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Comparison of Shockwave Lithotripsy Outcomes in Patients Receiving Sufentanil or Lidocaine Spinal Anesthesia

CALEB P. NELSON, M.D., TRISHA A. FRANCIS, M.D., and J. STUART WOLF, Jr., M.D.

ABSTRACT

***Purpose*. To determine whether the use of intrathecal sufentanil, which allows the patient to move during shockwave lithostripsy (SWL), affects treatment outcomes and operative and recovery times compared with standard lidocaine spinal anesthesia.**

***Patients and Methods*. We retrospectively studied a series of 62 SWL procedures performed on an unmodified Dornier HM3 lithotripter. The mean calculus size was 10.7 mm. There were 46 renal calculi, 13 ureteral calculi, and 4 patients with calculi in both locations. Of the 63 procedures, 25 were performed using intrathecal sufentanil alone, and 37 were performed with intrathecal lidocaine with or without additional agents. We compared treatment outcomes, as well as treatment time, fluoroscopy time, postanesthesia care unit (PACU) time, time to voiding, and time to ambulation.**

***Results*. Sufentanil use was associated with a significantly higher rate of successful treatment, defined as residual fragments absent or <4 mm on follow-up imaging, compared with lodocaine: 68% *v*. 40% ($p = 0.0394$). There was no significant difference between the groups in treatment time or fluoroscopy time. Use of sufentanil was associated with significantly shorter PACU time, time to ambulation, and time to voiding postoperatively. These differences persisted when men and women were analyzed separately, although the differences were less significant in women.**

***Conclusions*. The use of intrathecal sufentanil for anesthesia during SWL does not adversely affect treatment outcome; it is, in fact, associated with better outcomes. The advantages of this agent in shortening recovery times and in easing patient transfer into the HM3 gantry argue for increasing its use.**

INTRODUCTION

EXTRACORPOREAL SHOCKWAVE LITHOTRIPSY (SWL) is widely utilized for the treatment of renal and ureteral calculi. The noninvasive nature of SWL allows patients to be treated on an outpatient basis; this means that anesthesia recovery time is often the limiting factor in the patient's length of stay in the hospital. Second- and third-generation lithotripters have been developed that allow treatment at lower energy levels, which minimizes or eliminates anesthesia requirements. However, the efficacy of the newer systems is generally acknowledged to be inferior to that of the original Dornier HM3,[1] a device that usually necessitates general or regional anesthesia. At institutions where the Dornier HM3 is still used, therefore, efforts have been directed toward the development of anesthetic techniques that allow more rapid recovery and discharge.

Spinal anesthesia, with subarachnoid injection of an anesthetic agent, is commonly employed during SWL. The traditional agent is lidocaine, which produces a dense sensory and motor blockade. More recently, sufentanil been used in an effort to reduce the motor blockade and allow faster recovery. Sufentanil is an opioid agonist that, when injected intrathecally, produces effective spinal-type analgesia. Intrathecal sufentanil was initially evaluated in the treatment of labor pain.[2,3] Prospective comparisons of lidocaine and sufentanil for SWL have shown that patients receiving sufentanil for spinal anesthesia were discharged significantly faster after their treatment.[4] Subarachnoid sufentanil is now routinely used in our institution during SWL.

One consequence of the sufentanil block, as opposed to the block containing lidocaine, is that the patient is able to move the lower extremities. This is particularly helpful when using

Section of Urology, Department of Surgery, University of Michigan, Ann Arbor, Michigan.

the HM3 lithotripter, because the patient can assist in transfer to and from the treatment gantry; this process requires several assistants and a good deal of heavy lifting for the patient with traditional lidocaine spinal anesthesia. The ability to move during treatment, however, could result in shifting of the calculus away from the F2 position, resulting in less effective fragmentation. Use of sufentanil for SWL has thus raised concerns that treatment efficacy might be decreased, or that treatment and fluoroscopy times would be increased, as a result of poorly aimed shocks or patient repositioning.

To investigate the hypotheses that sufentanil regional anesthesia reduces treatment efficacy and increases treatment and fluroscopy times, we retrospectively compared treatment parameters and outcomes of SWL in patients who received either intrathecal lidocaine or intrathecal sufentanil.

PATIENTS AND METHODS

We performed a retrospective chart and operating room log review of patients undergoing SWL at the University of Michigan Hospitals. As use of sufentanil became common in this institution in 1995, we identified all patients who underwent SWL during 1994 (when lidocaine was standard) or 1996 (when sufentanil had become standard). For the 1994 cohort, we selected all patients who received intrathecal lidocaine, with or without other intrathecal agents. For the 1996 cohort, we selected all patients who received intrathecal sufentanil alone. Exclusion criteria included administration of general or epidural anesthesia, attending urologist from outside this institution, or follow-up care at another institution. Patients in the lidocaine group received one of the following intrathecal combinations: pure lidocaine, lidocaine with epinephrine, or lidocaine with sufentanil. For purpose of analysis, all patients who received lidocaine, with or without another agent, were grouped into the lidocaine cohort, as these patients all had a motor block; the sufentanil cohort consisted of patients who received pure sufentanil. There was a total of 57 patients having 63 SWL procedures (Table 1).

Spinal anesthesia was achieved using standard described techniques. Lidocaine doses ranged from 70 to 100 mg, and sufentanil doses ranged from 10 to 25 μg. Ureteral catheterization was performed prior to lithotripsy in 16 lidocaine patients (42%) and 5 sufentanil patients (21%); this difference was not significant ($P = 0.104$). The SWL was performed, after fluoroscopic positioning, using the unmodified Dornier HM3 lithotripter (Dornier Medical Systems, Marietta, GA). Following lithotripsy, patients were taken to the postanesthesia care unit (PACU) for recovery. After meeting Phase I discharge criteria, patients were transferred to the Phase II area and, after meeting Phase II criteria, were discharged home. Since the period during which these patients were treated, recovery guidelines at our institution have been changed such that patients receiving a sufentanil spinal anesthetic are not required to go to the PACU but can be transferred directly to the Phase II area.

Treatment outcome was assessed by a plain abdominal radiograph at the follow-up visit 4 weeks postoperatively. Treatment failure was defined by presence of residual stone fragments >4 mm in diameter. Data were analyzed using Statview statistical software V. 4.57 (Abacus Concepts, Inc., Berkeley, CA). The significance of associations was assessed using Fisher's exact test for categorical variables and the Mann-Whitney U test for continuous variables; p values <0.05 were considered significant.

RESULTS

Bilateral SWL was performed on four patients (three on the same day, and one on separate days), and each of these cases was counted as two procedures, as were repeat ipsilateral procedures on two patients. The only parameter in which the patients differed significantly was in the number of shocks received: 1919 ± 384 in the sufentanil group *v.* 1724 ± 397 in

Table 1. Patient and Procedure Characteristics

	Overall	*Sufentanil* (N = *25*)	*Lidocaine* (N = *38*)	P *value*[a]
Age	49.1 ± 14.2	53.1 ± 15.0	46.5 ± 13.2	0.1257
M/F	35/28	12/10	17/14	0.7961
ASA (I/II/III)	14/44/4	6/18/1	8/26/3	0.6515
BMI	29.0 ± 7.1	29.1 ± 5.1	29.0 ± 8.4	0.4434
Stone size (mm)	10.7 ± 6.2	11.0 ± 6.0	10.6 ± 6.4	0.3932
Stone position (renal/ureteral/both)	46/13/4	17/7/1	29/6/3	0.4510
Ureteral stenting	34 (21/62)	21 (5/24)	42 (16/38)	0.1043
Treatment time (min)	45.1 ± 27.0	39.0 ± 15.7	49.9 ± 31.9	0.4352
Number of shocks	1802 ± 400	1919 ± 384	1724 ± 397	0.0455
Kilovolts	21.4 ± 1.1	21.3 ± 1.3	21.4 ± 1.0	0.6567
Fluoroscopy time (min)	4.3 ± 2.7	4.8 ± 3.1	3.9 ± 2.5	0.1983
Pruritus treatment (%)	19 (12/63)	44 (11/25)	3 (1/38)	<0.0001
Nausea treatment (%)	29 (18/63)	24 (6/25)	32 (12/38)	0.5790
Additional IV sedation (%)	92 (58/63)	96 (24/25)	89 (34/38)	0.6399
Outcome (% successful)	51	68	40	0.0394

[a]For difference between the sufentanil and lidocaine groups.

the lidocaine group ($P = 0.455$). Distribution of stones by location did not differ significantly between the treatment groups. All patients tolerated the procedure well enough to be discharged home on the day of treatment. None of the patients had significant complications.

The incidence of side effects was consistent with the known profiles of these agents. As expected, pruritus was common in the sufentanil group, with 44% receiving treatment (diphenhydramine) *v* 3% in the lidocaine group ($P < 0.0001$). The incidence of nausea was more evenly distributed, with 24% of the sufentanil patients receiving treatment (prochlorperazine) *v* 32% of the lidocaine group ($P = 0.579$). Among treatment parameters (Figure 1), significant differences were observed between the sufentanil and lidocaine groups in time to ambulation (103 ± 64 *v* 170 ± 74 minutes; $P = 0.0018$), time to voiding (113 ± 63 *v* 177 ± 70 minutes; ($P = 0.0013$), and total PACU time (131 ± 69 *v* 192 ± 93 minutes; $P > 0.0085$).

Although the use of sufentanil resulted in substantial differences in times in the recovery room, there were no differences in times in the treatment room (Table 1). Fluoroscopy time tended to be greater in the sufentanil group, although not significantly so (4.8 ± 3.1 *v* 3.9 ± 2.5 minutes; $P = 0.1983$). This finding is consistent with our clinical impression that patient movement results in slightly more frequent and lengthy use of fluoroscopy to acquire and maintain targeting. However, the somewhat longer fluoroscopy time did not result in longer treat-

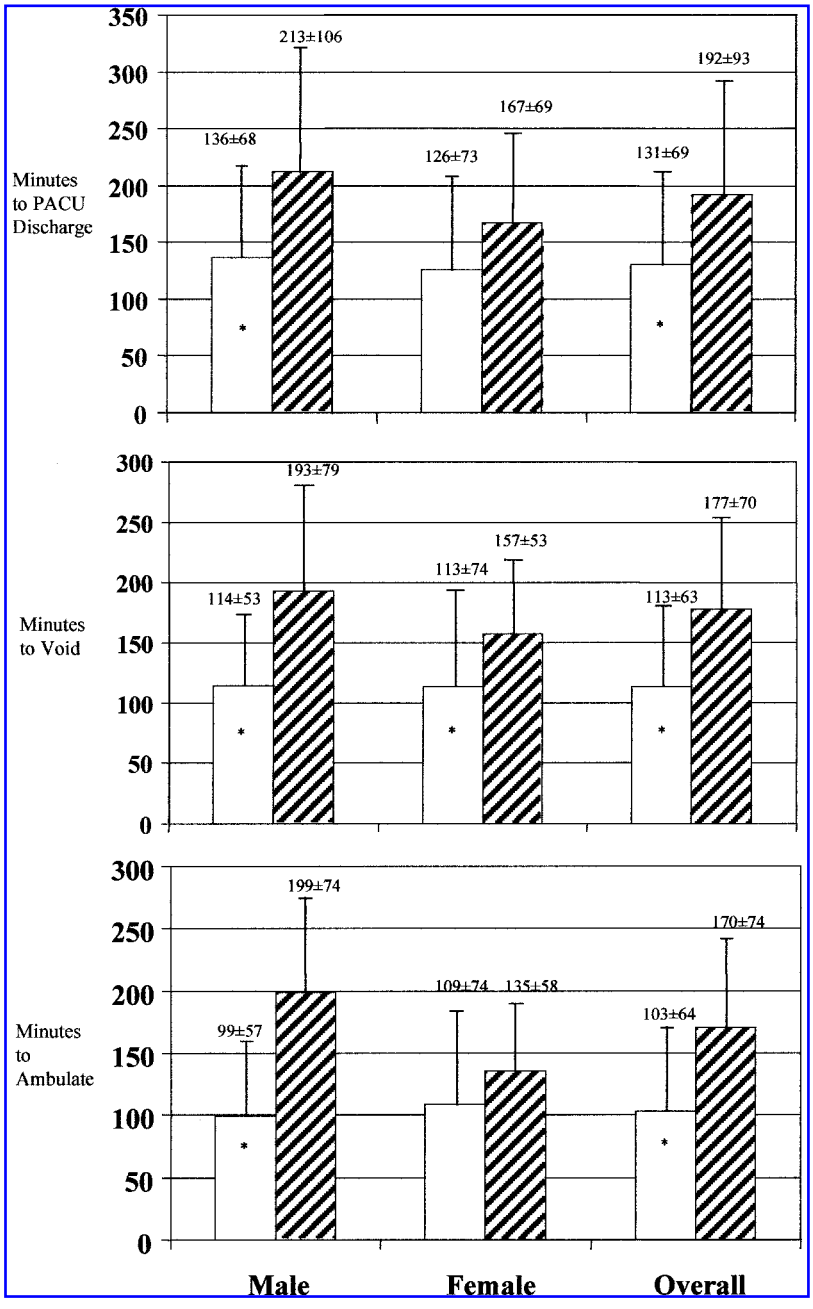

FIG. 1. PACU time, time to void, and time to ambulate after sufentanil *v* lidocaine anesthesia, analyzed overall and separately by sex. Comparisons where sufentanil and lidocaine groups differ significantly are marked by asterisks. For PACU time males: $P = 0.0466$; females: $P = 0.0670$; overall: $P = 0.0085$. For time to void males: $P = 0.0083$; females: $P = 0.0423$; overall: $P = 0.0013$. For time to ambulate males: $P = 0.0017$; females: $P = 0.1977$; overall: $P = 0.0018$. White bars, sufentanil; striped bars; lidocaine.

ment times; overall treatment times actually tended to be shorter in the sufentanil group, although again, this difference was not significant (39 ± 16 *v* 49 ± 32 minutes; $P = 0.4352$).

The overall treatment success rate was 50.8% (see Table 1). The use of intrathecal sufentanil did not have a deleterious effect on treatment outcome; in fact, use of sufentanil was associated with a notably higher incidence of successful SWL (68% *v* 39.5%), and this difference was significant ($P = 0.0394$). This improvement in outcome was observed despite the similarity in average stone size in the two cohorts, as well as similar anesthesia time.

Most patients (90%) received some additional intravenous anesthesia. For most patients (68%), this consisted only of low-dose anxiolytics (e.g., midazolam 1–10 mg), low-dose narcotic analgesics (e.g., fentanyl 0.025–0.3 mg), or a combination. Only 22% required heavy sedation with propofol, ketamine, or other agents. There were no significant differences between the treatment groups with respect to agents used for intravenous anesthesia.

When the data were analyzed separately by sex (Fig. 1), it was found that the reduction in recovery times seen with sufentanil was of greater magnitude in the male patients, and this reduction was statistically significant. Among female patients, the shorter mean time to voiding (113 ± 74 *v* 157 ± 53 minutes; $P = 0.0423$) and shorter mean PACU time (126 ± 73 *v* 167 ± 69 minutes; $P = 0.0670$) were significant and tended toward significance, respectively, while the shorter mean time to ambulation (109 ± 74 *v* 135 ± 58 minutes; $P = 0.3522$) of the sufentanil group compared with the lidocaine group was not statistically significant. Of note, female patients overall (regardless of anesthetic) had shorter recovery times than male patients (e.g., PACU time 150 ± 72 *v* 183 ± 100 minutes; $P = 0.2420$), but again, these differences did not reach statistical significance.

With regard to treatment outcomes, there was not a significant difference between men and women in overall success rates or success rates within each anesthetic group.

DISCUSSION

A wide variety of anesthesia strategies have been employed for SWL since the introduction of the technology in the early 1980s. These have ranged from general anesthesia,[5,6] epidural anesthesia,[7,8] and intravenous sedation[9] to intercostal blocks with local infiltration[10] and local topical agents.[11,12] At our institution, we utilize a Dornier HM3 lithiotripter, which generates energy levels that necessitate general or regional anesthesia to achieve adequate pain control. Heavy intravenous sedation has been used successfully with the Dornier HM3,[9] but it is the experience of the senior author that sufentanil spinal anesthesia provides a more predictable anesthetic outcome. Although 90% of our patients did receive some form of intravenous anesthetic, as noted above, most of these treatments consisted only of a low-dose anxiolytic, analgesic combinations, or both and did not result in sedation sufficient for treatment without regional anesthesia.

Eaton and Kristensen[13] reported the first use of intrathecal sufentanil for anesthesia during lithotripsy. Two subsequent randomized trials[4,14] compared the use of intrathecal lidocaine with intrathecal sufentanil for lithotripsy, and both demonstrated faster recovery from anesthesia and discharge from the PACU with sufentanil. The present study confirms these findings, but we have included follow-up data regarding treatment outcome, which show that the use of intrathecal sufentanil did not negatively impact SWL efficacy. This finding demonstrates that, although the patient is able to move during treatment, such movement does not seem to diminish our ability to target and fragment the stone effectively.

We demonstrated that total PACU time, time to ambulation, and time to voiding were all shorter with the sufentanil spinal procedure; the absence of a motor blockade allows patients to meet discharge criteria faster and leave the facility sooner. The ability of the patient to move and, therefore, to assist with transfer into the HM3 lithotripter gantry represents a major benefit of the sufentanil spinal anesthetic. It reduces the number of people (lifting help) needed in the lithotripsy suite during transfer, reduces the strain on those who are assisting the patient, and reduces the risk of injury to the patient.

The finding that treatment success was actually higher in the sufentanil group is somewhat surprising. Our underlying hypothesis—that patient movement may result in a poorer treatment outcome—appears to have been rejected. The apparent improvement in outcome with the sufentanil spinal, however, is not easily explained. The only significant difference in treatment parameters between the two groups was in number of shocks received, with the sufentanil group receiving, on average, about 200 more per treatment. While a difference of only 10% seems unlikely to have a significant impact on the outcome of lithotripsy, it is a possibility. Stone location was evenly distributed between the two treatment groups, so this is unlikely to have had a significant differential impact on the outcomes.

The conclusions of this study are limited by the fact that this was retrospective analysis. Patients were not randomized to a particular anesthetic category. Nonetheless, cohorts from two different time periods were selected, during each of which one or the other anesthetic regimen was predominant. Other treatment factors regarding SWL at this institution remained essentially constant across the time periods.

One possible confounding variable is the urologist performing the procedure. Five attending urologists were involved with these cases. Four of the urologists accounted for 86% of the cases; among the cases done by these four, 31% were done using intrathecal sufentanil, with the percentage ranging from 25 to 41 for individual urologists. The success rates for these four urologists ranged from 40% to 50%. In contrast, the fifth urologist performed 85% (8/9) of his cases using intrathecal sufentanil, and his overall success rate was 78%. This represents a potential skewing factor in the analysis. Indeed, recent data suggest that the best SWL outcomes are obtained by urologists who treat the most patients and use the highest number of shocks[15]; indeed, the fifth urologist has the most experience with SWL and used the most shocks per patient (2122). Nonetheless, when the data are analyzed excluding the nine cases performed by this physician, the superior SWL success rate with sufentanil persists, although the difference loses its significance (65% [11/17] *v* 38% [14/37]; $P = 0.0835$).

As noted above, the randomized study by Eaton and Kristensen[13] demonstrated significantly shorter recovery measures (time to ambulation, time to voiding, PACU time) for patients

who received a sufentanil spinal anesthetic. When they analyzed male and female patients separately, however, the difference in recovery measures between groups was not significant for the men. By contrast, our data show that it was the *male* cohort that demonstrated a more significant difference in time to discharge. While the male cohort in the study by Eaton and Kristensen did not show a significant difference because recovery times in the men, in both treatment groups, were universally long, the marginally significant differences in our female group result from the recovery times in the women, in both treatment groups, being universally short. Thus, we show that there is a substantial benefit to using sufentanil with regard to recovery of urinary function in men—one that is even greater than the benefit in women.

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Address reprint requests to:
J. Stuart Wolf, Jr., MD
2916 Taubman Center
1500 East Medical Center Drive
Ann Arbor, MI 48109-0330

E-mail: wolfs@umich.edu

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