Computed tomography versus ureteroscopy in identification of renal tract stone with ureteral stent in situ

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ABSTRACT

INTRODUCTION The aim of this study was to validate the use of non-contrast computed tomography (CT) with a ureteral stent in situ instead of ureteroscopy for identification of renal tract stones.

METHODS All patients who had stents inserted for renal tract stones and underwent non-contrast CT with the stent in situ followed by ureteroscopy between May 2008 and October 2009 at The Canberra Hospital, Australia, were analysed retrospectively. Statistical analysis was performed to compare any differences between CT and ureteroscopy in the identification of stones.

RESULTS Overall, 57 patients were included in the study. The difference between CT and ureteroscopy findings was statistically significant. CT identification of stones with a stent in situ had a sensitivity of 86%, a specificity of 46%, a positive predictive value of 63%, a negative predictive value of 76% and an accuracy of 67%.

CONCLUSIONS Our study suggests that non-contrast CT is inferior to the 'gold standard' of ureteroscopy. It lacks sensitivity, specificity, positive predictive value, negative predictive value and accuracy. Therefore, we cannot recommend using non-contrast CT to replace ureteroscopy.

KEYWORDS

Computed tomography – Ureteral stent – Ureteroscopy – Calculi

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Non-contrast helical computed tomography (CT) is well validated in diagnosing urinary tract stone disease. It has been shown that this technique is superior to all other imaging modalities with a 97% sensitivity and a 96% specificity in detecting renal tract calculi.¹ Nevertheless, using CT to diagnose stones in the urinary tract with a ureteral stent in situ is more difficult due to the complexity in differentiating between the stent and stones. Tanrikut *et al*² and Yoshida *et al*³ suggested that stone density has a Hounsfield unit value of between 400 and 1,600 whereas a ureteral stent has a Hounsfield unit value of over 2,000. When using abdominal window settings to analyse CT, it is difficult to differentiate between stent and stone because they would have a similar bright white appearance. By using bone window settings, however, there would be a visual distinction between the stent and stone.^{2,5}

The method of using bone window settings in the diagnosis of a stone with a stent in situ has not yet been validated. In our study, we attempted to validate this method by comparing the results of CT and ureteroscopy in identification of renal tract stones with a ureteral stent in situ. Ureteroscopy is often perceived as the current 'gold standard' as it allows clinicians to directly visualise stones in the renal

tract. In spite of this, it is still possible to miss small stones with ureteroscopy.

If CT were proven to be as good as ureteroscopy, then clinicians could safely rely on CT to pre-operatively diagnose stone clearance with a stent in situ. This would have implications for the type of surgery offered to patients, namely local anaesthetic removal of ureteral stents versus the more invasive and more time consuming ureteroscopy procedure. This would ultimately offer improvements in theatre efficiency.

Methods

All patients who had stents inserted for renal tract stones and underwent non-contrast CT with the stent in situ followed by ureteroscopy between May 2008 and October 2009 at The Canberra Hospital, Australia, were analysed retrospectively.

Helical CT was performed using a 1mm slice collimation without intravenous or oral contrast administration. CT was reported in bone window settings to determine the presence and size of stones by consultant radiologists from the same department.

All patients underwent both semirigid and flexible ureteroscopy to further investigate the presence of stones. The

Table 1 Time interval between computed tomography and ureteroscopy

	All patients	True positive	True negative	False positive	False negative
Median time (days)	12	14	31	7	29.5
Range (days)	0–57	1–57	1–54	0–19	1–34

Table 2 Distribution of stone sizes and positions

Stone position	Stone size		
	<4mm	4–6mm	>6mm
Kidney	4	7	10
Ureter	5	6	8

Table 3 Comparison of computed tomography (CT) against ureteroscopy for identification of stones

CT	Uteroscopy	
	True positive	True negative
True positive	25	15
True negative	4	13

McNemar's test: $\chi^2=5.26$, $df=1$, $p=0.0218$ (two-tailed)

procedures were carried out either by consultant urologists or senior registrars who had previously performed over 150 semirigid and flexible ureteroscopies.

Statistical analysis was performed using R statistical software (<http://www.r-project.org/>) without statistician involvement. The null hypothesis of the study was that there would be no difference between CT and ureteroscopy in detecting stones with a ureteral stent in situ. McNemar's test was used to compare differences in the identification of stones between CT and ureteroscopy. A difference with a p -value of <0.05 was considered statistically significant. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of CT were compared to those of ureteroscopy.

Results

A total of 57 patients met the criteria of having had ureteral stents inserted for renal tract stones and subsequently undergoing non-contrast CT with a stent in situ followed by ureteroscopy. All patients underwent ureteroscopy within 57 days (median: 12 days, range: 0–57 days) of CT (Table 1). Stone sizes identified by CT were measured with a median diameter of 4mm (range: 0–18mm). Stone sizes and positions were further classified (Table 2).

CT suggested that 40 of the 57 patients had stones and 17 did not while ureteroscopy suggested that 29 patients had stones and 28 did not. The true positives, false positives, true negatives and false negatives are shown in Table 3. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of using CT identification of stones with a stent in situ were calculated against ureteroscopy and were 86%, 46%, 63%, 76% and 67% respectively.

Discussion

Non-contrast CT used in the diagnosis of renal tract stones without ureteral stents in situ has been shown to be superior to ureteroscopy in terms of sensitivity, specificity, positive predictive value, negative predictive value and accuracy (97%, 96%, 96%, 97% and 97% respectively).^{1,4–15} In particu-

lar, using CT for following up residual fragments after stone treatment can reduce unnecessary follow-up ureteroscopies by up to 20% and can therefore save theatre time and cost.¹⁵

Conversely, our results suggest non-contrast CT is inferior in identifying stones when a ureteral stent is in situ. The inherent radiation risk for a single non-contrast CT scan (~4.9mSv) and a potentially fatal cancer risk (~1 in 10,000)¹⁴ therefore make routine use of CT as opposed to ureteroscopy unjustifiable in this situation. In 2007 the results of an investigation into using ultra-low dose CT with a radiation dose close to a plain abdominal x-ray were published.¹⁵ It was reported to have comparable results to full dose CT in identifying stones in renal colic. However, the sensitivity can be affected by a number of factors including stone size and body mass index. Its use in identifying stones with a stent in situ has not been investigated; the accuracy is therefore unknown.

The low sensitivity, specificity, positive predictive value, negative predictive value and accuracy in this study were due to the relatively high number of false positive and false negative results. The false positive and false negative groups were examined further.

In the false positive group of 15 patients, all patients received ureteroscopy within 19 days (median: 7 days) of CT (Table 1). The relatively small time interval between CT and ureteroscopy indicates it is unlikely that the false positivity was caused by stones passing spontaneously. We therefore believe that the false positive result is a genuine finding. Of course, the false positive result could be explained by CT being more accurate in identifying stones than ureteroscopy (eg one can identify very small stones with CT whereas these would be missed with ureteroscopy).

In the false negative group of four patients, all patients received ureteroscopy within 34 days (median: 29.5 days) of CT (Table 1). It is therefore unlikely that new stone formation or stent encrustation caused the false negative findings.

Conclusions

Our study found that CT was inferior to ureteroscopy in identifying stones in the renal tract when a ureteral stent is in situ. We cannot therefore recommend using non-contrast CT to replace ureteroscopy in this situation.

References

- Smith RC, Verga M, McCarthy S, Rosenfield AT. Diagnosis of acute flank pain: value of unenhanced helical CT. *Am J Roentgenol* 1996; **166**: 97–101.
- Tanrikut C, Sahani D, Dretler SP. Distinguishing stent from stone: use of bone windows. *Urology* 2004; **63**: 823–826.
- Yoshida S, Hayashi T, Okada T *et al.* Discrimination between ureteral stent and stone by non-contrast helical computed tomography in the clinical setting. *Int J Urol* 2007; **14**: 171–173.
- Boulay I, Holtz P, Foley WD *et al.* Ureteral calculi: diagnostic efficacy of helical CT and implications for treatment of patients. *Am J Roentgenol* 1999; **172**: 1,485–1,490.
- Dorio PJ, Pozniak MA, Lee FT, Kuhlman JE. Non-contrast-enhanced helical computed tomography for the evaluation of patients with acute flank pain. *WMJ* 1999; **98**: 30–34.
- Chen MY, Zagoria RJ. Can noncontrast helical computed tomography replace intravenous urography for evaluation of patients with acute urinary tract colic? *J Emerg Med* 1999; **17**: 299–303.
- Chen MY, Zagoria RJ, Saunders HS, Dyer RB. Trends in the use of unenhanced helical CT for acute urinary colic. *Am J Roentgenol* 1999; **173**: 1,447–1,450.
- Vieweg J, Teh C, Freed K *et al.* Unenhanced helical computerized tomography for the evaluation of patients with acute flank pain. *J Urol* 1998; **160**: 679–684.
- Fielding JR, Fox LA, Heller H *et al.* Spiral CT in the evaluation of flank pain: overall accuracy and feature analysis. *J Comput Assist Tomogr* 1997; **21**: 635–638.
- Dalrymple NC, Verga M, Anderson KR *et al.* The value of unenhanced helical computerized tomography in the management of acute flank pain. *J Urol* 1998; **159**: 735–740.
- Pires C, Machet F, Dahmani L *et al.* Sensitivity of abdominal radiography without preparation compared with computed tomography in the assessment of residual fragments after percutaneous nephrolithotomy. *Prog Urol* 2003; **13**: 581–584.
- Osman Y, El-Tabey N, Refal H *et al.* Detection of residual stones after percutaneous nephrolithotomy: role of nonenhanced spiral computerized tomography. *J Urol* 2008; **179**: 198–200.
- Pearle MS, Watamull LM, Mullican MA. Sensitivity of noncontrast helical computerized tomography and plain film radiography compared to flexible nephroscopy for detecting residual fragments after percutaneous nephrostolithotomy. *J Urol* 1999; **162**: 23–26.
- Berrington de González A, Mahesh M, Kim KP *et al.* Projected cancer risks from computed tomographic scans performed in United States in 2007. *Arch Intern Med* 2009; **169**: 2,071–2,077.
- Poletti PA, Platon A, Rutschmann OT *et al.* Low-dose versus standard-dose CT protocol in patients with clinically suspected renal colic. *Am J Roentgenol* 2007; **188**: 927–933.