Clinical Study

Is shunt series X-ray necessary before revision of obstructed ventriculoperitoneal shunt?

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Abstract

Objectives: The purpose of this study is to estimate whether routine preoperative shunt series (POSS) lead to clinically relevant new information, that helps in the management of ventriculoperitoneal shunt (VPS) obstruction, focusing on its role in diagnosing mechanical causes of shunt obstruction.

**المخ恰**

أهداف البحث: إن الهدف من هذه الدراسة هو تقييم أهمية عملية فحص السائل الشعاعي على تحولية السائل الشعاعي البطينية الصناعية بصرف رنين، في علاج الأنسداد، مع التركيز على دورها في تشخيص الأسباب الميكانيكية للمشكلة.

**طرق البحث:** أجريت دراسة استقصائية على 64 مريضاً على التوالي أجريت لهم عملية تحولية علاج السائل الشعاعي البطيني الصناعي في قسم جراحة الدماغ، والأعضاء parspal الأ-error لمريض مع مع زيادة الضغط في السائل الشعاعي في الفترة من يوليوز 2002 إلى ديسمبر 2011، وانضم نسبة النجاح الإيجابي على طريقة علاج السائل الشعاعي.

**التناقصات:** تم إجراء فحص السائل الشعاعي على تحولية السائل الشعاعي لعدد 64 مريضاً قبل أختراهم علاج السائل الشعاعي، وبلغ متوسط أعمارهم 11.8 سنة وكان مثلى 25 من الإناث، وكانت النجاح الإيجابي عقب 12 مريضاً ولها دالة لحالة إنسداد أقل من 0.05، وقد تغير فحص السائل الشعاعي بعد 10 مريض منهم. وكانت النتائج الإيجابية عبر عقب علاج السائل الشعاعي عند 2 مريض منها، وكانت النتيجة الإيجابية عقب علاج السائل الشعاعي عند 1 مريض منها، ووجود القسطرة عند 4 مريض منها، ووجود القسطرة البطينية خارج الدماغ لمرسومين.
Introduction

Ventriculoperitoneal shunts (VPSs) are prone to complications, with failure rates as high as 40% within the first year after placement and 50% within 2 years. The most common types of VPS failure are obstruction and infection. Mechanical causes of obstruction may include disconnection, fracture or calcification, subgaleal coiling, intra-abdominal or extra-peritoneal catheter migration, viscus perforation and anal migration of the shunt catheter.\(^1\)\(^2\)\(^3\)\(^4\)

The diagnostic evaluation of VPS obstruction usually includes CT scan of the brain, and does not include shunt series alone. Shunt series X-ray alone is not a diagnostic tool for shunt malfunction, and POSS should be reserved for patients with proven shunt failure on CT or MRI scan. There was a significant impact of POSS on the operative decision for those undergoing revision for VPS obstruction.

**Keywords:** Preoperative shunt series; Shunt obstruction; Shunt revision; Ventriculoperitoneal shunt

Results

Sixty-nine POSS were performed for 64 patients before revision of obstructed VPS. Their mean age was 11.8 years, and 25 patients among them were females. Seventeen (24.6%) POSS had abnormal finding, that was statistically significant (\(P = 0.005\)), and only 10 of them influenced the surgical technique or choice of therapeutic procedure (\(P = 0.0001\)). Positive findings were in the form of; broken/disconnected catheter (\(n = 4\)), intra-abdominal migration of peritoneal catheter (\(n = 4\)), coiled/extra-peritoneal distal catheter (\(n = 2\)), short peritoneal end (\(n = 1\)), and retained catheter/more than one shunt (\(n = 6\)). However, majority of shunt series (75.4%) were normal.

**Conclusion:** Routine shunt series X-ray alone is not a diagnostic tool for shunt malfunction, and POSS should be reserved for patients with proven shunt failure on CT or MRI scan. There was a significant impact of POSS on the operative decision for those undergoing revision for VPS obstruction.

Materials and Methods

This study included 64 patients who underwent revision or replacement of obstructed VPS, between June 2002 and December 2011, at the neurosurgery unit of King Saud University, Riyadh, Saudi Arabia. The study focused on the POSS findings that contributed to shunt failure and the influence of positive findings on the surgical procedure performed for shunt revision.

For all patients, detailed information were collected noting patients’ age, gender, cause of hydrocephalus, type of the shunt system, and duration of VPS, history of previous revisions, assessing the proportion of abnormal POSS findings and their impact on the management of shunt obstruction.

Data were analyzed using a commercial statistical software package (SPSS, version 15.0 for Windows; SPSS, Inc., Chicago, IL).

Results

Age of the patients ranged from 3 days to 73 years, with the median age being 11.8 years. Out of 64 patients, 25 (39%) were females and 39 (61%) were males. All patients were treated as emergencies with symptoms and signs of hydrocephalus related to shunt malfunction, and underwent surgical revision or replacement of obstructed VPS. All patients had POSS, but 5 were operated twice for VPS obstruction during the study period and POSS were performed therefore twice.

Sixty-nine POSS were reviewed; 17 (24.6%) found to have abnormal finding, 10 of them influenced the surgical technique or choice of therapeutic procedure, avoiding surprises during surgery e.g. absence of distal catheter on exploring the shunt due to migration, and preparing for laparoscopic retrieval of migrated catheter. Abnormal findings were; broken/disconnected catheter (\(n = 4\)) (Figure 1), intra-abdominal migration of peritoneal catheter (\(n = 4\)) (Figure 2), coiled/extra-peritoneal distal end (\(n = 2\)) (Figure 3), short peritoneal catheter (\(n = 1\)) (Figure 4), and retained catheter/more than one shunt (\(n = 6\)) (Figure 2). However, majority of POSS (75.4%) did not show gross abnormality (Table 1).

Statistical analysis

Z-test of the percentages drawn from one sample was used, assuming that there is a significant difference if \(P < 0.05\)
Figure 1: Plain X-ray of the head and neck showing broken catheter at the neck (arrow) and its distal end is not visible (a), leaving a gap between the two ends (b) (two arrows). The distal catheter is disconnected from the valve and seen in the neck (c).

Figure 2: Shunt series showing intra-abdominal migration of peritoneal catheter (white arrow). (b) Shunt series showing a retained peritoneal catheter (white arrow), and two distal catheters (black arrows) of ventriculoperitoneal shunts are also seen.

Figure 3: (a) Shunt series showing coiled top part of distal catheter around the valve (white arrow), an occipital sac representing encephalocele (black arrow). (b) Coiled distal end extra-peritoneal causing shunt obstruction.
On comparing 17 (24.6%) POSS that had positive findings vs. 52 (75.4%) normal POSS, it showed significant statistical difference since $P = 0.0001$. Ten (14.5%) out of the 17 positive shunt series were influential in the surgical decision before shunt revision, when compared with 52 normal shunt series, it was statistically significant ($P = 0.0001$). However, there was no statistical difference on comparing the two positive groups 10/17 (58.8%) and 7/17 (41.2%) ($P > 0.05$).

**Table 1: Findings of POSS (preoperative shunt series).**

<table>
<thead>
<tr>
<th>POSS</th>
<th>No.</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal POSS</td>
<td>52/69</td>
<td>75.4</td>
</tr>
<tr>
<td>Positive POSS</td>
<td>17/69</td>
<td>24.6</td>
</tr>
<tr>
<td>Broken/disconnected catheter</td>
<td>4/17</td>
<td>23.5</td>
</tr>
<tr>
<td>Abdominal migration of peritoneal catheter</td>
<td>4/17</td>
<td>23.5</td>
</tr>
<tr>
<td>Coiled distal catheter</td>
<td>2/17</td>
<td>11.8</td>
</tr>
<tr>
<td>Short peritoneal end</td>
<td>1/17</td>
<td>5.9</td>
</tr>
<tr>
<td>Retained catheter/more than one catheter</td>
<td>6/17</td>
<td>35.3</td>
</tr>
<tr>
<td>POSS performed twice</td>
<td>5/64</td>
<td>7.8</td>
</tr>
<tr>
<td>POSS influenced surgical decision</td>
<td>10/17</td>
<td>58.8</td>
</tr>
</tbody>
</table>

**Discussion**

Ventriculoperitoneal shunt obstruction is one of the most common clinical problems encountered in neurosurgical practice. Cranial CT scan alone is usually enough to diagnose VPS malfunction, and the use of shunt series alone is not a diagnostic tool for shunt failure. Some neurosurgeons may consider it an unnecessary addition to the evaluation. Although it is made to determine the presence of mechanical breaks, kinks, and disconnections in the shunt system, that may help in the surgical procedure.

Pitteti et al. (2007) proved the importance of shunt series when they found six patients with signs and symptoms suggestive of a shunt malfunction, having a normal cranial CT scan, and abnormal shunt series (either disconnection or discontinuity). They recommended that in all cases of suspected shunt malfunction, both shunt series and a cranial CT scan should be necessary components of the evaluation. They also emphasized on that shunt series alone cannot be relied upon to diagnose shunt malfunction, and patients with signs and symptoms highly suggestive of shunt malfunction, should be investigated thoroughly. This was supported by Desai et al. (2007) who concluded that shunt series were insensitive and demonstrated a significant false-negative rate, children with suspected shunt failure should proceed directly to more advanced and reliable imaging.

Performing POSS was also useful to maintain cost effectiveness, by precisely planning for surgical procedure before shunt revision, hence avoiding the wastage of precious and limited financial resources. We may argue that POSS do not expose the patients to unjustifiable radiation, as the estimated radiation dose from a plain radiograph examination of the skull, chest, and abdomen is 525 millirem (5.28 mSv). This radiation dose is approximately equivalent to two years of background radiation.

In the King Saud University Neurosurgery unit, shunt series X-rays have become limited for patients with clinical and radiological evidence (cranial CT scan or MRI) of shunt obstruction, and admitted to the hospital for shunt revision or replacement or endoscopic third ventriculostomy and removal of the obstructed VPS.

In this study, although the majority of POSS (75.4%) did not show gross abnormality of the shunt system, when compared with 17 (24.6%) POSS that have positive findings, it showed significant statistical difference ($P = 0.0001$). The most frequent abnormal finding of shunt series in VPS obstruction is catheter breaks or disconnection, this is more likely to occur in the neck (Figure 1), owing to its increased mobility. This is in agreement with the findings in this series, where POSS showed distal catheter disconnection at the level of the valve, at the level of the calvarium or neck in 8/17 (47%).

Most of the time a POSS would not change the decision regarding the choice of operative procedure. In this series, it was observed that, 10 out of 69 POSS who ultimately were put into consideration and influenced the surgical decision ($P = 0.0001$). It was useful knowing about migrated or broken distal catheter before subjecting the patient for shunt revision or exploration. Because a small percentage of POSS is expected to be abnormal, this may explain why many neurosurgeons do not consider the POSS important in most of the cases.

In children who have had a shunt system for many years, plain X-ray films are important for detecting shunt fracture. Most shunt hardware is visible on plain X-ray film although some components are not and small gaps in a shunt system can be misinterpreted as a shunt fracture. In this series the number of POSS with positive findings was 17/69 (24.6%) Nine of these patients (53%) were shunted since 4 years or more. This suggests a positive correlation between the duration of VPS and positive findings on POSS. To the

![Figure 4: Showing short peritoneal catheter (arrow), and on surgical exploration it was found outside peritoneal cavity.](image-url)
authors knowledge the relation between positive findings in shunt series and duration of shunting were not studied before. It has been now agreed in many neurosurgery units to reserve shunt series for patients proved to have VPS obstruction and going for surgical treatment.

Conclusion

Preoperative shunt series are useful test in the management of VPS obstruction. Although shunt series alone cannot be relied upon to diagnose shunt malfunction, it should be performed as indicated by clinical and CT/MRI findings suggestive shunt obstruction, preferably before shunt revision. There is a significant impact of POSS on the operative decision for those undergoing revision for VPS obstruction.

Conflict of Interest

None.

Acknowledgment

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References