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ORIGINAL PAPER

Comparison of an electromagnetic and an electrohydraulic lithotripter: Efficacy, pain and complications

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Summary

***Introduction.** We analyzed efficacy and complications of extracorporeal shock wave lithotripsy (SWL) and analgesia requirement during the treatment in two groups of patients treated with different lithotripters.*
***Materials and methods.** The patients treated were 189, 102 between September 2016 and April 2017 with HMT Lithotron® LITS 172, electrohydraulic, and 87 between May and September 2017 with Storz Medical Modulith® SLK, electromagnetic. The main differences between the lithotripters are: type of energy source, patient position, frequency and number of shock waves. All the patients underwent sonography before and four to eight weeks after the treatment. The targeting was sonographic for renal stones and X-ray for ureteral stones. All the patients received Ketorolac before the treatment with a supplement of Pethidine if needed. People lost to follow-up and with incomplete data were excluded.*
***Results.** We enrolled 173 patients, 94 treated with the electrohydraulic lithotripter and 79 with the electromagnetic one. 43 patients (54%) in the electromagnetic group and 31 (33%) in the electrohydraulic group were stone free or presented clinically insignificant residual fragments (CIRFs), defined as asymptomatic, noninfectious, ≤ 3 mm. The association between CIRFs and the kind of lithotripter was statistically significant ($p = 0.004$).*
An increased need for analgesia was found in 14.9% of patients in the electromagnetic group and in 81% of patients in the electrohydraulic group ($p < 0.001$). The access to emergency room (intractable pain, kidney failure, fever, Steintrasse) after the treatment was similar in the two groups ($p = 0.37$).
***Conclusions.** The best results in stones fragmentation and less analgesia requirement were demonstrated in the electromagnetic lithotripter group. No differences were demonstrated considering the need for emergency room after the treatment.*

KEY WORDS: *Lithotripter; Stones; Extracorporeal shock wave lithotripsy; Electromagnetic; Electrohydraulic.*

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INTRODUCTION

Shock wave lithotripsy was introduced in the 1980s for the treatment of urinary stones and became a first line treatment option (1). Since the introduction of the Dornier HM3 lithotripter, there have been many changes to produce machines that were easier and more practical to use. Three shock wave generating principles have been used in clinical lithotripters: electrohydraulic, electromagnetic and piezoelectric, but they work substantially the same way (2). Many studies compare different lithotripters or different energy source in order to evaluate efficacy (3, 4). In our institution, we used an electrohydraulic lithotripter and when it was no longer available, we used an electromagnetic one.

MATERIALS AND METHODS

We retrospectively reviewed the data collected and compared the results obtained with the two lithotripters, using chi-square test, with significance considered at $p < 0.05$.
The patients collected were 189. Between September 2016 and April 2017 we treated with *HMT Lithotron®* LITS 172, an electrohydraulic lithotripter, 102 patients and when it was no longer available we use, between May and September 2017, a *Storz Medical Modulith® SLK*, electromagnetic, with 87 patients.
All the patients underwent sonography before and four to eight weeks after the treatment, performed by the same urologists. The targeting during the treatment was sonographic for renal stones and X-ray for ureteral stones. All the patients received Ketorolac (30 mg) before the treatment or Paracetamol (1g) in case of allergy with a supplement of Pethidine, according to weight, if needed. When we evaluated complications after the treatment, patients who visited the emergency room within 48 hours were included (5). People lost to follow-up and with incomplete data were excluded.

RESULTS

We enrolled 173 patients, 129 males and 44 females with a mean age of 58 ± 12 years. 94 were treated with the electrohydraulic lithotripter, 23 females and 71 males, and 79 with the electromagnetic one, 21 females and 58 males.
In the group treated with the electromagnetic lithotripter the mean diameter of the stones was 9.59 ± 3.04mm and 16 patients had multiple stones. 73 had stones in the kidney and 6 in the ureter.
The mean number of shock waves was 3079 (3043 in the kidney and 3516 in the ureter) with a 3-4Hz frequency.
In the group treated with the electrohydraulic one, the mean diameter of the stones was 10.39 ± 3.41 mm and 18 patients had multiple stones. 73 had stones in the kidney and 21 in the ureter. The mean number of shock

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waves was 2228 (2139 in the kidney and 2500 in the ureter) with a 1-2Hz frequency (Table 1).
43 patients (54%) in the electromagnetic group and 31 (33%) in the electrohydraulic group presented clinically insignificant residual fragments, defined as asymptomatic, noninfectious, ≤ 3 mm fragments (CIRFs).
The data were compared using chi-square test, demonstrating that the association between presence of CIRFs or stone free status and kind of lithotripter was statistically significant ($p = 0.004$).
An association between the kind of lithotripter and the need for more analgesia during the treatment was evaluated. 14.9% of people treated with electromagnetic (13 patients) and 81% of people treated with electrohydraulic (83 patients) asked for Pethidine. People treated with electromagnetic lithotripter needed less analgesia ($p < 0.001$).
The causes of access to the emergency room were intractable pain, kidney failure, fever (> 38°C) and Steintrasse. 10 patients treated with electromagnetic an 8 treated with electrohydraulic went to emergency room within 48 hours and the difference was not statistically significant ($p = 0.37$) (Table 2).

Table 1.
Characteristics of stones and treatments.

	Electromagnetic lithotripter	Electrohydraulic lithotripter
Mean diameter of the stones	9.59 ± 3.04 mm	10.39 ± 3.41 mm
Patients with multiple stones	16	18
kidney stones	73	73
ureteral stones	6	21
Mean number of shock waves	3079 (3043 kidney and 3516 ureter)	2228 (2139 kidney and 2500 ureter)
Frequency of shock waves	3-4Hz	1-2Hz

Table 2.
Success rate,complications and analgesia requirement.

	Electromagnetic lithotripter	Electrohydraulic lithotripter	P
CIRFs	43	31	0.004
Lithiasis > 3 mm	36	63	
Access to emergency room	10	8	0.37
No complications	69	86	
Analgesia requirement	13	83	0.00001
Asymptomatic patients	74	19	

Discussion

The electrohydraulic lithotripter has a source that generates a shock wave that is focused by an ellipsoidal reflector. The pressure pulse originates as a shock wave and remains a shock wave at all times. During shooting, there can be significant variation in the amplitude of the shock wave and there can be some shift in the position of the focal zone at the target.
The electrodes wear out and must be replaced because this can affect their acoustic output. The electromagnetic lithotripter uses an electrical coil in proximity to a metal plate as an acoustic source. When the coil is excited by a short electrical pulse, an acoustic wave is generated. Focusing is very reproducible and the variation in measured pressure waves is less than 10%.
The shock waves generated by electromagnetic lithotripters are inherently more consistent than in electrohydraulic. An additional advantage is that there are no electrodes to replace (2).
As seen above, there are inherent differences between the two kinds of lithotripter, but each brand has its own features (6-8).
The position of the patient is different. With *Lithotron*®, the patient is supine, with his flank lying on the therapy head and sometimes must be fixed to the bed to avoid involuntary movements (9). With *Modulith*®, the patient is prone and the respiratory movements are smaller. In both, the therapy head is filled with water, covered by a thin rubber membrane pressed against the patient and through which the shock wave passes and gel is used as coupling agent (10).
The number of the shock waves depends on the stone fragmentation. The frequency depends on the configuration of the lithotripter. For the *Lithotron*® the frequencies available are 1 or 2 shock waves per second. For the *Modulith*® the frequency depends on the energy delivered and with higher energy the frequency is 3 or 4 shock waves per second.
In literature there are many studies that compare different lithotripters. Some studies evaluate, as we did, the differences between electrohydraulic and electromagnetic lithotripters, however, the results are discordant (3, 4).
In our series electromagnetic lithotripter has better results.
Another important argument about SWL is pain management (11).
Discomfort during shock wave treatment is due primarily to the sensation of cutaneous pain over the area of shock wave entry at the surface of the body (2). Analgesics used include opioids, NSAIDs and local analgesia, however, there is no consensus on standard analgesia for pain during SWL (12).
In our series, pain is better managed in patients treated with electromagnetic lithotripter.
Many complications after ESWL are reported. The most dangerous are renal hematomas and injuries to adjacent organs, but the most frequent are flank pain, hematuria, fever, nausea with vomiting and acute urinary retention (5). We had no severe complication and in the two groups, the access to the emergency room was similar.

Conclusions

All the treatments and the follow up were performed by the same group of urologists with years of experience.
In the series we considered, the best results in stones fragmentation ($p = 0.004$) and less analgesia requirement ($p < 0.001$) were demonstrated in the electromagnetic lithotripter group. No differences were demonstrated considering the need for emergency room after the treatment ($p = 0.37$).

References

1. *Tailly GG. Extracorporeal shock wave lithotripsy today. Indian J Urol. 2013; 29:200-7.*

2. *Cleveland RO, McAteer JA. The physics of shock wave lithotripsy. In: Smith AD, Badlani GH, Preminger GM, et al., editors. Smith's Textbook on Endourology 3. Vol. 1. Hoboken: Wiley-Blackwell; 2012; pp. 529-558.*

3. *Matin SF, Yost A, Streem SB. Extracorporeal shock-wave lithotripsy: a comparative study of electrohydraulic and electromagnetic units. J Urol. 2001; 166:2053-6.*

4. *Bhojani N, Mandeville JA, Hameed TA, et al. Lithotripter outcomes in a community practice setting: comparison of an electromagnetic and an electrohydraulic lithotripter. J Urol. 2015; 193:875-9.*

5. *Lu CH, Kuo JY, Lin TP, et al. Clinical analysis of 48-h emergency department visit post outpatient extracorporeal shock wave lithotripsy for urolithiasis. J Chin Med Assoc. 2017; 80:551-557.*

6. *Ng CF, Thompson TJ, McLornan L, Tolley DA. Single-center experience using three shockwave lithotripters with different generator designs in management of urinary calculi. J Endourol. 2006; 20:1-8.*

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