overall median time of transurethral

catheterization was 31.5 hours after surgery. Among the 203 patients who benefited from early bladder catheter removal, 12 developed POUR. Of those, 6 were female and 6 were male. The overall incidence of POUR was 5.9%. The definition of POUR was different among studies analyzed. Chia et al¹⁰ were succinct in their definition, stating that if POUR occurred 6 hours after removal of the bladder catheter, an In and Out insertion was performed. Their method to diagnose POUR was not specified. In contrast, Tripepi-Bova et al,¹¹ Ladak et al,⁹ and Zaouter et al⁸ defined POUR as patients' inability to void when the urinary bladder volume exceeded a predetermined volume (500 mL for Tripepi-Bova et al, 600 mL for Ladak et al, and Zaouter et al). They assessed presence of POUR using ultrasound devices, starting 3 to 4 hours after the catheter removal in the Ladak et al and Zaouter et al studies, or 8 hours after its discontinuation in the Tripepi-Bova et al investigation. Ladak et al did not specify which device they used, but Zaouter et al and Tripepi-Bova et al used a dedicated bladder ultrasound scanner (Bladderscan, BVI 3000; Verathon Medical Inc, Bothell, WA). The characteristics of significance extracted from each study are presented in Table 1. The anesthetic solution mixture was different among the 4 studies considered. Fifty-five patients received a solution containing bupivacaine, 0.1%, with fentanyl (3 µg/mL) in the Zaouter et al study. Chia et al administered bupivacaine, 0.08%, with morphine (0.04 mg/mL) and neostigmine (7 µg/mL) to all their patients. Two different anesthetic mixtures were injected in the Ladak et al investigation; 46 patients received bupivacaine, 0.1%, with hydromorphone (0.015 mg/mL) and 3 patients received ropivacaine, 0.2% only. In the Tripepi-Bova et al investigation, 5

Table 1. Characteristics of the Studies Included in the Review

Authors	Ladak et al	Zaouter et al	Chia et al	Tripepi-Bova et al
Number of patients (n)	49	55	38	61
Type of study	Prospective observational	RCT	RCT	Prospective observational
Gender, M/F	18/31	26/29	19/21	32/29
Level of epidural insertion (n)	T3-T6 (46) T6-T8 (3)	T4-T6 (55)	T5-T8 (38)	T5-T8 (61)
Type of epidural infusion	TPCEA	TEA	TPCEA	TPCEA
Anesthetic solutions infused in the epidural space (n)	Ropivacaine 0.2% (4) Bupivacaine 0.1% + Hydromorphone 15 mcg/mL (45)	Bupivacaine 0.1% + Fentanyl 13 mcg/mL (55)	Bupivacaine 0.08% + Morphine 40 mcg/mL + Neostigmine, 7 mcg/mL (38)	Bupivacaine 0.0625% (3) Bupivacaine 0.1% (6) Bupivacaine 0.125% (2) Bupivacaine 0.0625% + Fentanyl 2 µg/mL (9) Bupivacaine 0.1% + Fentanyl 2 µg/mL (41)
Average epidural continuous infusion rate mL/h	4.6	9	2.5	5.5
Volume of the bolus used during infusion	N/S	N/A	2.5	3.4
Urinary infection rate, n (%)	N/S	0 (0)	0 (0)	0 (0)
Incidence of POUR, n (%)	5 (10.2)	3 (5.4)	0 (0)	4 (6.6)
Length of transurethral catheterization (h)	33	17	30	36

Abbreviations: F, female; M, male; N/S, not specified (author contacted via email but did not reply); N/A, not applicable; POUR, postoperative urinary retention; RCT, randomized controlled trial; T, thoracic dermatome; TEA, thoracic epidural analgesia; TPCEA, thoracic patient-controlled epidural analgesia.

different epidural medications were infused; 38 patients received bupivacaine, 0.1%, with fentanyl (2 µg/mL), 8 patients received bupivacaine, 0.0625%, with fentanyl (2 µg/mL), and 11 patients received bupivacaine only in different concentrations as shown in Table 1. In each investigation, the epidural was kept in situ for different time lengths. Zaouter et al and Tripepi-Bova et al kept it for 5 days on average, Chia et al kept it for 72 hours, and Ladak et al did not mention for how long the epidural was left in situ. To ascertain that TEA was working properly, Zaouter et al reported that an Acute Pain Service (APS) daily assessed the presence of a sensory block. If the epidural was not satisfactory, it was replaced. Tripepi-Bova et al replied to this inquiry by email, reporting that an APS should round daily on patients with epidurals to determine the proper functioning of the TEA. In the Ladak et al and Chia et al studies, no daily assessment was described to ensure that TEA was working efficiently. Only the Zaouter et al and Chia et al investigations reported the incidence of UTI. Tripepi-Bova et al, who were contacted via email, revealed that no patient in their prospective cohort contracted UTI. Overall, no patient developed UTI when early bladder catheter discontinuation was performed (Table 1). Zaouter et al observed that the difference between the 2 randomized groups was statistically significant not only in terms of infection but also in terms of hospital length of stay. Zaouter et al published another paper further describing more specific details about their patients.¹² In this latter paper, they provided the mean with standard deviation (SD) of the length of time necessary to start micturition: 342 (165) minutes. They also have described the 52 patients who did not develop POUR: 33 patients were able to obtain post-void residual volume <200 mL after first micturition, and for the remaining 19 patients, their first PVR was >200 mL. However, among the latter 19 patients, none developed POUR or UTI. For all 52 patients, the mean with standard deviation (SD) of the length of time required to reach post-void residual volume <200 mL was 407 (208) minutes. Another point of interest was reported by Ladak et al. Patients' perceptions related to the presence or absence of the indwelling catheter were recorded through a questionnaire. Results indicated that 76% of patients did not feel discomfort with the presence of the transurethral catheter, but 66% of them stated relief after its removal. More importantly, 18% of the patients enrolled in the Ladak et al investigation did not ambulate when the bladder catheter was inserted. Similarly, Chia et al reported that early urinary bladder catheter removal was associated with more comfort and less pain. Finally, 3 of 4 investigations screened and excluded preoperatively patients at risk of POUR. The Tripepi-Bova et al investigation was the only study that did not screen for a population at risk but did incorporate data on such patients. Four patients at risk were observed prospectively in their trial: 2 had a history of benign prostate hypertrophy and 2 had a history of pelvic surgery. None of them developed POUR.

DISCUSSION

The present review showed that the transurethral catheter could be removed safely on the day after surgery. Among the

203 patients presented in this review, 6 females and 6 males developed POUR, revealing an overall incidence of 5.9%. This incidence was almost fivefold lower than the average incidence reported in the literature⁷ for patients receiving TEA and the same surgery. Data concerning the incidence of UTI in 153 patients were obtained; none of them contracted such catheter-related infection postoperatively. In major thoracic surgery requiring a thoracotomy, the most appropriate length of transurethral catheterization in patients receiving TEA is not established yet. The common practice of placing a bladder catheter in major thoracic surgery as long as TEA is working, is based purely on theoretic assumption regarding the neuraxial blockade that can trigger POUR.

To the best of the authors' knowledge, no literature review has been performed yet exclusively in the field of thoracic surgery. Many recent reviews have discussed this problem thoroughly but looking more at the correlation between the type of analgesia and the incidence of POUR. However, the causes that can trigger POUR are multifactorial involving complex mechanisms. Thus, it might be important to review the incidence of POUR related to surgeries requiring a thoracotomy. Early indwelling catheter removal could be crucial because it can motivate early ambulation, which is one of the most important aspects of the fast-track recovery pathway. In addition, it seems that it could reduce significantly the incidence of UTI and, consequently, the length of hospital stay.⁸ These aspects are of paramount importance, because the number of patients scheduled for thoracotomy is climbing dramatically every year.

Pain

Thoracic surgery causes excruciating pain postoperatively.⁵ It can stimulate the inhibitory sympathetic reflexes significantly and may cause an increased tone of the urinary sphincter and/or a deficiency of the detrusor contraction leading to POUR. Thus, adequate pain relief can deactivate the stress-induced inhibitory sympathetic stimuli and, consequently, favor satisfactory micturition. In the studies reviewed, pain was controlled using TEA, which is considered the gold standard for postoperative pain relief for thoracotomies.⁶ Only Zaouter et al and Chia et al provided information concerning the pain score at the moment of the indwelling catheter removal. Both studies had satisfactory pain relief. The visual analog scale (VAS) score was <4 on coughing or moving and had lower incidence of POUR (3 of 93 points, 3.2%) compared with the Ladak et al and Tripepi-Bova et al studies, which did not yield pain score (9 of 110 points: 8.2%). However, each study used both a different mixture of anesthetic solution and a different volume of continuous infusion.

Anesthetic Solution Mixtures and Volumes Injected

The Ladak et al study,⁹ which had more patients developing POUR, used hydromorphone as an adjuvant to their anesthetic solution. Hydromorphone is known to be more hydrophobic than morphine and less lipophilic than fentanyl. For these latter properties, it seems that it leads to less urinary retention compared with other opioids because its action is limited to the dermatomes of infusion.¹³ Ladak et al used a continuous

infusion of 4.6 mL/hour, on average, which was half of the volume used in the Zaouter et al investigation (9 mL/hour).⁸ However, Ladak et al did not report the volume of the bolus and the lockout of this latter. High volume and brief lockout, theoretically, can increase the incidence of POUR and explain their higher incidence of POUR compared with the other 3 studies.

Chia et al¹⁰ used neostigmine as an adjuvant. Neostigmine is known to reduce the dose of bupivacaine and fentanyl by 13.5% improving the analgesia possibly by 2 mechanisms.¹⁴ One could be a local action on muscarinic and nicotinic receptors and the other one might be through stimuli of the brain's cholinergic receptors. The combination of these 3 drugs might have been the reason for small continuous volume and small bolus injections. In fact, Zaouter et al, who used only bupivacaine and fentanyl, had to infuse a larger volume to relieve pain satisfactorily. Thus, fentanyl could have triggered either a systemic effect or a local effect on the dorsal roots of the spinal cord, leading to higher incidence of POUR compared with the Chia et al investigation. In addition, Zaouter et al might have had a higher incidence of POUR than Chia et al, because they did not use a third adjuvant to spare the volume injected. The results of the Tripepi-Bova et al study¹¹ corroborated these hypotheses, because patients who developed POUR in their trial received bupivacaine + fentanyl (1 patient received bupivacaine, 0.0625%, + fentanyl 2 µg/mL and the other 3 received bupivacaine, 0.1%, + fentanyl 2 µg/mL) with a similar volume injected in the epidural space (8.9 mL/hour; average continuous volume infused was 5.5 mL/hour + average bolus injected 3.4 mL/hour). Adrenaline could have been a drug with volume sparing effect. In fact, Niemi et al¹⁵ showed that adrenaline significantly could improve TEA analgesia, reducing the total dose of bupivacaine and fentanyl injected in the epidural space, lowering the systemic lipophilic effects of fentanyl.

Ways to Identify POUR

An aspect that plays a central role in early bladder catheter removal is the method to identify the presence of POUR. Palpation or percussion both underestimate the presence of urinary retention because they are not sensitive enough and could result in unnecessary bladder catheterization.¹⁶ This latter procedure is invasive and correlated with important complications such as UTIs, urethral trauma, and prostatitis.¹⁷ Measurement of urine volume by ultrasound has been shown to be accurate and easy to perform.¹⁸ Thus, when early urinary catheter discontinuation is planned, it is essential to define POUR appropriately to avoid unnecessary transurethral catheterization and misdiagnose POUR. Help provided from ultrasound devices seems to be a proper choice to determine effectively when indwelling catheters should be reinserted when early removal is performed.

Early Mobilization

Early mobilization is considered to be a fundamental factor in the fast recovery process.¹⁹ A recent review reported that early ambulation in the presence of a TEA is possible and safe for patients undergoing thoracotomy when low doses of both

local anesthetic (ropivacaine or bupivacaine) and opioids are used.²⁰ Zaouter et al⁸ infused one of the highest concentration of bupivacaine in the epidural space with the highest infusion rate (9 mL/hour on average). In their trial, patients were able to ambulate independently on the first postoperative day using a standard method for ambulation consisting of an intravenous pole on wheels. In addition, the results of the Chia et al and Ladak et al studies showed that early discontinuation of the transurethral catheter provided more comfort and less pain. In light of these evocative observations, it could be advocated even more strongly that proceeding with early discontinuation of transurethral drainage could motivate early, safe, independent mobilization, when low doses of epidural medications are infused, and could facilitate a fast-track pathway leading to early hospital discharge and saving costs.

UTI

In contrast, late indwelling catheter removal includes direct complication and indirect financial implications related to the catheter-related UTIs. Independently of its etiology, urinary tract infection is the primary source of healthcare-associated infections, and it leads to a greater number of deaths per year.²¹ In fact, prolonged urinary bladder catheterization has been shown to increase mortality by threefold because of nosocomial infections.²² Infection related to a urinary bladder catheter considerably increases hospitalization expenses, antimicrobial prescriptions, and social repercussions. It has been estimated that each episode of catheter-associated UTI costs nearly \$2,900²³ for a total of \$400 million per year in the United States.²⁴ Benoist et al²⁵ reported that early bladder catheter discontinuation, within the first postoperative day, can reduce the incidence of UTIs from 42% to 20%. Considering these major repercussions, early bladder catheter discontinuation can play a decisive and convincing role.

Which patients are likely to benefit from a transurethral catheter for more than 1 day?

On the basis of this review, patients at no risk of POUR could have their bladder catheter removed safely within 31.5 hours when appropriate monitoring with an ultrasound device is ensured to avoid bladder overdistention and to determine when recatheterization is necessary. Conversely, patients who would benefit from a urinary catheter for more than 1 day are, theoretically, patients presenting conditions known to be at risk of POUR (Table 2). However, Tripepi-Bova et al showed that patients considered to be at greater risk than the rest of the population did not develop POUR. Their results included only 4 patients at risk and they were not powered to make a definite statement on this matter, but they did offer hints for further trials on this topic concerning patients at risk of developing POUR.

In summary, the present review indicated that no patients needed the bladder catheter for more than 1 day when they were at no risk of POUR. Early removal in patients at risk to develop POUR seems possible, but caution is advised because data on only 4 patients were available on this particular concern. More investigations should be performed on this topic in this specific population at risk to confirm such assertion.

Table 2. Conditions Known to Be at Risk for POUR

Medical conditions	Surgical conditions
Creatinine > 160 µmol/L	History of prostatectomy,
Positive uroflowmetry test*	History of proctocolectomy
Benign prostate hypertrophy	History of low anterior resection
Acute UTI	History of pelvic surgery
Abnormal bladder anatomy	
History of neurologic disease with atonic bladder	
History of previous POUR	
ASA V	
UTI indicates urinary tract infection	

*The uroflowmetry test to identify the presence of lower urinary tract flow obstruction based on the flow rate of urine over time. Abbreviations: ASA, American Society of Anesthesiologists; POUR, postoperative urinary retention; UTI, urinary tract infection.

Limitation

The first main limitation of this review was that the data obtained were restricted to only 4 studies. All except for the 4 patients enrolled in these 4 investigations were at no risk of POUR. At first glance, clinicians might be surprised by the results revealing that the number of women who developed POUR was equal to the number of men, because men are more susceptible to POUR because of benign prostate hypertrophy and anatomic disposition. The reason was that, overall, only 4 of 203 patients were at risk to develop POUR. Thus, the results presented in this review cannot be generalized to the overall thoracic surgery population. Further studies should be conducted in the population at risk to evaluate whether this strategy of early transurethral discontinuation is rational as well. The Tripepi-Bova et al results indicated that it could be possible. None of the 4 patients at risk had POUR. This review

included patients undergoing thoracotomy and receiving the same postoperative analgesia technique, but the anesthetic solution and the volume injected in the epidural space were different among the studies analyzed. This might explain the slightly different results among the investigations retained. However, the incidence of POUR was similar among the different studies and nearly fivefold lower compared with the incidence reported in the literature, showing that early removal is feasible and safe. Finally, the definition of POUR was not unanimous. This latter might have jeopardized the results as well, allowing false positive when ultrasound technology was not used.

CONCLUSION

Early transurethral discontinuation after thoracotomy is a topic of extreme importance for the outcome of patients scheduled for this procedure. Although there is a paucity of publications reporting that this early discontinuation can be performed, the present review claimed that transurethral catheter could be discontinued safely on the day after surgery in the presence of TEA. When early bladder catheter removal was executed, incidence of POUR was low. In addition, it promoted early patient mobilization, reducing pain and discomfort. Early independent mobilization in the presence of TEA was possible and safe when low doses of epidural medications were infused. An early removal also significantly reduced the incidence UTI, allowing shorter length of hospital stay and cost savings. Therefore, institutions where thoracic surgeries are performed should consider establishment of enhanced recovery pathway programs after surgery, starting to remove indwelling catheters on the first postoperative day in patients with TEA, and using ultrasound devices to determine if POUR is occurring.

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