

Lumboperitoneal Shunt Surgery Under Rachianesthesia

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Research Article

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Abstract

Purpose: In the very elderly, complications such as postoperative pneumonia or delirium, which are directly associated with longer hospitalization, are more frequent. In order to overcome these drawbacks, we switched from general anesthesia to rachianesthesia for the lumboperitoneal shunt (LPS) procedure in idiopathic normal pressure hydrocephalus (iNPH) patients. This is because iNPH suffers particularly elderly patients, and neuraxial anesthesia techniques such as rachianesthesia reportedly decrease postoperative complications in patients of very advanced age as compared with general anesthesia.

Methods: We retrospectively analyzed 45 patients who underwent LPS in our institution, and divided them into two groups based on the anesthetic approach; 1) general anesthesia, 2) rachianesthesia. We analyzed these two groups with regard to postoperative delirium score and the hospital stay.

Results: In the general anesthesia group, two patients had respiratory complications after the surgery. The mean postoperative delirium score using the intensive care delirium screening checklist (ICDSC) was 1.3 (1.4) and the length of hospital stay was 13.9 (4.7) days. In the rachianesthesia group, no patients had respiratory complications. The postoperative mean ICDSC was 1.3 (1.4), and the length of hospital stay was 10.8 (2.1) days. The statistical analysis showed the rachianesthesia group to have significantly shorter hospital stays.

Conclusions: LPS under rachianesthesia is an alternative to performing this procedure under general anesthesia in elderly patients.

Introduction

Postoperative cognitive decline and delirium associated with general anesthesia reportedly occur more frequently in those over 60 years of age.[15, 4] These risks are reported to be associated with poor functional outcomes and longer hospitalization.[4, 1] Neuraxial anesthesia such as rachianesthesia reportedly decreases the aforementioned complications and provides better recovery as compared with general anesthesia, thereby reducing in-hospital mortality and the length of hospitalization.[11, 10]

Since publication of the first edition of the guidelines for management of idiopathic normal pressure hydrocephalus (iNPH) in 2004 (the English version was published in 2008) and multicenter trial to assess lumboperitoneal shunt (LPS) implantation in patients with iNPH (SINPHONI-2), rising numbers of iNPH patients have been undergoing LPS.[6, 16, 8, 13] The shunt surgeries for iNPH can, however, be problematic because the procedures are performed in very elderly patients[16, 2], which is why we select rachianesthesia for this population. Herein, we analyzed our methods focusing on the postoperative outcomes of our patients.

Patients And Methods

We retrospectively analyzed 46 patients who underwent LPS for iNPH in our institution during the period from February 2017 to January 2020, with more than 12 months of follow-up. All patients were confirmed to be free of obstructive hydrocephalus, based on having normal intracranial pressure as determined by spinal lumbar puncture, and were diagnosed as having iNPH. All patients selected LPS rather than standard VPS after they and/or their first-degree relatives received a full explanation of both procedures prior to surgery. Then, all patients selected either general anesthesia or rachianesthesia after they and/or their first-degree relatives received a full explanation of both forms of anesthesia prior to surgery. All procedures performed in this study were in accordance with the ethical standards of our institutional and national research committee, as well as with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. We also obtained approval from the ethics committee of our institution for this study. Written informed consent was obtained from all individual participants and/or their first-degree relatives, prior to inclusion in the study.

For all patients, anesthesiologists determined preoperative American Society of Anesthesiologists physical status (ASA-PS), and registered nurses determined both preoperative and postoperative delirium scores using the intensive care delirium screening checklist (ICDSC).[3, 12] Perioperative complications, postoperative symptomatic improvements, and the length of hospital stay were analyzed in all patients by three neurosurgeons. In order to control for potential confounding factors regarding the ICDSC and the length of hospital stay analyses, we excluded from this study patients who were transferred to our institution from other hospitals only for the LPS surgical procedure and those who were transferred to other hospitals after LPS regardless of their status; all of the patients in this study were non-institutionalized and had been admitted to our hospital from their own homes and were discharged to their homes (Fig. 1). In order to compare the two anesthetic approaches chosen, we divided the patients into two groups; 1) general anesthesia and 2) rachianesthesia. We analyzed these two groups with regard to postoperative complications and the length of hospital stay (Table 1).

Table 1
Patient characteristics of each group

	General anesthesia	Rachianesthesia	Total	P-values
	(n = 29)	(n = 16)	(n = 45)	
Age (years)	79.4 (5.2)	81.1 (8.3)	80.0(6.5)	0.6604
BMI	25.5 (0.3)	21.1 (2.7)	22.4 (3.0)	0.5375
ASA-PS	2.1 (0.3)	2 (0)	2.1 (0.2)	0.1879
Preoperative ICDSC	0.6 (0.8)	0.9 (0.9)	0.7 (0.9)	0.1966
Surgical time (minutes)	41.6 (33.4)	33.9 (24.0)	38.8 (30.6)	0.1760
Postoperative ICDSC	1.3 (1.4)	1.3 (1.4)	1.3 (1.3)	0.8246
Length of hospital stay (days)	13.9 (4.7)	10.8 (2.1)	12.8 (4.2)	0.0360
ASA-PS: American Society of Anesthesiologists physical status, BMI: body mass index, ICDSC: intensive care delirium screening checklist				

Patients in the general anesthesia group underwent bolus administration of propofol and/or sevoflurane, remifentanil hydrochloride, and rocuronium bromide, followed by tracheal intubation or fixation of a laryngeal mask airway. During the surgery, anesthesiologists administered these medications continually or intermittently. There was no use of sedation (i.e., dexmedetomidine hydrochloride) or neuraxial anesthesia in any patients before or after the surgery. Postoperative pain control was achieved with acetaminophen or loxoprofen sodium hydrate. The LPS procedures were as follows; a 3cm skin incision was made in the posterior lumbar region, at a site depending on the preoperatively determined level using lumbar computed tomography scans. After making this small skin incision and dissecting the subcutaneous connective tissue, we inserted a 14-gauge needle from the inter-spinous ligament or inter-lamina space (Fig. 2). After achieving lumbar puncture, we inserted a spinal catheter into the subarachnoid space and ascertained the cerebral spinal fluid outflow from this catheter. Then, we placed the indwelling valve system on the lumbar posterior side of the paravertebral spinal muscle beneath the skin of the lower back. The main component of valve system was a CODMAN CERTAS Plus programmable valve with a SiphonGuard system (Codman Neuro, MA, USA), and initial valve pressure was determined based on the patient's body weight and height, then adjusted depending on their activities and clinical manifestations as documented by periodic outpatient visits.[14]

Patients in the rachianesthesia group underwent lumbar puncture and were administered 20 milligrams of isobaric bupivacaine hydrochloride hydrate into the lumbar subarachnoid space, at a slow pace. After the anesthesiologist confirmed that the patient had no sensation beneath the ensiform process, which usually took 10 to 15 minutes while maintaining the decubitus position, we started the LPS procedures. Minimal levels of sedation with dexmedetomidine hydrochloride were used in some patients, depending on their conditions. None of the patients received additional sedation or neuraxial anesthesia either

before or after the surgery. Postoperative pain control, the LPS procedures, and valve pressure adjustments were the same as those employed in the general anesthesia group.

Results

There were 29 patients in the general anesthesia group. Preoperative ASA-PS was 2.1 (0.3) (mean (standard deviation)). All patients showed symptomatic improvement postoperatively in at least one of the following: walking, frequent urination, and cognitive function, as well as showing a score increase of at least one point on the iNPH grading scale.[9] The postoperative ICDSC was 1.3 (1.4). The length of hospital stay was 13.9 (4.7) days. Two patients had mild aspiration pneumonia after the surgery; one quickly recovered in response to oral antibiotic therapy and the other required a week of intravenous antibiotic administration before the infection resolved.

There were 16 patients in the rachianesthesia group. Preoperative ASA-PS was 2.0 (0). In one patient, we had to switch from rachianesthesia to general anesthesia during the surgery because a severe intestinal adhesion was found, necessitating that we cut the intestinal membrane, thereby creating adequate space to insert the shunt tube, and finally completed the LPS. All patients showed symptomatic improvement postoperatively in at least one of the following: walking, frequent urination, and cognitive function, as well as showing a score increase of at least one point on the iNPH grading scale. The postoperative ICDSC was 1.3 (1.4). The length of hospital stay was 10.8 (2.1) days. None of our patients developed respiratory complications after the surgery.

According to the statistical analysis results, the rachianesthesia group had a significantly shorter length of hospital stay ($p= 0.036$) (in describing demographic characteristics, p-values across each score were obtained by the Mann-Whitney U Test). A value of $P < 0.05$ was considered to indicate a statistically significant difference. SAS software [version 9.4; SAS Institute, Inc., Cary, North Carolina] was used for all statistical analyses).

Discussion

There is an increasing demand for shunt surgeries for iNPH in aging societies.[8] However, treating patients of advanced age with dementia can present challenges.[16, 2] Factors that have been implicated in increased risk for complications after surgery include advanced age, preoperative dementia, and receiving general rather than regional anesthesia.[10, 4] All of the above factors reflect the situation of shunt surgeries for iNPH patients. If feasible, surgeons should minimize these factors as much as possible. In this study, there were no postoperative respiratory complications in the rachianesthesia group, which may have contributed to the reduced length of the hospital stay in this group.

LPS does not require an intracranial procedure or subepidermal tube insertion in the upper part of the body trunk. Therefore, theoretically, it would be simple to proceed with LPS under rachianesthesia instead of using general anesthesia. However, to our knowledge, no studies have focused on this issue. Our

method is advantageous in elderly iNPH patients not only in terms of decreasing postoperative complications but also allowing shunt surgeries even in patients at high risk for general anesthesia.

The majority of neurosurgeons are still reluctant to perform LPS since certain unfavorable features of this procedure, such as low-pressure syndrome, have been reported.[17] Nonetheless, advancements in valve systems now allow pressure control across a wide range, such that problems are steadily being overcome.[13, 5] It is true that LPS remains an unfamiliar procedure compared to VPS.[7] However, LPS under neuraxial anesthesia might be a good option for performing shunt surgery in very elderly patients.

In this study, we had to change rachianesthesia to general anesthesia during the surgery in one patient because of a severe intestinal adhesion, in whom we were able to complete LPS without complications after this change. Preoperative planning for patients and surgical procedures are mandatory, and it might be better to avoid rachianesthesia in patients with a history of several prior abdominal operations. If unexpected findings, such as adhesions, are encountered intraoperatively the surgeon should be ready to switch from rachianesthesia to general anesthesia and complete the surgery by employing the optimal approach.

Limitations

The limitations of this study include the small number of patients and its retrospective design. These factors decrease the validity of our conclusion.

Conclusions

LPS under rachianesthesia is among the good options for performing this procedure and might thus result in LPS becoming more widely accepted when managing elderly iNPH patients. A randomized controlled study is needed to examine our modification of the anesthesia used for LPS surgery.

Declarations

Source of support: Non

Conflict of interest: The authors have no conflicts of interest to declare.

Details of previous presentation of the work: This manuscript has not previously been accepted nor is it being considered for publication elsewhere.

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Conflicts of interest/Competing interests: The authors have no conflicts of interest to declare.

Availability of data and material: Raw data were recorded at the corresponding author's institution from the medical records of the participants. Statistical analysis for neurological status was performed by the corresponding author and the second author. The data used in this study are available upon request from the corresponding author and the data will remain available at corresponding author's institution for 20 years, i.e. until 2041. The data are not publicly available due to their containing information that could compromise the privacy of the research participants.

Code availability: N/A

Ethics approval: We obtained approval from the ethics committee of our institution for this study.

Consent to participate: Written informed consent was obtained from all individual participants and/or their first-degree relatives, prior to inclusion in the study.

Consent for publication: We obtained approval from the ethics committee of our institution for publication of this study. Written informed consent was also obtained from all individual participants and/or their first-degree relatives for publication of this study.

Authors' contributions: Conception and design: Goto. Drafting the article: Goto. Treating the patients: Goto and Nozuchi. Analyzing the imaging data: Goto and Inoue. Critically revising the article: Inoue. All authors read and approved the final manuscript.

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Figures

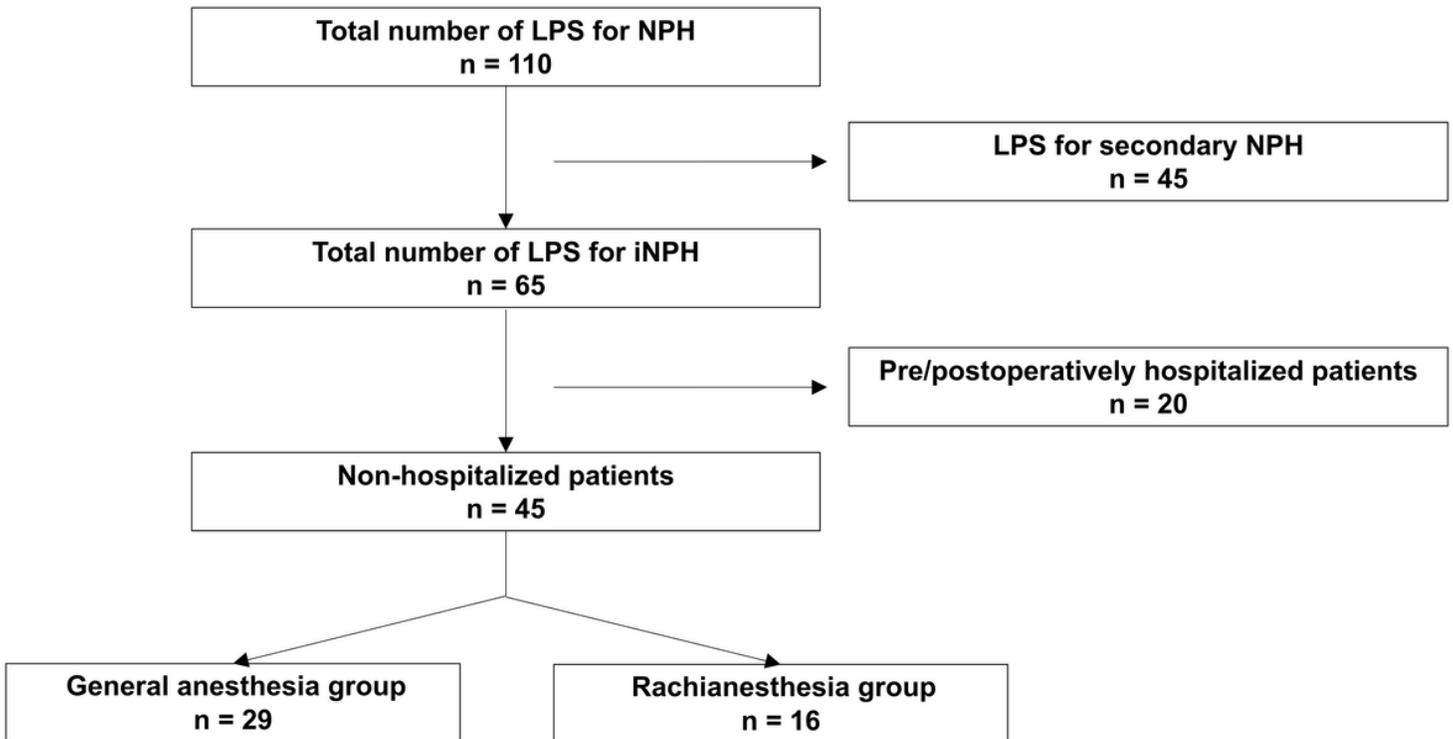
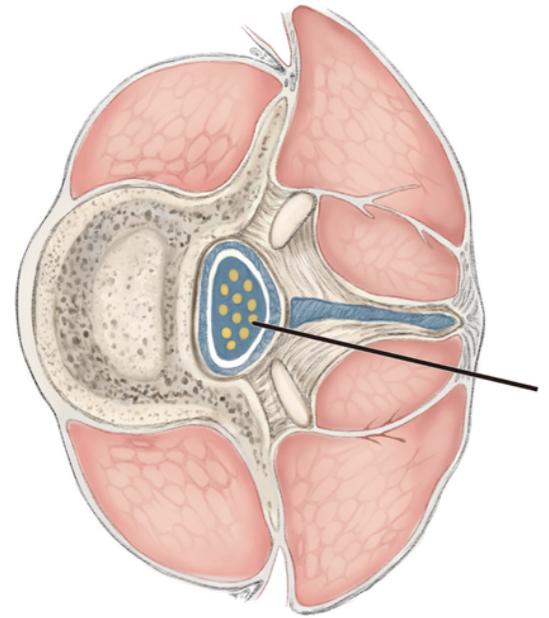
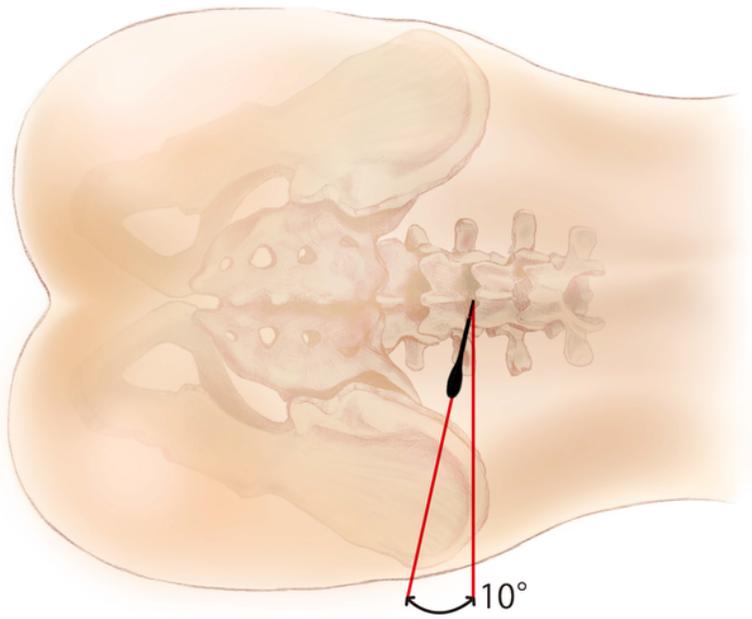


Figure 1

Participant flow diagram



A B

C D

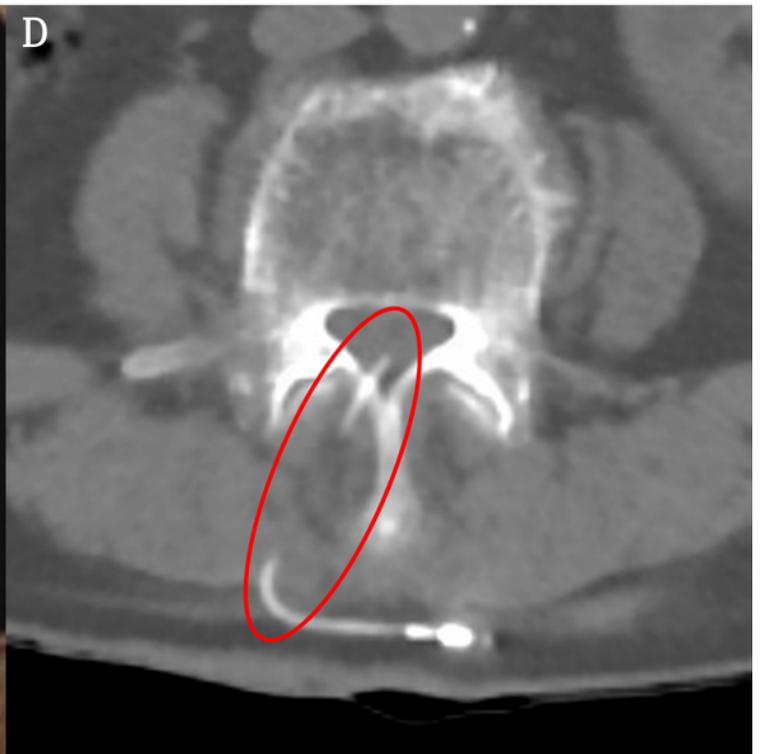
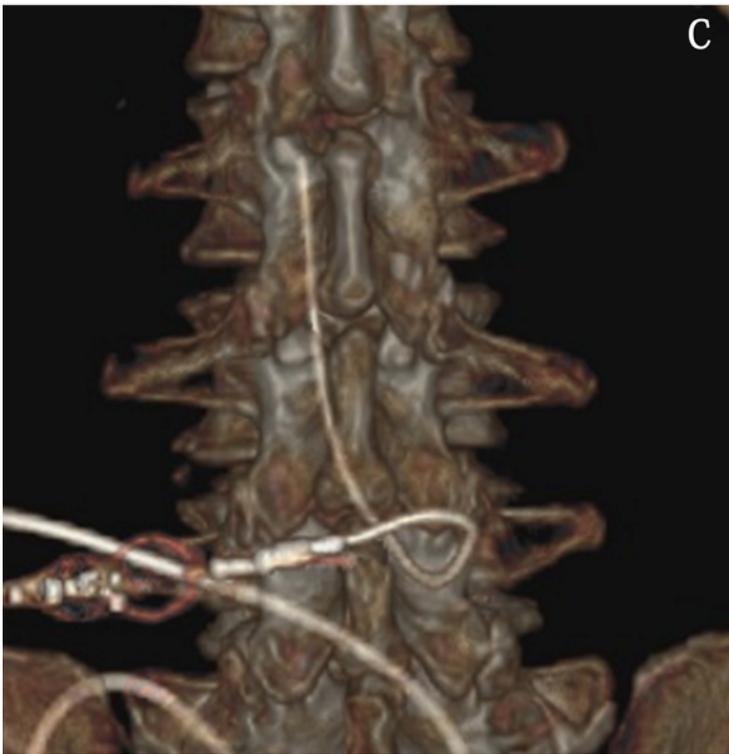


Figure 2

Figures of lumbar puncture direction and postoperative spinal CT scans

A: The red line in the figure indicates the direction and angle of the lateral lumbar puncture, which was 2.0 cm inferior and lateral to the midline, with the needle directed 10 degrees to the midline. **B:** The black line in the figure also indicates the direction and angle in the axial plane.

C: The figure is a 3-dimensional spinal CT scan. The spinal tube is inserted via the L3/4 inter-lamina space. **D:** The figure is an axial spinal CT scan. The spinal tube is inserted via the L3/4 inter-lamina space (red circle)