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A Protocol to Reduce Self-Reported Pain Scores and Adverse Events Following Lumbar Punctures in Older Adults

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Abstract

Objective: Lumbar punctures (LPs) are important for obtaining CSF in neurology studies but are associated with adverse events and feared by many patients. We determined adverse event rates and pain scores in patients prospectively enrolled in two cohort studies who underwent LPs using a standardized protocol and 25g needle.

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Ethical Standards

These studies were conducted with approval from the Duke IRB (Pro00083288, Pro00045180) and are registered with clinicaltrials.gov (NCT01993836, NCT03273335). All persons gave their informed consent prior to their inclusion in the study.

Declaration of Conflict of Interest

MB acknowledges income from a legal consulting cases related to postoperative cognition in older adults, and material support from Massimo for a study unrelated to the data presented here. MB has also taken part in a peer-to-peer consulting session for Massimo, for which his honorarium was donated (at his request) to the Foundation for Anesthesia Education & Research. The other authors declare that they have no conflict of interest.

Methods: 809 LPs performed in 262 patients age ≥60 years in the MADCO-PC and INTUIT studies were analyzed. Medical records were monitored for LP-related adverse events, and patients were queried about subjective complaints. We analyzed adverse event rates, including headaches and pain scores.

Results: There were 22 adverse events among 809 LPs performed, a rate of 2.72% (95% CI 1.71% – 4.09%). Patient hospital stay did not increase due to adverse events. Four patients (0.49%) developed a post-lumbar puncture headache (PLPH). Twelve patients (1.48%) developed nausea, vasovagal responses, or headaches that did not meet PLPH criteria. Six patients (0.74%) reported lower back pain at the LP site not associated with muscular weakness or paresthesia. The median pain score was 1 [0, 3]; the mode was 0 out of 10.

Conclusions: The LP protocol described herein may reduce adverse event rates and improve patient comfort in future studies.

Keywords

lumbar puncture; protocol; pain; headache

INTRODUCTION

Lumbar punctures (LPs) can result in complications, such as back pain, headache, and post-lumbar puncture headache (PLPH) [1], as well as more serious complications, including infection and subarachnoid bleeding. Post-LP adverse event rates in memory clinics are ~31%; including lower back pain (17%), headache (19%), and PLPH (9%) [1]. High PLPH rates (17.5%) have also been reported in studies involving patients with neurologic diseases [2]. PLPH risk factors include previous headache history and the use of cutting type or larger bore spinal needles [1,3,4]. Additionally, procedural confidence may affect PLPH rates, since this may be a proxy for accessing the intrathecal space with fewer needle passes [5]. Minimizing PLPHs and patient discomfort are important, since many patients have concerns regarding LP safety that can decrease willingness to participate in research [6].

Here, we describe adverse event rates and pain scores in study patients who underwent LPs according to a standardized protocol. We hypothesized that adherence to this LP protocol would reduce adverse events and minimize pain.

METHODS

Patient Population

Lumbar punctures included in this analysis were performed on patients enrolled in the MADCO-PC study [7] and the first 100 patients enrolled in the INTUIT [8] study at Duke University Medical Center (Durham, NC). In the recently completed MADCO-PC study, surgical patients underwent lumbar punctures pre-operatively, 24 hours, six weeks, and 1-year post-operatively, and non-surgical controls underwent lumbar punctures at the same time intervals. The primary aim of the MADCO-PC study was to study the relationship between perioperative changes in cognition and CSF tau levels. In the ongoing INTUIT study, surgical patients underwent lumbar punctures at the same time points described

above; the primary aim of the INTUIT study is to study the relationship between perioperative changes in cognition and neuroinflammation (as measured by CSF MCP-1 levels and the CSF monocyte/lymphocyte ratio). Both studies were approved by the Duke IRB (Pro00083288, Pro00045180) and registered with clinicaltrials.gov (NCT01993836, NCT03273335). Patients were eligible for both studies if they were age ≥60 years old, English speaking, and undergoing elective non-cardiac, non-neurologic surgery scheduled for ≥2 hours. Patients were excluded if they were on anticoagulants or chemotherapy [9]. In both studies, patients underwent LPs before surgery, and at 24 hours, 6 weeks, and 1 year after surgery.

Lumbar Puncture Protocol

Patients were seated upright and leaning forward or placed in the lateral decubitus position if unable to tolerate this position. We performed LPs at L4–L5 or one interspace above or below, based on anatomic landmarks. In anatomically complicated patients, a 60mm, 5–2 MHZ curvilinear ultrasound probe was used to visualize the dura and spinal anatomy (BK Medical; Peabody, MA) [10,11], and to determine best LP site and angle/trajectory. The lower back was sprayed with 20% benzocaine (available over the counter) and we waited 10-minutes for it to anesthetize the skin.

Next, an attending anesthesiologist (or a resident/fellow under attending supervision) performed the LP with strict sterile technique using a standard Portex spinal anesthesia kit (Smiths Medical; Dublin, OH). Up to 5 cc of 1% lidocaine was injected to create a skin wheal over the desired interspace and to anesthetize the anticipated needle tract. Occasionally, anatomic complications such as osteophytes or spinal stenosis would make the LP difficult to perform at a given level, which case another level was injected with 1% lidocaine again. We waited 2 full minutes for the lidocaine to take effect. Then, a 20-gauge, 1.25-inch introducer was inserted, into which a pencil-point 25-gauge spinal needle was inserted to perform the LP. After CSF flow was confirmed, CSF was gently aspirated using a 10-mL Luer-Lock polypropylene syringe (Becton & Dickinson, Franklin Lakes, NJ) [12]. Sterile gauze was then taped over the site and the patient was instructed to lie flat for 30 minutes.

In the first four MADCO-PC patients, a 25-gauge spinal catheter (Wiley Spinal; Johnstown, NY) was used to obtain CSF at the preoperative and 24 hr postoperative time points, but we had difficulty obtaining CSF through these 25-gauge lumbar catheters and thus switched to the method described above for remaining LPs. In less than 10 subsequent LPs, there was difficulty accessing the dura with a 25-gauge pencil-point needle (Smith's Medical, Dublin, OH) typically due to anatomic abnormalities, in which case a 22-gauge Quinke needle was used [13].

Data Reporting

We monitored the electronic health record of all enrolled patients for adverse events related to the LP. Additionally, all patients were asked about subjective complaints after each LP and while they were on-site for their surgery and/or study visits. Each patient was given the study PI's contact information (including cell phone number) and instructed (both verbally

and in writing) to call at any time if they experienced headaches, nausea, fever, back pain, neck stiffness, or other symptoms of concern. Starting on March 21, 2018, pain scores (from 0 to 10) during the LP were recorded in INTUIT study patients.

Statistics

Study group characteristics were summarized using mean (SD) or median [Q1, Q3] for numeric variables and count (%) for categorical variables. Adverse event incidence was summarized with 95% Clopper-Pearson exact confidence intervals. A Kruskal-Wallis test was used to compare LP-associated pain scores by study visit/time point, since these pain scores were non-normally distributed.

RESULTS

Baseline patient demographics are listed in Table 1. A total of 809 LPs were performed: 553 LPs on 176 MADCO-PC patients and 256 LPs on 86 INTUIT patients. The maximum CSF volume collected was 13.5mL, with a median and mode of 10mL. Supplemental video 1 shows our lumbar puncture procedure. Supplemental Figure 2 shows an ultrasound image showing spine anatomy to guide needle placement during LP.

There were 22 adverse events (Table 2), for a post-LP complication rate of 2.72% (95% CI 1.71% – 4.09%). There were no infections or subarachnoid hemorrhages, and no patients had their postoperative hospital stay extended (in days) due to post-LP complications. Four patients (0.49%) developed a PLPH, of which three resolved with conservative treatment (bed rest, increased fluid and caffeine intake) [14]. One patient with a PLPH required a blood patch (0.12%), after which the PLPH resolved. Importantly, all four patients returned for subsequent LPs in the study and none had a repeat PLPH. Twelve patients (1.48%) developed nausea, a vasovagal response, or a headache that did not meet PLPH criteria. If the same patient experienced more than one of the symptoms in this subgroup after a single LP (e.g. nausea and vasovagal response) this was counted as a single adverse event. No same patient reported an AE after more than one of the four LPs at different time points. Six patients (0.74%) reported lower back pain at the LP site not associated with muscular weakness, radiating pain or paresthesia(s).

Pain during the procedure was rated ≤2 out of 10 during 125 of 165 LPs (73.3%; Figure 1). The median pain score was 1 out of 10 [0, 3] and the mode was 0 out of 10. There was no difference in LP-associated pain scores by pre-operative, 24 hours, six weeks, and 1-year post-operative time point (p=0.44) (Supplemental Figure X).

Discussion

In >800 LPs performed in two prospective cohort studies, we report a lower post-LP adverse event rate (2.72%) than seen in prior studies with similar cohorts [1,2], and a lower PLPH rate (0.49%) than the 6–36% rates previously reported [15]. In comparing our study to other published papers, one major difference is standardization of the lumbar puncture needle. For instance, in the Monserrate et al study, which had a PLPH rate of 4.4%, they stated that an atraumatic 22G or 24G needle was part of the protocol, but non-standard needles were also used (20G, 23G, 25G, 26G). The use of non-standard needles in their study was associated

with a significant risk for PLPH. Furthermore, their study found a 3.2% PLPH rate with a 22G needle. In comparison, our study used a spinal anesthesia kit with a 25G atraumatic needle and had a 0.62% PLPH rate.

These data support the safety and tolerability of the LP protocol described here, including standardized 25G atraumatic needle, topical benzocaine spray usage, timed waiting periods following topical analgesia, and ultrasound guidance when needed. Ultrasound usage has been correlated with decreased procedural pain [16–18] and topical benzocaine application has been shown to decrease pain of needle insertion [19]. Although the addition of benzocaine and ultrasound has not yet been studied for LPs, we believe that these can contribute to increased patient comfort.

One limitation of this study was the use of patient self-report and electronic health record monitoring to detect post-LP adverse events versus 24-hour follow up phone calls [20]. Nonetheless, we observed a lower PLPH rate (i.e. 0.49% vs 5.7–13.9%) than seen in other studies that similarly used patient self-report and EHR monitoring to define adverse events [15,21]. Here, all patients were given the study PI's contact information and told to call anytime if they experienced headaches or any other symptoms of concern.

We are confident that there were no serious infections such as leptomeningitis, though we cannot rule out minor self-limited infections that may have gone undetected. The data reported here are from older adults (median age of 68 years) and PLPH rates decline with age [13]. However, the adverse event rate reported here is still 5-fold lower than in other studies in this age group [2].

Since the standardized LP protocol described here resulted in low adverse event rates and pain scores, it may be useful for reducing post-LP complications and improving patient comfort in future studies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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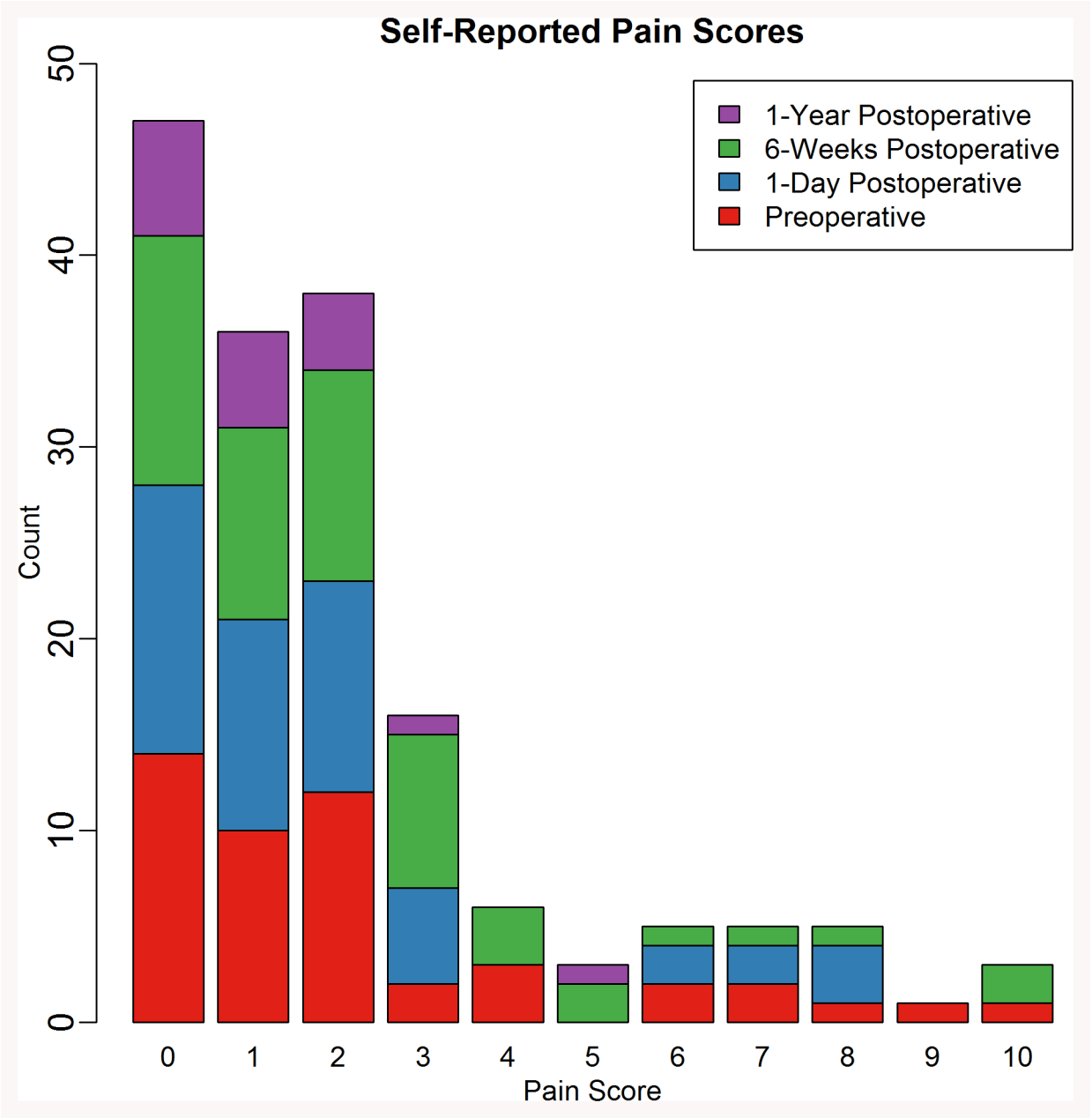

Figure 1.

Distribution of self-reported pain scores of INTUIT patients following LP. Stacked bar chart demarcates if the LP was performed at the pre-operative, post-operative, 6-week follow up, or 1 year follow up time points.

Table 1.

Summary of baseline patient characteristics for patients in the MADCO-PC and INTUIT studies. These data reflect 191 patients originally enrolled in the MADCO-PC study (of whom 15 refused LPs or dropped out of the study), and the first 100 patients enrolled in the INTUIT study (of whom 14 refused LPs or dropped out of the study). MMSE, mini mental status examination.

Variable	MADCO-PC (n=176)	INTUIT (n=86)	Total (n=262)
Age, median [Q1, Q3]	68 [64, 73]	68 [64, 72]	68 [64, 73]
Race, n (%)			
Caucasian/White	148 (84.1)	72 (83.7)	220 (84.0)
Black or African American	27 (15.3)	12 (14.0)	39 (14.9)
Asian	1 (0.6)	2 (2.3)	3 (1.1)
Gender (Female), n (%)	71 (40.3)	48 (55.8)	119 (45.4)
Years of Education, median [Q1, Q3]	16 [13, 18]	16 [13, 17]	16 [13, 18]
MMSE total Score, median [Q1, Q3]	29 [28, 29]	28 [27, 29]	29 [27, 29]
MMSE Category, n (%)			
<20	1 (0.6)	1 (1.2)	2 (0.8)
20–24	9 (5.1)	6 (7.0)	15 (5.7)
25–30	166 (94.3)	79 (91.9)	245 (93.5)

Table 2.

Summary of adverse events following lumbar punctures in the MADCO-PC and INTUIT studies. Percentages reflect the number of adverse events over the total numbers of LPs performed in each study. PLPH, post-lumbar puncture headache.

Adverse Events	MADCO-PC (n=553)	INTUIT (n=256)	Total (n=809)
Leptomeningeal infection	0	0	0
Subarachnoid hemorrhage	0	0	0
PLPH requiring blood patch	1	0	1
PLPH not requiring a blood patch	1	2	3
Non-PLPH headache, nausea, vagal responses	6	6	12
Lower back pain	4	2	6
Total Adverse Events (N)	12	10	22
Percentage	2.17%	3.91%	2.72%
Event Rate (95% CI)	(1.13, 3.76)	(1.89, 7.07)	(1.71, 4.09)