Lumbo-peritoneal shunt surgery with initial valve pressure setting “Virtual off mode” for iNPH patients

T Kawahara¹, M Atsuchi¹, K Takagi¹, and K Yoshimoto²

¹Division of Neurosurgery, Atsuchi Neurosurgical Hospital, Kagoshima, Japan

²Department of Neurosurgery, Graduate School of Medical and Dental Sciences, Kagoshima University, Japan
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Introduction

Over-drainage (OD) after LP shunt surgery might cause postural headache, and severe subdural hematoma in patients with iNPH. Controllable valves are intended to prevent these complications. However, some patients suffer these complications even in the condition of highest valve setting.

**CT findings of Over drainage after LP shunt**

We have been able to use the MRI resistant programmable valve with a virtual off mode from 2016 in Japan. Here, we describe the usefulness of highest valve setting of controllable valve for initial valve setting of LPS.

**History of shunt valve systems**

- **1980**
  - Prefixed differential pressure valve: DPV
  - Flow regulated valve, Orbis Sigma valve
- **1992**
  - Programmable valve/ pressure optimization after shunting, Codman Hakim programmable valve, CHPV
- **2004**
  - MRI-resistant valve, Polaris valve
- **2008**
  - MRI-resistant gravitational valve, ProGAV
- **2009**
  - Strara NSC Shunt system
  - CHPV + SiphonGuard
- **2016**
  - MRI-resistant programmable valve with virtual off mode, Certas plus valve
Methods

We started the study of iNPH patients undergoing LPS procedure with initial valve setting 8 of Codman® CERTAS Plus valve from December 2018 to July 2019. Thirty seven patients’ outcomes were retrospectively reviewed.

Changes of outcome measures with these batteries.

- Time up & go (3 m): TUG
  Over 10% improvement rate

- Mini-Mental State examination: MMSE
  Over 3 point improvement

- Frontal assessment battery: FAB
  Over 2 point improvement

- Trail making test: TMT-A
  Over 30% improvement rate

- INPHGS
  Over 1 point improvement

The difference in Evans Index before and one week after LPS was 0.02, and it was significant.
Results

Patient outcomes one month after operation.

<table>
<thead>
<tr>
<th>Outcomes of patients with “Virtural off” mode as an initial valve pressure setting.</th>
<th>n=37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved</td>
<td>n=32 (86%)</td>
</tr>
<tr>
<td>Not improved</td>
<td>n=5 (14%)</td>
</tr>
</tbody>
</table>

![Graph showing TUG improvement 3 months after LPS](image1)

- TUG improvement 3 months after LPS: P=0.02
  - Ave. 22.6 Pre-operation, 16.5 Post-operation

![Graph showing MMSE 3 months after LPS](image2)

- MMSE 3 months after LPS: P=0.58
  - Ave. 19.8 Pre-operation, 20.2 Post-operation
Results

### Postoperative complications of cases with initial setting 8.

<table>
<thead>
<tr>
<th>Patients implanted LP shunt with Certas plus programmable valve</th>
<th>n=67</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over drainage</td>
<td>13 (19%)</td>
</tr>
<tr>
<td>Headache: not serious</td>
<td>10</td>
</tr>
<tr>
<td>required tandem valve</td>
<td>1</td>
</tr>
<tr>
<td>CSDH: not serious</td>
<td>6</td>
</tr>
<tr>
<td>required irrigation or ligation</td>
<td>1</td>
</tr>
<tr>
<td>Local wound infection</td>
<td>3 (1%)</td>
</tr>
<tr>
<td>Others*</td>
<td>4</td>
</tr>
</tbody>
</table>

* Cerebral infarction, Cardiac failure and two Femoral fractures: No relation to LP shunt surgery.
**Strategy of Valve setting for management of OD after LPS**

- **Initial pressure setting**: 8
- **OD(+) → Bed rest → OD(+) → Tandem valve**
  - Quick (after a few weeks)
- **OD(-)**
  - Slowly
  - Valve setting

OD: over drainage
Discussions

The reason we use Virtual off mode as initial valve setting.

Idiopathic normal pressure hydrocephalus is a slowly progressive disease. Complications might be caused by acute CSF flow after shunt surgery. It is reasonable to treat iNPH slowly.

The benefits of Virtual off as initial valve pressure setting.

- It might reduce OD symptoms such as orthostatic headache. So rehabilitation can be started early after surgery.
- The frequency of postoperative subdural hematomas might reduce.
- We do not have to consider the number of initial valve pressure setting.
Summary Points

• Controllable valves are useful for OD after LP shunt for iNPH patients, and highest valve pressure setting is even more useful.

• Virtual off mode as initial valve pressure can be expected to prevent postoperative OD.

• Even with this method, there are some cases that OD cannot be avoided. Such cases may require the Tandem valve method.

• Careful observation of patients is necessary in postoperative follow-up.