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ESWL for large pancreatic calculi: Report of over 5000 patients

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ABSTRACT

Introduction: The primary aim of this study was to evaluate efficacy, safety and short-term pain relief after ESWL for large pancreatic calculi in over 5000 patients at a single center.
Methods: This is a retrospective analysis of prospectively collected data. Patients with painful calculi >5 mm, located in the head, neck and body region in the MPD, who were not amenable for extraction by the standard procedure of endoscopic pancreatic sphincterotomy were subjected to ESWL using a third generation dual focus lithotripter. Patients were followed up at 6 months for outcome evaluation.
Results: A total of 5124 patients (66% males) were subjected to ESWL. Majority of stones (79.2%) were radiopaque. Single calculi were seen in 3851 (75.1%).The majority of stones were located in head region of MPD in 2824 (55.1%) patients. 4386 (85.5%) patients required 3 or less sessions for fragmentation and complete stone clearance was achieved in 3722 (72.6%). EPS was performed in 5022 (98%) while PD stenting was required in 3536 (69%) patients. Of the 4280 patients followed up for 6 months, 3529 (82.6%) patients were pain free. Another 512 (11.9%) patients had significant reduction in VAS score. In 229 (5.3%) there was no decrease in pain intensity. Minor and self-limiting complications were reported in 1153 (22.5%).
Discussion: Our study confirms the safety and efficacy and short-term pain relief of ESWL for large calculi in the MPD. ***In properly selected patients,*** this should be offered as the first line of therapy for all large MPD calculi not amenable to the standard techniques of stone extraction.

Introduction

Chronic pancreatitis (CP) is a disease of diverse etiology associated with progressive and irreversible changes in the pancreas leading to loss of functional pancreatic tissue and resulting in both exocrine and endocrine deficiency. Alcohol is the commonest etiological agent in most industrialized nations. In India, however, though the incidence of alcohol induced CP is rising, non-alcoholic idiopathic type of CP is still the most prevalent [1]. A genetic predisposition is believed to be the main contributing factor [2,3]. Pancreatic calculi (PC) are the sequalae of this disease and may be present in over 50% of patients [1,4]. These calculi obstruct the main pancreatic duct (MPD) causing upstream ductal hypertension. Pain, often recurrent and excruciating, is the commonest presenting symptom in patients with CP; due to this ductal hypertension [5,6]. Endoscopic and surgical therapies have evolved over the years **and** aim to remove these calculi **to** reduce the ductal hypertension and the associated pain. **The pain in CP can also be secondary to ischemia, neural entrapment and central hypersensitivity; these causes can explain the persistence of pain in a few patients despite the complete clearance of MPD.** [7].

PC are classified based upon type, number and location. 1. Radio opaque, radio lucent or mixed; 2. Single or multiple; 3. Located in MPD, side branches or parenchyma; 4. Located in head, body or tail. Extra corporeal shockwave lithotripsy (ESWL) is the standard of care for large PC (>5 mm), especially for those in the head, neck and body region [8–13]. The European Society of Gastrointestinal

Abbreviations: CP, chronic pancreatitis; PC, pancreatic calculi; MPD, main pancreatic duct; ESWL, extracorporeal shock wave lithotripsy; ESGE, European Society of Gastrointestinal Endoscopy; ERCP, endoscopic retrograde cholangio pancreatography; US, ultrasound; EUS, endoscopic ultrasound; MRCP, magnetic resonance cholangio pancreatography; EPS, endoscopic pancreatic sphincterotomy; EA, epidural anesthesia; TIVA, total intra venous analgesia; CCP, chronic calcific pancreatitis; POP, per oral pancreatoscopy; LL, laser lithotripsy; PEP, post ERCP pancreatitis.

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Endoscopy (ESGE) clinical guidelines state that for uncomplicated and painful CP with calculi >5 mm in the MPD, ESWL should be the first step in management, followed by extraction of the stone fragments at a subsequent Endoscopic Retrograde Cholangio Pancreatography (ERCP) [14].

The primary aim of this study was to evaluate, efficacy, safety and short-term pain relief after ESWL for large PC in over 5000 patients from a single, tertiary, academic center.

Methods

This is a retrospective analysis of prospectively collected data of patients with large pancreatic ductal calculi who presented at Asian Institute of Gastroenterology – a tertiary referral center in Hyderabad, India, between February'2004 to March'2018. Necessary approval was obtained from the Institutional Review Board prior to study initiation. We also included data of the 1006 cases that we had reported earlier [5]. **The earlier study enrolled patients between February 2004 to July 2009 whereas remaining subjects were included from this period upto March 2018.**

All patients having CP with pain as their dominant symptom were evaluated. Imaging was performed using transabdominal ultrasound (US), Endoscopic Ultrasound (EUS), Magnetic Resonance Cholangio Pancreatography (MRCP) and ERCP. Patients with calculi >5 mm in the MPD who were not amenable for extraction by the standard procedure of Endoscopic Pancreatic Sphincterotomy (EPS) with basket and balloon trawl were taken up for ESWL. **The decision for extraction of PD stones by balloon sweep or subjecting them to ESWL was taken by the performing endoscopist. For some patients' decision for ESWL was taken depending on cross-sectional imaging. A complementary imaging was performed only if a single technique did not provide adequate information.** PD stones located in the head, neck and body region were targeted at ESWL. Subjects with isolated calculi in the tail, extensive calculi in head, body and tail, multiple pancreatic ductal strictures, ascites or a pancreatic head mass and pregnancy were not considered for ESWL. Patients with cholangitis or coagulopathy secondary to biliary strictures were subjected to ESWL only after these were corrected. The standard protocol followed at our institute is shown in Fig. 1.

ESWL was performed with a third generation electromagnetic lithotripter (Delta Compact, Dornier Med Tech, Wessling, Germany) This has both fluoroscopy and ultrasound imaging facility. All procedures at our institute were performed using fluoroscopy. Radio opaque calculi were targeted directly while a naso pancreatic tube (NPT) was placed for all radiolucent calculi and contrast was passed through this to localize the calculi. Between 5000 and 6000 shocks were delivered per session with an intensity of 15–16 kV at a frequency of 90 shocks per minute. **In the later part of study, the number of shocks administered daily were increased to 6000 shocks especially if it could avoid an extra session of ESWL. Patients with small asymptomatic pseudocysts were also taken up for ESWL. Calculi in distal body were also targeted if the patient was unfit or refused surgery.** The aim was to fragment the calculi to <3 mm or demonstrate a decrease in heterogeneity or density of the calculi in the MPD [1,14]. Shocks were delivered on consecutive days till fragmentation was achieved. If there was no fragmentation after four sessions of ESWL the procedure was labeled as unsuccessful and patient was advised surgery. Most procedures were performed under epidural anesthesia (EA). This

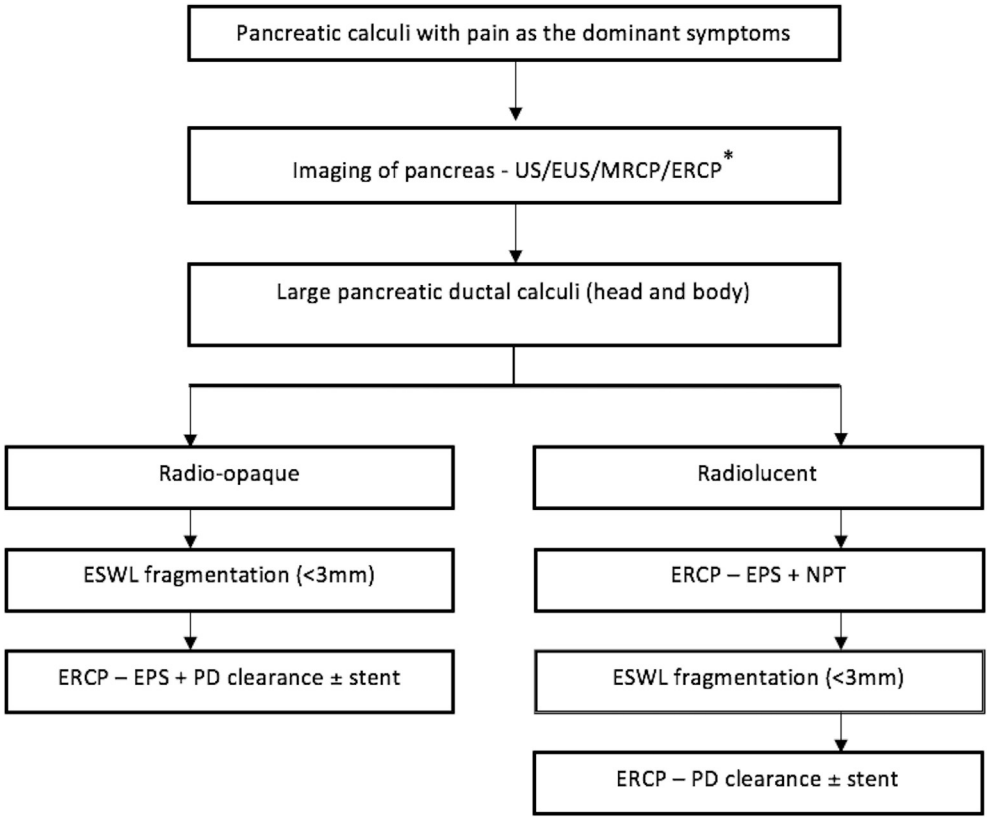

Fig. 1. Protocol followed at Asian Institute of Gastroenterology, for extracorporeal shockwave lithotripsy of large pancreatic duct calculi [1,5,6] * ***if adequate information is not available with a single imaging technique then a second imaging procedure was performed***
EPS: Endoscopic pancreatic sphincterotomy; US: Ultrasound; EUS: Endoscopic ultrasound; MRCP: Magnetic resonance cholangiopancreatography; ERCP: Endoscopic retrograde cholangiopancreatography; PD: Pancreatic duct; ESWL: Extracorporeal shock wave lithotripsy; NPT: Naso-pancreatic tube.

offered many distinct advantages and has been successfully used for ESWL of both biliary and pancreatic calculi at our center [15]. Parenteral sedation, Total Intra Venous Analgesia (TIVA) and very occasionally general anesthesia were used when EA was technically not feasible or contraindicated.

Clearance of MPD was classified as follows [1,5,12,16].

1. Complete clearance – clearance of >90% of stone volume.
2. Partial clearance – clearance between 50 and 90% of stone volume
3. Unsuccessful clearance – failure to fragment or clearance <50% of stone volume.

Following ESWL patients were subjected to ERCP within 24–48 h, EPS was performed and the fragmented calculi were cleared by a mini basket, balloon trawl and flushing with saline. Pancreatic stents (5 or 7 Fr) were placed when indicated. These included patients with associated strictures or with incomplete clearance. Stents were also placed prophylactically in those outstation patients who had no access to advanced medical care. These stents were removed during follow up (3–6 months) and re-stenting was carried out whenever indicated. Complications were recorded in a structured questionnaire.

Follow up was performed at 6 months preferably in a hospital visit. Patients who could not visit the hospital were followed through a structured telephone interview. **Social media was used for pain assessment after 2013.** At follow up, routine blood chemistry and ultrasound imaging was performed. Pain was assessed using Visual Analog Score (VAS) for pain. The quantity of oral or parenteral analgesics used pre and post ESWL were also recorded on follow up. **NSAIDs and Tramadol are used for pain relief in our patients. Pethidine and morphine are not prescribed.** The evaluation of long-term pain relief is under assessment and will be documented subsequently in a later study.

Statistical analysis

Data were recorded in a structured pre-designed questionnaire and a database was generated in MS Excel. Continuous variables were expressed as mean (SD) while categorical variables were expressed as proportions. Comparison of outcomes (pain and analgesic requirement) before and after ESWL was performed using the chi square test of trend and a two-tailed 'p' value of <0.05 was considered statistically significant.

Results

Patient characteristics (Table 1**)-** A total of 5124 patients were subjected to ESWL during the study period. These included 3384 (66%) males. Of these, majority of patients (69.1%) were under the age of 40 years. Only 495 (9.6%) of all patients consumed alcohol in significant quantity or smoked regularly.

Characteristics of pancreatic ductal stones (Table 1**)-** Single calculi were seen in 3851 (75.1%) while the rest had multiple calculi. Radio opaque calculi constituted a majority and were present in 4063 (79.2%), while 820 (16%) were radiolucent and the rest were both radio opaque and radiolucent. Stone location included 2824 (55.1%) in the head, 1099 (21.4%) in the body and 384 (7.4%) in the tail. Diffused distribution in head, body and tail was seen in 817 (15.9%) patients. These were taken up for ESWL either because they refused or were unfit for surgery.

ESWL characteristics (Table 2**)-** Stones in the head and body were targeted at ESWL. Calculi in the tail were not subjected to shock waves because of the high possibility of collateral damage to the spleen. Majority of the patients, [4386 (85.5%)] required 3 or less sessions for fragmentation. About 4% of patients required between 5 and 8 sessions. Complete stone clearance was achieved in 3722 (72.6%), partial in 886 (17.3%) while in the rest fragmentation was unsuccessful. EPS was performed in 5022 (98%) while stenting was carried out in 3536 (69%) (Figs. 2–4). Associated stricture was seen in 1153 (22.5%). These characteristics are listed in Table 2.

Outcome on follow-up (Tables 3 and 4**)-** A six monthly follow up was obtained in 4280 patients; and follow-up data were compared with baseline only for these patients. Of these 3529 (82.6%) were pain free and had stopped the use of analgesics. Another 512 (11.9%) patients had significant reduction in VAS score. In 229 (5.3%) there was no decrease in pain intensity. Analgesic use

Table 1
Characteristics of patients and pancreatic calculi (n = 5124).

		Number	%
Age	<20 years	1066	20.8
	21–40	2475	48.3
	41–60	1035	20.1
	>60	548	10.6
Female		***1655***	***32.3***
Etiology	***Alcohol and/or Smoking***	***495***	***9.6***
	Idiopathic	***4629***	***90.4***
Stone characteristics	Single	3851	75.1
	Multiple	1273	24.8
	Radiopaque	4063	79.2
	Radiolucent	820	16.0
	Mixed	241	4.7
Stone location	Head	2824	51.1
	Body	1099	21.4
	Tail	384	7.4
	Head/Body/Tail	817	15.9
Associated stricture		1153	22.5

Table 2
Characteristics of ESWL.

		Number	%
ESWL sessions	1	614	11.9
	2	1148	22.4
	3	2624	51.2
	4	534	10.4
	>5 (maximum 8)	204	3.9
Fragmentation	Complete	3722	72.6
	Partial	886	17.3
	Unsuccessful	516	10
Pancreatic sphincterotomy		5022	98
Pancreatic ductal stenting		3536	69
Associated stricture		1153	22.5

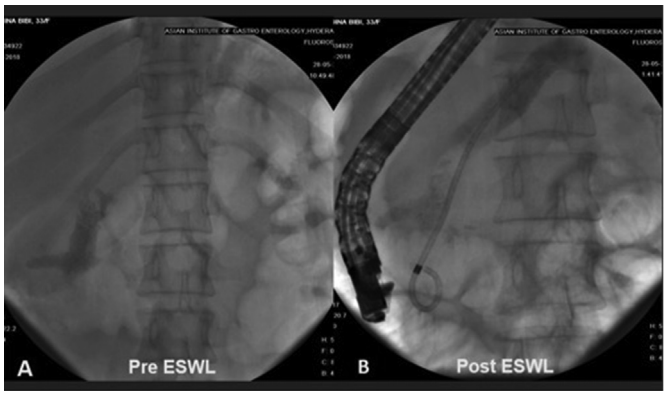

Fig. 2. (A) Large calculi in the head (B) Post ESWL dilated PD with stent in situ. Calculi have been cleared.

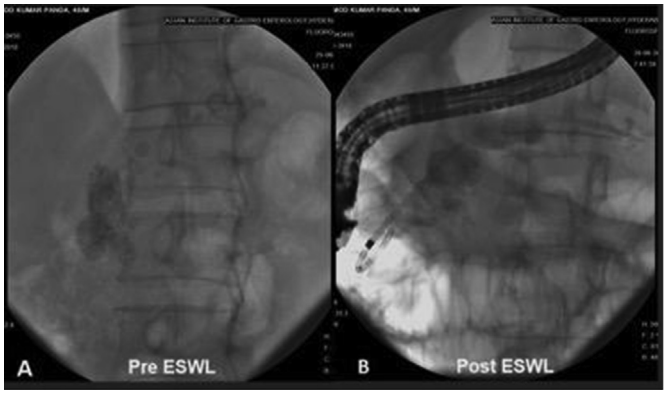

Fig. 3. (A) Large calculi in the head & body (B) Post ESWL calculi cleared and stent placed in dilated PD.

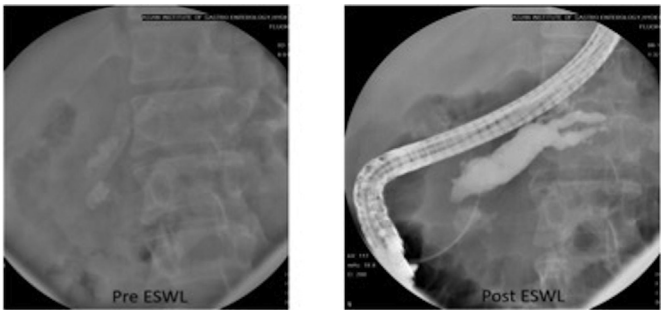

Fig. 4. Large pancreatic calculi in head and genu, cleared by extracorporeal shockwave lithotripsy followed by pancreatic stenting.

Table 3
Pain score pre and post ESWL (n = 4280).

VAS	Pre ESWL	Post ESWL	'p' value
0–1	844 (16.5%)	3539 (82.6%)	<0.0001
2–3	814 (15.9%)	304 (7.1%)	
4–6	1947 (38.0%)	208 (4.8%)	
>7	1519 (29.6%)	229 (5.3%)	

Table 4
Use of analgesics/month pre and post ESWL (n = 4280).

No. of analgesics/month	Pre ESWL	Post ESWL	'p' value
0	0 (0%)	3539 (82.6%)	<0.0001
1–5	814 (19.0%)	388 (9.0%)	
6–10	2963 (69.2%)	152 (3.5%)	
>10	503 (11%)	201 (4.7%)	

was not reported in the 3529 patients who were relieved of pain. In the rest there was a significant reduction in the number of analgesic consumed every month and these results on tabulated in Table 4. **In the previously published cohort, the follow-up has been extended upto 12 years with 465 patients and complete pain relief was seen in 58.5%. No significant improvement in pain was seen in 9.6% and these patients were subjected for surgery.** [17] (See Table 5).

Complications- 1153 (22.5%) patients reported complications, which were minor and self-limiting. These included mild pain at the site of contact of the cushion of ESWL machine with the skin in 692 patients (13.5%), ecchymosis in 974 (19%) and mild acute pancreatitis in 159 (3.1%). Severe pancreatitis requiring hospitalization greater than 3 days was seen in 0.5%. The incidence of pancreatitis following ESWL and ERCP was not higher than with ERCP performed for other indications at our center. There was no procedure related mortality in our study.

Discussion

Chronic Calcific Pancreatitis (CCP) of the non-alcoholic etiology is associated with calculi that are dense, large and often occur in young individuals [1,12,18]. Calculi >5 mm are difficult to extract endoscopically because they are dense and adherent to the MPD. Further, the diameter and tortuosity of the pancreatic ducts makes the passage of accessories technically challenging. ESGE clinical guidelines recommend that all large PD calculi should be subjected to fragmentation by ESWL and subsequently extracted at ERCP [14]. Use of mechanical lithotripsy or Dormia baskets for large PD stone has not been universally successful. A retrospective analysis of over 100 patients showed a success rate of 9% with the use of Dormia basket [19]. In a multi-center study the complication rates with mechanical lithotripsy were unacceptably high, thrice higher as compared to biliary stone extraction [20]. Pancreatoscopy using the recently available pancreatoscope, combined with laser lithotripsy (LL) is a technique under evaluation and experience is limited. A recent retrospective study of per oral pancreatoscopy (POP) with LL using a holmium laser achieved complete clearance in 79% and partial clearance in 11% in a total of 28 patients. Follow up of these over 13 months revealed improvement in pain in 25 of 28 patients. Adverse effects were minor and seen in 29% of patients [21]. This procedure requires non-standard equipment with considerable expertise which limits its utility. There has been no head to head comparison of ESWL with POP and LL,. At present, in our opinion, POP and LL should be considered as a complimentary option for calculi that are refractory to an adequately performed ESWL procedure [1].

ESWL is the standard of care for managing large PD calculi not amenable to extraction by the standard procedure of EPS followed by basketing or balloon trawl [1,5,8–12,19,22] (Table 5). A meta-analysis of 17 studies revealed pain relief between 37 and 100%

Table 5
Efficacy of extracorporeal shockwave lithotripsy for pancreatic calculi.

Author	No. of patients	Complete clearance (%)	Pain relief (%)	Follow-up (mo)
Delhaye et al. [9]	123	59	85	14
Costamagna et al. [11]	35	74	72	27
Kozarek et al. [22]	40	–	80	30
Farnbacher et al. [19]	125	64	48	29
Dumonaceau et al. [39]	29	–	55	51
Adamek et al. [25]	80	–	76	40
Tandan et al. [5]	1006	76	84	6
Tandan et al. [17]	272	76	60	96
Tandan et al. (present study)	5124	72.9	82	6

[13]. A large systematic review of over 1000 patients reported successful stone fragmentation in 89% of patients [23]. We achieved a complete clearance of 73% and partial clearance in 17%. Follow up of over 4200 patients over 6 months revealed complete pain relief in 82% and partial relief in another 9%. However, as CCP in the tropics is a disease of the young the long term beneficial effect of ESWL in this cohort is yet to be assessed. Our earlier study of follow up of 272 patients over 8 years revealed complete pain relief in 60%. Mild to moderate pain was seen in 35.7% while in the rest there was no relief [17]. **As mentioned earlier a 12 year follow-up of 465 patients complete pain relief was seen in 58.5% and 9.6% were subjected for surgery.** The long-term pain relief in this large group of over 4000 patients is under evaluation. In a retrospective analysis of long-term pain relief in 120 patients complete pain relief with avoidance of narcotic use was reported in 50% and partial pain relief in 84% [24]. Similar results on long-term follow up were also reported from other centers [4,10,25–27]. **Pain relief in our study is higher as compared to the west. This is probably due to the fact that most of our patients had idiopathic calcific pancreatitis. Earlier studies have reported poorer pain relief in west as compared to east because of higher incidence of alcoholic pancreatitis, greater incidence of smoking and use of opioids.** [28–30] **It is also possible that the phenotype of our patients is more tolerant to pain.** Recurrence rate of calculi from our earlier study of long term follow up is around 23% though all patients do not complain of pain [17].

ESWL is a safe procedure and complications are mild, and do not need any intervention. There was no procedure related mortality in this study. The incidence of post ERCP Pancreatitis (PEP) is no higher with ESWL followed by ERCP as compared to ERCP alone at our center. Complication rate of 5.8% with a single complication related mortality (0.05%) was reported in over 1800 patients which included over a 1000 from our center [14]. Another study reported a complication of 6.7% in over 1470 ESWL procedures [31]. Accurate targeting of the calculi and reduced patient movements prevent collateral damage and minimized complications [1,5,12,15]. Serious complications of ESWL include peri renal hematoma, biliary obstruction, splenic rupture, bowel perforation, necrotizing pancreatitis and liver trauma [32–35]. These however occur rarely and reports are mostly anecdotal.

ESWL despite being a safe and efficient procedure has its own limitations. A failure of fragmentation is seen in around 10% of patients. If these calculi could be identified prior to ESWL an alternative procedure can be advised. Calculi having a density of >820.5 Hounsfield units on non-contrast tomography are associated with reduced fragmentation [36]. A further validation is required to identify such calculi which are not likely to get fragmented. Recurrence of calculi (upto 23% on 8 year follow up [17]) have been reported though all them are not associated with recurrence of pain. Pharmacological agents could possibly prevent this reformation and thus avoid the need for reintervention. Following ESWL improvement in exocrine and endocrine dysfunction has been reported in a few studies [37], while others have failed to do so [25,26]. Further studies are required to clarify these issues. The role of ESWL, if applied early in the course of disease in preventing development of pancreatic carcinoma has also not been evaluated. Yet another debated issue is the practice of ERCP following ESWL. Two uncontrolled studies revealed ESWL alone could clear the MPD of all calculi [37,38]. Another randomized study comparing ESWL alone and ESWL followed by ERCP demonstrated equal efficacy in both groups but the cost of treatment was higher in patients who underwent ESWL and ERCP [39].

The limitations of our study include a retrospective analysis, a recall bias and subjective assessment of pain. **Pain relief in post ESWL patients with who were stented and those were not stented not compared**. This study has a short term follow up of majority of patients (long term follow up is under assessment).

In conclusion, our study confirms the safety and efficacy and short-term pain relief of ESWL for large calculi in the MPD. The clearance rates are excellent with good relief of pain. In properly selected patients it should be offered as the first line of therapy for all large MPD calculi not amenable to the standard techniques of stone extraction.

Individual author contribution

Manu Tandan: Conceived the study, performed ERCP, retrieved data, and drafted the manuscript.

D. Nageshwar Reddy: Generated data, provided intellectual inputs, drafted the manuscripts.

Rupjyoti Talukdar: Performed statistical analyses, and drafted manuscript.

Vinod K: Performed ESWL and generated data.

Kiran SVVS: Performed ESWL and generated data.

Santosh D: Provided anesthesia during ESWL and ERCP.

Rajesh Gupta: Performed ERCP and provided intellectual inputs.

Mohan Ramchandani: Performed ERCP and provided intellectual inputs.

Sundeep Lakhtakia: Performed ERCP and provided intellectual inputs.

Rakesh K: Performed ERCP and provided intellectual inputs.

Manohar P: Performed ERCP and provided intellectual inputs.

Zaheer N: Performed ERCP and provided intellectual inputs.

Jahangeer Basha: Performed ERCP and provided intellectual inputs.

Nitin Jagtap: Performed ERCP and provided intellectual inputs.

GV Rao: Performed ERCP and provided intellectual inputs.

References

[1] Tandan M, Talukdar R, Reddy DN. Management of pancreatic calculi: an update. Gut Liver 2016;10:873–80.
[2] Chandak GR, Idris MM, Reddy DN, et al. Absence of PRSS1 mutations and association of SPINK1 trypsin inhibitor mutations in hereditary and non-hereditary chronic pancreatitis. Gut 2004;53:723–8.
[3] Bhasin DK, Singh G, Rana SS, et al. Clinical profile of idiopathic chronic pancreatitis in North India. Clin Gastroenterol Hepatol 2009;7:594–9.
[4] Rosch T, Daniel S, Scholz M, et al. Endoscopic treatment of chronic pancreatitis: a multicenter study of 1000 patients with long-term follow-up. Endoscopy 2002;34:765–71.
[5] Tandan M, Reddy DN, Santosh D, et al. Extracorporeal shock wave lithotripsy and endotherapy for pancreatic calculi-a large single center experience. Indian J Gastroenterol 2010;29:143–8.
[6] Tandan M, Reddy DN. Extracorporeal shock wave lithotripsy for pancreatic and large common bile duct stones. World J Gastroenterol 2011;17:4365–71.
[7] Talukdar R, Reddy DN. Pain in chronic pancreatitis: managing beyond the pancreatic duct. World J Gastroenterol 2013;19:6319–28.
[8] Neuhaus H. Fragmentation of pancreatic stones by extracorporeal shock wave lithotripsy. Endoscopy 1991;23:161–5.
[9] Delhaye M, Vandermeeren A, Baize M, et al. Extracorporeal shock-wave lithotripsy of pancreatic calculi. Gastroenterology 1992;102:610–20.
[10] Dumonceau JM, Deviere J, Le Moine O, et al. Endoscopic pancreatic drainage in chronic pancreatitis associated with ductal stones: long-term results. Gastrointest Endosc 1996;43:547–55.
[11] Costamagna G, Gabbrielli A, Mutignani M, et al. Extracorporeal shock wave lithotripsy of pancreatic stones in chronic pancreatitis: immediate and medium-term results. Gastrointest Endosc 1997;46:231–6.
[12] Ong WC, Tandan M, Reddy V, et al. Multiple main pancreatic duct stones in tropical pancreatitis: safe clearance with extracorporeal shockwave lithotripsy. J Gastroenterol Hepatol 2006;21:1514–8.
[13] Guda NM, Partington S, Freeman ML. Extracorporeal shock wave lithotripsy in the management of chronic calcific pancreatitis: a meta-analysis. JOP 2005;6:6–12.
[14] Dumonceau JM, Delhaye M, Tringali A, et al. Endoscopic treatment of chronic pancreatitis: European society of gastrointestinal endoscopy (ESGE) clinical guideline. Endoscopy 2012;44:784–800.
[15] Darisetty S, Tandan M, Reddy DN, et al. Epidural anesthesia is effective for extracorporeal shock wave lithotripsy of pancreatic and biliary calculi. World J Gastrointest Surg 2010;2:165–8.

[16] McHenry L, Watkins JL, Kopecky K, et al. Extracorporeal shock-wave lithoptripsy for pancreatic calculi: a 10-year experience at a single U.S. Center. Gastrointest Endosc 2004;59:P205.
[17] Tandan M, Reddy DN, Talukdar R, et al. Long-term clinical outcomes of extracorporeal shockwave lithotripsy in painful chronic calcific pancreatitis. Gastrointest Endosc 2013;78:726–33.
[18] Chari S, Jayanthi V, Mohan V, et al. Radiological appearance of pancreatic calculi in tropical versus alcoholic chronic pancreatitis. J Gastroenterol Hepatol 1992;7:42–4.
[19] Farnbacher MJ, Schoen C, Rabenstein T, et al. Pancreatic duct stones in chronic pancreatitis: criteria for treatment intensity and success. Gastrointest Endosc 2002;56:501–6.
[20] Thomas M, Howell DA, Carr-Locke D, et al. Mechanical lithotripsy of pancreatic and biliary stones: complications and available treatment options collected from expert centers. Am J Gastroenterol 2007;102:1896–902.
[21] Attwell AR, Patel S, Kahaleh M, et al. ERCP with per-oral pancreatoscopy-guided laser lithotripsy for calcific chronic pancreatitis: a multicenter U.S. experience. Gastrointest Endosc 2015;82:311–8.
[22] Kozarek RA, Brandabur JJ, Ball TJ, et al. Clinical outcomes in patients who undergo extracorporeal shock wave lithotripsy for chronic calcific pancreatitis. Gastrointest Endosc 2002;56:496–500.
[23] Nguyen-Tang T, Dumonceau JM. Endoscopic treatment in chronic pancreatitis, timing, duration and type of intervention. Best Pract Res Clin Gastroenterol 2010;24:281–98.
[24] Seven G, Schreiner MA, Ross AS, et al. Long-term outcomes associated with pancreatic extracorporeal shock wave lithotripsy for chronic calcific pancreatitis. Gastrointest Endosc 2012;75:997–1004 e1.
[25] Adamek HE, Jakobs R, Buttmann A, et al. Long term follow up of patients with chronic pancreatitis and pancreatic stones treated with extracorporeal shock wave lithotripsy. Gut 1999;45:402–5.
[26] Schneider HT, May A, Benninger J, et al. Piezoelectric shock wave lithotripsy of pancreatic duct stones. Am J Gastroenterol 1994;89:2042–8.
[27] Delhaye M, Arvanitakis M, Verset G, et al. Long-term clinical outcome after endoscopic pancreatic ductal drainage for patients with painful chronic pancreatitis. Clin Gastroenterol Hepatol 2004;2:1096–106.
[28] Garg PK. Antioxidants for chronic pancreatitis: reasons for disappointing results despite sound principles. Gastroenterology 2013;144:e19–20.
[29] Bhardwaj P, Garg PK, Maulik SK, et al. A randomized controlled trial of antioxidant supplementation for pain relief in patients with chronic pancreatitis. Gastroenterology 2009;136:149–159 e2.
[30] Siriwardena AK, Mason JM, Sheen AJ, et al. Antioxidant therapy does not reduce pain in patients with chronic pancreatitis: the ANTICIPATE study. Gastroenterology 2012;143:655–663 e1.
[31] Li BR, Liao Z, Du TT, et al. Risk factors for complications of pancreatic extracorporeal shock wave lithotripsy. Endoscopy 2014;46:1092–100.
[32] Hirata N, Kushida Y, Ohguri T, et al. Hepatic subcapsular hematoma after extracorporeal shock wave lithotripsy (ESWL) for pancreatic stones. J Gastroenterol 1999;34:713–6.
[33] Plaisier PW, den Hoed PT. Splenic abscess after lithotripsy of pancreatic duct stones. Dig Surg 2001;18:231–2.
[34] Karakayali F, Sevmis S, Ayvaz I, et al. Acute necrotizing pancreatitis as a rare complication of extracorporeal shock wave lithotripsy. Int J Urol 2006;13:613–5.
[35] Leifsson BG, Borgstrom A, Ahlgren G. Splenic rupture following ESWL for a pancreatic duct calculus. Dig Surg 2001;18:229–30.
[36] Ohyama H, Mikata R, Ishihara T, et al. Efficacy of stone density on noncontrast computed tomography in predicting the outcome of extracorporeal shock wave lithotripsy for patients with pancreatic stones. Pancreas 2015;44:422–8.
[37] Inui K, Tazuma S, Yamaguchi T, et al. Treatment of pancreatic stones with extracorporeal shock wave lithotripsy: results of a multicenter survey. Pancreas 2005;30:26–30.
[38] Ohara H, Hoshino M, Hayakawa T, et al. Single application extracorporeal shock wave lithotripsy is the first choice for patients with pancreatic duct stones. Am J Gastroenterol 1996;91:1388–94.
[39] Dumonceau JM, Costamagna G, Tringali A, et al. Treatment for painful calcified chronic pancreatitis: extracorporeal shock wave lithotripsy versus endoscopic treatment: a randomised controlled trial. Gut 2007;56:545–52.