Ungated extracorporeal shock wave lithotripsy: safe and effective in the pediatric population

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Purpose: *Ungated extracorporeal shock wave lithotripsy (SWL) is unsynchronized to the patient's electrocardiogram. Although ungated extracorporeal shock wave lithotripsy (SWL) is associated with cardiac arrhythmias in adults, the incidence of arrhythmias in children has not been established. We report on the safety and efficacy of ungated SWL of renal calculi in children.*

Materials and methods: *We evaluated all children less than 18 years of age undergoing ungated SWL for renal calculi. Lithotripsy with gradual incremental energy increase was used to treat the stones. Patients were monitored for arrhythmias and other standard monitoring intraoperatively and postoperatively.*

Results: *Twenty-four consecutive children (10 boys and 14 girls) between 3.5 and 17 years of age underwent 32 ungated SWL procedures for renal calculi. The stone size ranged from 5 mm to 19 mm. No patient had cardiac arrhythmias or other intraoperative complications, required to have the procedure terminated prematurely, or conversion to gated SWL. The overall stone free rate was 87% based on radiographic imaging.*

Conclusions: *This series supports our initial series that ungated SWL is safe and efficacious in children less than 18 years of age. The arrhythmias associated with adults do no appear to occur in children undergoing ungated SWL.*

Key Words: extracorporeal shockwave lithotripsy, ungated, urinary calculus, arrhythmias, pediatrics

Introduction

Extracorporeal shock wave lithotripsy (SWL) is established as a first line treatment for urinary calculi in children.[1-3] Newman et al successfully demonstrated the safety of SWL in the pediatric population with their initial experience in 1986.[4] In adults, SWL has been performed gated (synchronized shocks to the patient's electrocardiogram reading) and ungated (synchronized to an external fixed rate signal generator). Cardiac arrhythmias is an established complication of SWL in adults using the ungated method in up to 21% of patients.[5] However, we first reported on the safety of ungated SWL in children with our initial series of eight patients.[6] The purpose of the current study is to report on the safety and efficacy after a significantly greater experience using this technique in the pediatric population.

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Materials and methods

We evaluated all patients younger than 18 years of age who underwent ungated SWL of renal calculi. All procedures were performed by a single surgeon while the patient was under general anesthesia. Several different lithotripters were used in the series patients due to them being treated in several surgical facilities. Exclusion criteria were a history of arrhythmias and other cardiac conditions. Patients were monitored continuously for arrhythmias as well as the other vital signs per standard protocol in the operating room and postanesthesia care unit. Data regarding stone size, stone free rate, power settings, and complications were collected. Patients were evaluated at least 4 weeks postoperatively with renal and bladder ultrasonography and abdominal radiography.

Results

Twenty-four consecutive children (10 boys and 14 girls) between 3.5 and 17 years of age (median 12.7 years) underwent 32 SWL procedures for renal calculi. Twenty-seven of the 32 stones were located in the left kidney and five stones were located in the right kidney. The stone size ranged from 5 mm to 19 mm. All patients underwent lithotripsy with gradual incremental energy increase from 17 kv to 24 kv except one child (maximum of 18 kv) due to patient's age. No patients had cardiac arrhythmias intraoperatively or postoperatively, or required conversion to gated SWL. There were no other intraoperative complications or postoperative steinstrasse. Only two patients required postoperative acetaminophin with codeine. The overall stone free rate was 87% based on abdominal radiograph and renal/bladder ultrasonography.

Discussion

SWL is indicated as a first line in the pediatric population for renal stones less than 20 mm and proximal ureteral stones less than 10 mm without evidence of hydronephrosis or urinary infection.[1] Our series demonstrated a 87% stone free rate in children while the reported range in the literature varies from 52%-98%.[1-4,7-10] Some series note higher stone free rates with the treatment of ureteral calculi relative to renal calculi[2,9] while others show no difference with regards to stone location in children.[3,10]

The use of ungated SWL represents an advancement in technique established in adults patients. First generation lithotripters with water baths were associated with cardiac arrhythmias in 80% of patients, and were therefore configured to deliver shocks during the refractory period of the cardiac cycle.[11] By gating the shock to the "R" wave of the electrocardiogram reading, the incidence of SWL induced arrhythmias can be reduced to less than 1%.[12] However, this means that the number of shocks per minute is determined by the patient's heart rate and can only be manipulated pharmacologically with agents such as atropine, which is not an ideal option for children. With newer electromagnetic lithotripters, synchronizing the delivery of shock waves to an external fixed rate generator at a rate faster than the patient's heart rate has been shown to be safe and effective. The incidence of arrhythmias with ungated SWL is between 8.8% and 21% with most of these being premature ventricular contractions which resolved on conversion to gated SWL.[5,11,13,14] Some published series have noted that arrhythmias are prone to develop during treatment of renal stones compared to ureteral stones while others showed that rightsided stones had higher incidences over left.[11,14] These findings were not consistently demonstrated across different studies.

Ungated SWL also allows shorter operative times without the need for pharmaceutical intervention is an added benefit. One prospective series showed a mean operative time of 46 minutes at a fixed rate of 115-120 shocks/minute compared to a synchronized cohort with a mean of 67 minutes.[15] Efficacy was preserved with the ungated technique.

The safety and efficacy of ungated SWL has not been well established in the pediatric population. Our study builds on our initial experience with this method and demonstrates that there was no incidence of intraoperative or postoperative arrhythmias with unsynchronized SWL or need for conversion to gated SWL in children. Ungated SWL did not appear to reduce the success rate with our stone free rate at 87% at 4 weeks compatible with that reported in other series.[1-4,7-10] Recently, Shouman et al reported their experience of ungated SWL on 37 children ranging from 2 to 14 years of age with a similar success rate as we report.[16] Although our study has a smaller population it does have wider inclusion criteria of less than 18 rather than 14 years of age. Since pediatric urologists treat a wide range of children, this more inclusive criteria provides data of all pediatric ages.

Conclusions

Our results indicate that ungated SWL is a safe, effective, and efficient procedure for urinary lithiasis in the pediatric population. This expanded experience support our initial series and the other relatively few reports that ungated SWL does not result in cardiac arrhythmias. □

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