Comparison of urinary stone and stent encrustation biochemical analysis

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Objective To compare biochemical analysis of stent encrustation with that of urinary stones from the same patient.

Patients and Methods Patients were enrolled prospectively from February to December 2000. Any patient presenting with a symptomatic ureteric or renal calculus that required stenting and delayed calculus retrieval was enrolled in the study. The stent and stone were sent for biochemical analysis to the same laboratory and analysed by a qualitative and semi-quantitative chemical technique.

Results A total of 50 stents and matched calculi were available for comparison. Two of these patients had open ureterolithotomy, the remainder were treated by endoscopic or percutaneous means. Four stents were excluded due to insufficient encrustation for analysis. Every stone containing calcium oxalate had a stent that was positive for calcium oxalate. Four uric acid stones were available for comparison, and three of the four matched stents tested positive for uric acid.

Conclusion Biochemical analysis of urinary stent encrustation is a good predictor of urinary stone composition, especially for calcium oxalate containing stones. Uric acid stent encrustation is likely to occur in patients with uric acid stones.

Keywords urinary calculi, ureteric stent, stone analysis

Introduction

Urinary stone disease remains a common disorder. Approximately half of all patients presenting with a urinary stone will have a second attack within ten years[1]. Metabolic evaluation is advised for patients with recurrent or multiple stones, medical conditions predisposing to stone formation or a strong family history. Stone analysis is an important part of this evaluation, however occasionally a stone is not available for analysis. This may occur as a result of spontaneous passage or fragmentation by extracorporeal shock-wave lithotripsy (SWL).

Ureteric stents have fundamentally altered the management of urinary stone disease and ureteric obstruction from any cause. Stent insertion may be complicated by pain, lower urinary tract symptoms and encrustation. Several papers have addressed the aetiology of encrustation and developed polymers that may reduce its formation[-5]. The aim of this study was to determine whether there was any diagnostic value to the biochemical analysis of stent encrustation and how this analysis compared with that of urinary stones from individual patients.

Patients and Methods

Patients presenting with urinary stones who required intervention due to ongoing pain, fever or impaired renal function were enrolled prospectively. Our practise is to stent patients for a period of time before definitive stone removal, as the resulting ureteric dilatation facilitates subsequent ureteroscopy. We used 4.8 FG Microvasive (Boston Scientific) Contour Variable Length pigtail stents, which are made from Percuflex, a

proprieteric co-polymer with a hydrogel hydrophilic coating. Patients were given intravenous aminoglycosides prior to stent insertion and removal.

Following retrieval the urinary stone and stent were sent to the same laboratory for biochemical analysis. Mean duration of stenting overall was 46.3 days (range 14 – 91). In the patients with encrustation sufficient for analysis mean duration was 44.5 days (range 14 – 91), compared to those with insufficient encrustation whose mean was 61 days (range 24 – 90). Stents with obvious encrustation were scraped and the material was then mixed with distilled water before centrifugation and analysis of the sediment. Stents without macroscopic encrustation were washed with distilled water then centrifuged, usually generating sediment adequate for analysis.

Analysis was by a semi-quantitative chemical technique using the Merckognost urinary calculi analysis system. A stone or encrustation solution was prepared and the amount of calcium present was determined by titration. Oxalate, phosphate, magnesium, ammonium, uric acid and cystine fractions were determined by colourimetry. If a stone or stent encrustation had more than one component, these were recorded as major and subsidiary constituents.

Results

A total of 50 stents and stones from 48 patients were available for comparison. Four stents were excluded due to insufficient encrustation material for adequate analysis.

The stones were removed by a variety of methods (Table 1). The majority were removed by ureteroscopy, while the remainder were removed by percutaneous nephrolithotomy or ureterolithotomy.

The most common stone constituent was calcium oxalate (42/46, 91%), with or without calcium phosphate. A further 7 stones (7/46, 15%) contained uric acid either as the major or subsidiary constituent.

A comparison of the biochemical analyses of the stone and stent encrustation is shown in Table 2. Stent encrustation composition was an excellent predictor of stone composition in the calcium containing stones, with 41 of the 42 calcium containing stones having a corresponding stent which tested positive for calcium oxalate with or without calcium phosphate. Struvite was detected as a minor constituent in seven of the calcium containing stones, but was not found on any of the stents. Five (71%) of these patients took oral antibiotics during the period of stenting.

Urinary stent encrustation composition was also a reasonable predictor of the uric acid stones. 3 out of 4 patients (75%) with pure or predominantly uric acid containing stones had stents test positive for uric acid. There were also three calcium stones with uric acid as a subsidiary constituent, and two of these patients had a stent that tested positive for uric acid (2/3, 67%).

Discussion

The management of urinary calculi has two priorities. Immediate management is concerned with relieving obstruction if the stone does not pass spontaneously, in

particular for patients with ongoing pain, sepsis or impaired renal function. Initial treatment will vary depending on the position and size of the stone and other patient factors. Options include primary ureteroscopic stone removal or stenting and delayed SWL, ureteroscopy or percutansous nephrolithotomy. Subsequent management aims to prevent recurrent stone formation. This may include metabolic assessment, dietary and lifestyle advice or medications.

Investigation of patients with stone disease is tailored according to the number of previous episodes and other risk factors for recurrent stone formation. Stone analysis is accepted as an essential part of any stone workup[6,7]. The appearance of a stone on plain X-ray, that is, whether radiolucent or radiopaque, may be helpful in determining a stone type, however the relatively low sensitivity of plain X-rays makes non-contrast helical CT scan the preferred imaging modality for renal colic[12]. Plain X-rays are still used in some institutions as a surrogate method of predicting stone composition. The finding of a radiopaque calculus on plain imaging is diagnostic of a calcium-containing stone. In contrast the absence of a stone on X-ray may be due to interference by skeletal structures, bowel gas or stool, and is not diagnostic. Hounsefield unit density on noncontrast computed tomography to determine stone composition is another method under investigation with encouraging results in vivo[8,11].

The stone analysis in this study was a chemical technique, which was the only one available at our institution. Although more sophisticated physical techniques of stone analysis may have certain advantages, most authors agree that chemical analysis is a useful and efficient method [4,6]. In any case, the same method was employed for both the stone and encrustation material in our study.

Paradoxically, the period of stent indwelling time did not influence the presence and degree of encrustation. This may relate to variations in fluid intake or urinary composition between patients. It is difficult to advise a minimum amount of time required for encrustation to develop which is adequate to analysis. The lower limit of our range of patients with encrustation sufficient for analysis (14 days) could be used as a guide.

The popularity of less invasive forms of intervention for stone disease, such as SWL or ureteroscopic lithoclast with spontaneous fragment passage, means that a stone is not always available for analysis. An attempt at circumventing this problem has been suggested by one group, with urine collection immediately after SWL and subsequent fragment analysis[9], but this is inconvenient and time consuming for the patient. Spontaneous stone passage without retrieval is another situation where stone analysis is not possible.

We have proposed a novel investigation for the patient in whom a stone is not available for analysis, with analysis of stent encrustation providing a useful predictor of stone composition. To our knowledge such a comparison has not been made previously. Past studies have characterised ureteric stent encrustation by a variety of methods[3,4,10]. Although struvite could not be detected in urinary stent encrustation, this may be a consequence of antibiotic use during insertion of the stents or while they were indwelling. Although this represents a slight deficiency of the investigation, the presence of struvite is usually made obvious by the patient's presentation and the radiographic appearance of the stone. The value of our investigation lies in its ability to

differentiate patients with calcium containing stones from pure or mixed uric acid stones. This has important management implications both in the treatment of existing stones and in the prevention of future stone formation.

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Table 1

METHOD OF STONE REMOVAL	NUMBER OF STONES
Ureteroscopy	43
Percutaneous nephrolithotomy	4
Open ureterolithotomy	2
Extracorporeal lithotripsy	1

Table 2

STONE COMPOSITION			STENT ENCRUSTATION COMPOSITION	
Main constituent	*Subsidiary constituent*	*Number of stones / stents*	*Main constituent*	*Subsidiary constituent*
Calcium	nil	32	31/32 Calcium	-
Calcium	Struvite	7	7/7 Calcium	0/7 Struvite
Calcium	Uric acid	3	3/3 Calcium	2/3 Uric acid
Uric acid	Calcium	3	2/3 Uric acid	3/3 Calcium
Uric acid	nil	1	1/1 Uric acid	-