Prevalence and impact of incompetence of internal jugular valve on postoperative cognitive dysfunction in elderly patients undergoing robot-assisted laparoscopic radical prostatectomy

Go Un Roh[a], Won Oak Kim[b], Koon Ho Rha[c], Byung Ho Lee[a], Hae Won Jeong[a], Sungwon Na[b,*]

[a] Department of Anesthesiology and Pain Medicine, Ajou University School of Medicine, 164, World Cup-ro, Yeongtong-gu, Suwon 443-380, South Korea
[b] Department of Anesthesiology and Pain Medicine, Anesthesia and Pain Research Institute, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-752, South Korea
[c] Department of Urology, Urological Science Institute and Brain Korea 21 Project for Medical Science, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-752, South Korea

A R T I C L E   I N F O

A B S T R A C T

Internal jugular vein (IJV) is the main pathway of cerebral venous drainage and its valves prevent regurgitation of blood to the brain. IJV valve incompetence (IJVVI) is known to be associated with cerebral dysfunctions. It occurs more often in male over 50 years old, conditions elevating intra-abdominal or intra-thoracic pressure. In robot-assisted laparoscopic radical prostatectomy (RALRP), elderly male undergoes surgery in Trendelenburg position with pneumoperitoneum applied. Therefore, we assessed the IJVVI during RALRP and its influence on postoperative cognitive function. 57 patients undergoing RALRP were enrolled. Neurocognitive tests including Mini-Mental State Examination (MMSE), Auditory Verbal Learning Test, Digit Symbol Substitution Test, Color Word Stroop Test, digit span test, and grooved pegboard test were performed the day before and 2 days after surgery. During surgery, IJVVI was assessed with ultrasonography in supine position with and without pneumoperitoneum, and Trendelenburg position with pneumoperitoneum. 50 patients underwent sonographic assessment and 41 patients completed neurocognitive examination. A total of 27 patients presented IJVVI, 19 patients in supine position without pneumoperitoneum, 7 patients in supine position with pneumoperitoneum and 1 patient in Trendelenburg position with pneumoperitoneum. In neurocognitive tests, patients with IJVVI showed statistically significant decline of score in MMSE postoperatively ($p < 0.05$). IJVVI occurred in 38% in supine position but the incidence was increased to 54% after Trendelenburg position and pneumoperitoneum. Patients with IJVVI did not show significant differences in cognitive function tests except MMSE. Clinical and neurological significance of physiologic changes associated RALRP should be studied further.

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1. Introduction

Internal jugular vein (IJV) is the main pathway of cerebral venous drainage and it has valve system to prevent retrograde blood flow to the brain (Dresser & McKinney, 1987; Sanchez-Hanke, Puschel, & Leuwer, 2000). Physicians have paid great amount of attention to jugular venous pressure for hemodynamic and cerebral perfusion monitoring, however IJV valve (IJVV) abnormality which can affect IJV pressure and cerebral perfusion, has been less-noticed. Anatomical studies revealed that bicuspid or tricuspid valves were located in both jugular veins 2 cm above the subclavia-jugularis bifurcation and 7–18% of the valves were incompetent (Sanchez-Hanke et al., 2000; Silva et al., 2002). IJVV incompetence (IJVVI) may result in retrograde flow leading to brain congestion and increase of intracranial pressure (ICP), which can incur brain dysfunctions such as transient global amnesia (TGA), cough syncope, exertional headache, transient ischemic attack,

and air embolism (Doepp, Valdueza, & Schreiber, 2008; Maalikjy Akkawi et al., 2003; Nedelmann et al., 2007a; Sander et al., 2000; Styczynski et al., 2008). IJVVI is more prevalent in patients with following conditions: old age over 50 years; male; elevated intra-thoracic or intra-abdominal pressure; pulmonary hypertension (Akkawi et al., 2002; Avramov et al., 2004; D'Cruz et al., 2006).

Robot-assisted laparoscopic radical prostatectomy (RALRP) is one of the most commonly performed robotic surgeries because of its significant benefits including smaller incision, less severe postoperative pain, less intraoperative bleeding, and shorter hospital stay compared to traditional radical prostatectomy (Lee et al., 2007; Rocco et al., 2009; Sharma, Shah, & Neal, 2009). The patients undergoing RALRP are mostly over 50 years old and many of them have neurologic, cardiac and pulmonary comorbidities. For RALRP, patients are in Trendelenburg position with pneumo-peritoneum most of the time during surgery, which could cause increases in intraabdominal and intrathoracic pressure. Demo-graphic characteristics and operative procedure can make RALRP patients susceptible to IJVVI, however, it has never been evaluated for this population.

Therefore, we assessed the IJVVI during RALRP and compared the cognitive function of the subjects divided by the presence or absence of IJVVI to evaluate its clinical significance.

2. Materials and methods

2.1. Subjects

After approval by the institutional review board, 57 patients scheduled for RALRP at Severance Hospital Yonsei University gave their written informed consent and were enrolled in the study (NCT01905488). Patients who were over 50 years old, scheduled for RALRP and ASA class I or II were included. Patients who had previous neurological deficit, psychiatric diseases, alcoholism or any other drug dependence, serious hearing or visual impairment, and any other comorbidities which would preclude neuropsycho-logical tests were excluded (Kim, Kim, & Park, 2004; Monk et al., 2008).

2.2. Perioperative evaluation and management

Preoperative neurocognitive evaluation was performed the day before the surgery. During the surgery, sonographic evaluation for IJVVI was performed. Postoperative neurocognitive evaluation was performed 2 days after the surgery. Neurocognitive evaluation was performed by the same physician to prevent the inter-observer variation.

2.3. Neurocognitive assessment

The test battery comprised standard clinical tests to evaluate the cognitive function in different domain including global cognitive function, memory, psychomotor speed, executive func-tion, attention and motor function. It was appropriate for use with subjects in the age group studied, required minimal sensory or motor demands. Total administration time was approximately 30 min. Performed test battery included following exams: Mini-Mental State Examination, Korean version (MMSE); auditory verbal learning test, Korean version (AVLT); Auditory Verbal Learning Test, Digit Symbol Substitution Test (DSST); Color Word Stroop Test, Korean version (CWST); Digit Span Test (DST); Grooved Pegboard Test (GPT).

2.4. Anesthesia

Anesthesia was induced with intravenous propofol (1–1.5 mg/kg), remifentanil (0.3–0.5 mcg/kg/min) and rocuronium (0.6 mg/kg). Ventilator was adjusted to maintain inspiratory plateau pressure less than 30 cm H_2O (tidal volume at 8 ml/kg of ideal body weight or pressure controlled ventilation with inspiratory pressure of 28 cm H_2O during pneumoperitoneum) with 50% of inspired oxygen fraction of oxygen–air mixture. Respiratory rate was adjusted to maintain an end-tidal carbon dioxide (ETCO$_2$) pressure of 35–40 mmHg. After induction, the abdominal cavity was insufflated with CO_2 gas pressure set to 15 mmHg and then patients were placed in a 30° Trendelenburg position during surgery. Anesthesia was maintained with 0.8–1 minimum alveolar concentration of sevoflurane and remifentanil (0.1–0.2 mcg/kg/min). The surgeon performed the procedure at a control console located in the other side of operating room away from the operating table using the da Vinci robot surgical system (Intuitive Surgical, Sunnyvale, CA).

2.5. Sonographic assessment

Bilateral IJVV were examined with 10 MHz linear array transducer (Vivid-i, GE medical, Milwaukee, USA). The jugular blood flow direction was assessed with color Doppler and pulsed-wave Doppler at the head of the valves. The examination was performed after induction in supine with and without pneumo-peritoneum, and Trendelenburg position. Continuous retrograde flow more than 0.88 s at any side was considered to be positive for IJVVI (Nedelmann, Teschner, & Dieterich, 2007b).

2.6. Statistical analysis

Statistical analysis was performed using SPSS version 18.0 (SPSS Inc., Chicago, IL). Variables are presented as either mean with standard deviation or number as appropriate. For categorical variables, either chi-square or Fisher's exact test was performed. Either Student's t-test or Mann–Whitney U test were used for continuous variables. The difference between preoperative value and postoperative value was analyzed as well. p value less than 0.05 was considered as statistically significant.

3. Results

A total of 57 patients planning to have RALRP were enrolled for this study. Seven patients were excluded for cancellation of surgery. A total number of 50 patients underwent sonographic evaluation of IJVVI during the surgery. Among them, 41 patients completed pre- and post-operative neurocognitive assessments because 9 patients refused to take postoperative cognitive tests because of postoperative pain and discomfort.

Sonography identified bilateral valves in 45 subjects and unilateral valve in 5 patients. Nineteen patients (38%) showed IJVVI in supine position, and additional 7 patients (14%) demonstrated IJVVI after pneumoperitoneum. Only one patient showed IJVVI after Trendelenburg position and pneumoperito-neum. The rest 23 patients (46%) did not demonstrate IJVVI even after Trendelenburg position and pneumoperitoneum. To compare cognitive function, we classified 23 patients who did not show IJVVI as Group N and 27 who showed IJVVI as Group R. However, because of postoperative pain, 2 patients in group N and 7 patients in group R refused to take the postoperative cognitive tests. After exclusion of 9 patients, 21 patients for group N and 20 patients for group R were included for analysis of postoperative cognitive function. There were no significant differences in demographic data among groups (Table 1). Patients' age ranged between 56 and