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Case Report

Bilateral extracorporeal shock wave lithotripsy in a spinal cord injury patient with a cardiac pacemaker

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Objectives: To review the precautions to be observed before and during extracorporeal shock wave lithotripsy (ESWL) in spinal cord injury (SCI) patients with a cardiac pacemaker and the safety of bilateral ESWL performed on the same day.
Design: A case report of bilateral ESWL in a SCI patient with a permanent cardiac pacemaker.
Setting: The Regional Spinal Injuries Centre, Southport, the Lithotripsy Unit, the Royal Liverpool University Hospitals NHS Trust, Liverpool, and the Department of Cardiology, Manchester Royal Infirmary, Manchester, UK.
Subject: A 43-year-old male sustained a T-4 fracture and developed paraplegia with a sensory level at T-2. During the post-injury period, he developed episodes of asystole requiring implantation of a dual chamber (DDD) permanent pacemaker. Twenty-one months later, he developed a right ureteric calculus with hydronephrosis. A radio-opaque shadow was seen in the left kidney with no hydronephrosis. During right ureteric stenting, the ureteric stone was pushed into the renal pelvis. 1,500 shock waves were delivered to this stone on the right side, followed by ESWL to the left intra-renal stone with 1250 shock waves.
Results: The patient tolerated ESWL to both kidneys. The pacemaker was reprogrammed to a single chamber ventricular pacing mode at 30 beats per minute with a reduced sensitivity during lithotripsy. There were no untoward cardiac events during or after lithotripsy. The serum creatinine was 45 μmol/l before lithotripsy and 44 μmol/l two weeks after ESWL.
Conclusion: SCI patients with a cardiac pacemaker may be able to undergo extracorporeal shock wave lithotripsy following temporary reprogramming of the pacemaker. Bilateral, simultaneous ESWL is safe in the vast majority of patients provided that there is no risk of simultaneous ureteric obstruction by stone fragments. However, it should be remembered that a decrease in renal function could occur following bilateral ESWL of renal calculi.
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Keywords: extracorporeal shock wave lithotripsy; pacemaker; kidney-calculi; spinal cord injury

Introduction

Spinal cord injury and cardiac pacemaker

Bradycardia followed by cardiac arrest may occur in the patients with high spinal cord injury (SCI). This life-threatening condition is attributed to an imbalance in the autonomic nervous system resulting from dissociation of the parasympathetic from the sympathetic responses during the stage of spinal shock. SCI patients with continuing symptomatic bradycardia not responding to medical measures may require permanent cardiac pacing.[1]

Upper urinary calculi in SCI patients

SCI patients are at increased risk of urolithiasis. Patients with high spinal cord injury have profound changes in the physiology of the cardio-vascular and respiratory systems. Therefore, these SCI patients form a distinct group in contrast to able-bodied individuals

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with renal calculi. The policy of treatment of renal calculi in the patients with an intact neuraxis may not be applicable to SCI patients with compromised cardiopulmonary function. Extracorporeal shock wave lithotripsy (ESWL) remains the preferred treatment for renal calculus in a SCI patient.[2] The presence of infected stones, prior operative procedures, and medical complexity of the patients with SCI make complications after percutaneous nephrolithotomy more frequent and militates against this modality of treatment.

Cardiac pacemaker and shock wave lithotripsy

The presence of a cardiac pacemaker was previously thought to be an absolute contraindication for extracorporeal shock wave lithotripsy of urinary calculi. Cooper and associates[3] found that a single-chamber pacemaker functioned well when exposed to shockwaves. However, ESWL induced inhibition of the ventricular output in some dual-chamber pacemakers that are triggered by atrial-paced events. On this basis, Cooper and associates[3] recommended that dual-chamber pacemakers with atrial sensing be reprogrammed to the ventricular single-chamber (VVI) mode during ESWL.

A review of 131 pacemaker patients who received 142 ESWL treatments revealed pacemaker-related complications in four. None of the complications was fatal. No patient required replacement of the pacemaker.[4] The most serious problem was a change in pacing mode. The pacemaker was immediately reprogrammed without patient injury. The other patients developed irregular heart rhythms, although in one case more than 22 kV was used for ESWL. None of the three patients experienced serious adverse effects. Albers and associates[5] successfully treated 20 patients with various types of pacemakers. The number of shock waves utilised in treatment ranged from 300 to 2400, with an average of 1380. The kilovoltage ranged from 18 to 21. Dual-chamber pacemakers were reprogrammed to function as single-chamber devices immediately prior to ESWL. Abdominal pacemakers were excluded from the blast path. No patient experienced incidents requiring cardiovascular consultation during ESWL.

We report treatment of bilateral renal calculi by ESWL in a spinal cord injury patient with a dual-chamber pacemaker. ESWL of a right renal pelvic stone was performed followed immediately by ESWL of a left renal stone.

Case report

A 43-year-old male sustained a T-4 fracture and developed paraplegia with a sensory level at T-2 in August 1998. During the post-injury period, he developed episodes of transient asystole, and a dual chamber (DDD) permanent pacemaker (Medtronic Thera D Model 7964i) was implanted in the left pectoral region three months after injury (Figure 1).

This patient had an indwelling urethral catheter for drainage of his neuropathic bladder. He developed a temperature of 40°C with rigors in May 2000. An abdominal X-ray showed a radio-opaque shadow in the line of right ureter at the L3/4 level, and another shadow in the left kidney (Figure 2). Intravenous urography (IVU) showed marked right hydronephrosis. A radio-opaque shadow was seen in the pelvis of left kidney; but there was no hydronephrosis on this side (Figure 3).

The plan of treatment was to stent the right ureter followed by ESWL of both renal calculi. Cystoscopy showed multiple stones in the bladder. Electrohydraulic lithotripsy of the vesical calculi was performed. A 6F stent was inserted in the right ureter under fluroscopic guidance. During stent insertion, the ureteric stone was pushed into the renal pelvis (Figure 4).

During 18-months follow-up following pacemaker implantation, ECGs had consistently shown normal sinus rhythm. The pacemaker was therefore reprogrammed to a single chamber ventricular pacing mode at 30 beats per minute immediately prior to lithotripsy. In addition, the ventricular sensitivity setting was reduced to prevent inappropriate sensing of shock waves with its consequent risk of inappropriate inhibition of pacemaker activity. 1500 shock waves were delivered to the right renal pelvic stone. The output voltage was initially 14 kV, and it was increased to 15 kV during treatment. Immediately after therapy to the right kidney stone, the left renal stone was treated by ESWL with 1250 shock waves.

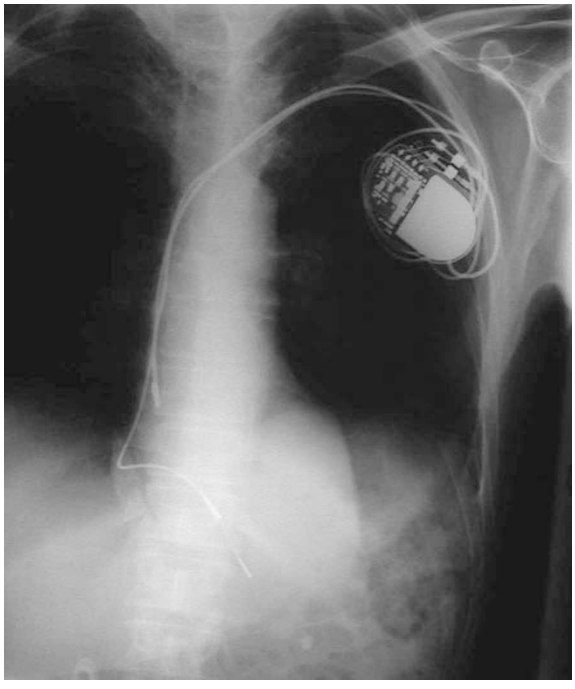

Figure 1 Chest X-ray shows cardiac pacemaker in the left pectoral region

Figure 2 X-ray KUB shows a radio opaque shadow in the line of right ureter at L3/4 level, and another shadow in the left kidney

Figure 3 15 minutes film of intravenous urography shows marked right hydronephrosis. A radio opaque shadow is seen in the pelvis of left kidney; but there is no hydronephrosis

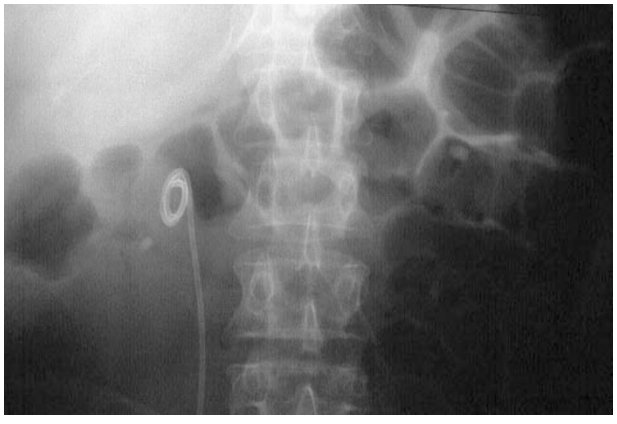

Figure 4 Following insertion of a stent in the right ureter, the ureteric calculus has been pushed in to the renal pelvis

The output voltage ranged from 14 to 15 kV. There were no cardiac problems during lithotripsy. After completion of ESWL, the pacemaker was reprogrammed to the usual dual-chamber pacing settings. Serum biochemistry showed urea to be 3.6 mmol/l and creatinine 45 μmol/l on the day of lithotripsy. Two weeks later, the urea and creatinine concentrations were 2.7 mmol/l and 44 μmol/l respectively. Follow-up X-ray of the abdomen revealed no residual stone fragment in the kidneys or the ureters. The right ureteric stent was removed 4 weeks later. The pacemaker continues to work normally.

Discussion

This patient with a cardiac pacemaker underwent bilateral ESWL of kidney stones on the same day without developing any cardiac or renal complication. However, the safety aspect of bilateral, simultaneous ESWL remains controversial.

Simultaneous versus staged ESWL of bilateral renal calculi

By and large, ESWL has been shown to be a safe and effective treatment for most renal and ureteric calculi. However, the safety of simultaneous bilateral ESWL has not been established. Whether bilateral treatments should be separated in time to minimise loss of renal function is a very controversial issue. Whereas it is convenient for the patient as well as the staff to administer bilateral treatments one after the other on the same day, Chandhoke[6] feels that the convenience should be a secondary issue compared to the issue of preserving renal function. Because there is no evidence that an untreated contralateral kidney aids the long-term recovery of the function of a treated kidney in all cases, simultaneous or separate bilateral renal ESWL would not influence the long-term reduction in renal function. ESWL of multiple renal stones and repeated ESWL are often associated with long-term reduction in renal function.[7]

Pienkny and Streem[8] studied 319 patients who had both kidneys treated simultaneously and 41 who were treated in a planned, staged fashion with the ESWL procedures separated by 3–20 weeks. The effects of simultaneous *versus* staged ESWL on renal function as measured by serum creatinine were not statistically significant using a multiple regression model which corrected for the effects of stone burden, number of shock waves, patient age, pre-treatment serum creatinine and length of follow-up ($P=0.19$). Therefore, these authors concluded that there is no clinically apparent difference in the long-term effect on renal function for patients with bilateral renal calculi treated with ESWL in a simultaneous *versus* staged fashion. Physicians caring for spinal cord injury patients should however remember that serious complications such as irreversible acute renal failure,[9] and acute pancrea-

titis[10] have been reported after bilateral ESWL. An important consideration, which must be made, is that the risk of ureteric obstruction due to stone fragments must be minimal. Either or both ureters should be stented if there is any risk of acute ureteric obstruction.

Precautions to be observed while performing ESWL in patients with cardiac pacemaker[5]

A cardiologist should be consulted to assess the patient and the pacemaker prior to ESWL. In patients who are pacemaker dependent (ie patients with little or no underlying cardiac rhythm), pacemaker failure may be catastrophic. ESWL should not be undertaken in these patients unless facilities for emergency pacing are immediately available. Most modern defibrillators are capable of transcutaneous (external) pacing but in the absence of a suitable device in the lithotripsy room, facilities for immediate transvenous pacing should be available. An experienced pacemaker technician should be present during lithotripsy and the ECG should be continuously monitored. Rate-responsive pacemakers may pace at an artificially high rate if the sensor detects energy from the shock wave and should be programmed to a non-rate-responsive mode during ESWL. Dual-chamber pacemakers should be programmed to a single-chamber ventricular pacing mode (VVI) with reduced sensitivity. Almost all pacemakers are implanted in the pectoral region, but in the small number of patients with abdominal pacemakers, a distance of 5 cm between the nearest edge of the pacemaker pulse generator and the blast path should be allowed for safe lithotripsy. This distance can be determined before ESWL by a study of the plain abdominal radiograph with measurement of the space between the stone and the pacemaker. Lithotripsy should be discontinued if any abnormal rhythm develops. Patients with poor ventricular function who cannot tolerate single-chambered pacing should be excluded from ESWL.

Summary

In conclusion, SCI patients with a cardiac pacemaker may be able to undergo extracorporeal shock wave lithotripsy provided that the patient is assessed by a senior pacemaker technician before lithotripsy and appropriate changes are made to the programming of the pacemaker before, and after ESWL. Bilateral simultaneous ESWL may be safe in the vast majority of patients, but a decrease in renal function may occur following bilateral ESWL of renal calculi.

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