Health Policy Advisory Committee on Technology

Technology Brief

Miethke proSA® adjustable gravitational shunt for hydrocephalus

July 2014

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emerging health technology
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For further information, contact the HealthPACT Secretariat at:

HealthPACT Secretariat
c/o Clinical Access and Redesign Unit, Health Service and Clinical Innovation Division
Department of Health, Queensland
Level 2, 15 Butterfield St
HERSTON QLD 4029

Postal Address: GPO Box 48, Brisbane QLD 4001

Email: HealthPACT@health.qld.gov.au Telephone: +61 7 332 89180

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This brief was prepared by Dr Meegan Vandepeer from the Australian Safety and Efficacy Register of New Interventionsal Procedures – Surgical (ASERNIP-S).
Technology, Company and Licensing

Register ID  WP182
Technology name  Miethke proSA® adjustable gravitational shunt
Patient indication  For use in patients with hydrocephalus

Description of the technology

The Miethke proSA® adjustable gravitational shunt consists of an adjustable gravitational valve and an adjustment set containing adjustment and verification instruments, an adjustment disc, a locator and compass, and an X-ray template. Its intended use is in the treatment of paediatric and adult patients with hydrocephalus by shunting cerebrospinal fluid (CSF) from the lateral ventricles of the brain into the peritoneum. The shunt may be implanted as part of a new shunt system or added to an existing one. It is recommended it be implanted in combination with a differential pressure unit.¹

The valve part of the shunt comprises a titanium housing that contains a ball-in-cone construction at the proximal end. This consists of a tantalum weight, leaf spring and sapphire ball (Figure 1). The valve is closed by the ball, which is connected to the tantalum weight. The position of the weight and the ball are determined by the spring. The tension of the spring reflects the opening valve pressure required when the patient is upright. This tension can be adjusted externally by turning a magnetic rotor using the special adjustment tool provided.¹,²,³

Figure 1  The Miethke proSA® adjustable gravitational shunt plus adjustment tool (B. Braun Australia, Pty Ltd)

The surgical procedure for inserting the Miethke proSA® shunt is the same as for other shunts. It is done in the operating room under general anaesthesia and takes 60 to 90 minutes. The patient’s scalp is shaved and scrubbed with antiseptic. A burr hole is made in the skull to allow the proximal catheter of the shunt to be passed into the lateral ventricle of the brain. This is done with the aid of an endoscope. The other end of the shunt (the distal
catheter) is threaded under the skin down into the peritoneal cavity (the fluid-filled gap between the wall of the abdomen and the abdominal organs). The valve (the part responsible for controlling the flow of CSF), which is connected to both catheters, is placed underneath the skin behind the ear or on top of the head. The incisions are then closed and sterile bandages applied. The patient is kept under observation for around 24 hours following the procedure.\textsuperscript{4,5}

After implantation, adjustments of the Miethke proSA\textsuperscript{®} valve can be made by a clinician using the hand-held adjustment tools and then verified with the verification instrument, but these adjustments must be confirmed by imaging (e.g. X-ray). The valve contains an Active-Lock MR brake to prevent inadvertent pressure changes by external magnetic fields and magnetic resonance imaging scanners (up to 3 Tesla). A range of opening pressures from 0 to 40 cmH\textsubscript{2}O in steps of 1 cmH\textsubscript{2}O enables surgeons to manage the needs of a wide selection of patient types and needs, such as height or weight changes.\textsuperscript{1}

Although gravitational valves are not new, the Miethke proSA\textsuperscript{®} is the first adjustable gravitational valve. When implanted in combination with fixed or adjustable valves, it allows surgeons to provide different pressure settings for the lying and upright position. The upright pressure can, therefore, be managed independently from the lying pressure. Previously, surgeons had to find a ‘middle road’ pressure (a compromise between optimal lying and standing pressure). The purported benefit of being able to manage lying and upright pressures independently is a reduction in symptoms (headaches, vomiting and nausea) arising from too low or too high intracranial pressure.\textsuperscript{6}

The way in which the Miethke proSA\textsuperscript{®} works is as follows. When the patient is in the horizontal position, the weight and adjusted spring tension do not affect the ball of the Miethke proSA\textsuperscript{®} shunt, thereby ensuring that the opening pressure is 0 cmH\textsubscript{2}O. In this mode the shunt opening pressure is completely defined by the pressure setting of the differential pressure valve, which is influenced by changes in pressure at the proximal catheter tip and the pressure at the drainage end. When the patient is in the upright position the Miethke proSA\textsuperscript{®} shunt is automatically activated. The tantalum weight in the valve is pulled down by gravity, adding resistance to the ball and increasing the opening pressure of the valve. In this way the Miethke proSA\textsuperscript{®} adjustable gravitational valve and the differential pressure valve work together. CSF flow must overcome the opening pressure of both the differential pressure valve and the Miethke proSA\textsuperscript{®} valve, keeping the intraventricular pressure within physiological limits.\textsuperscript{7}

\textbf{Company or developer}

Aesculap, Inc., Center Valley, Pennsylvania, United States of America.
Reason for assessment
The Miethke proSA® adjustable gravitational shunt is an advancement in existing gravitational shunt technology used to treat hydrocephalus in that it is the first gravitational system that is adjustable, enabling the surgeon to provide different opening pressures for supine and standing positions and thereby reducing the occurrence or severity of overdrainage.

Stage of development in Australia
☐ Yet to emerge ☒ Established
☐ Experimental ☐ Established but changed indication or modification of technique
☐ Investigational ☐ Should be taken out of use
☐ Nearly established

Licensing, reimbursement and other approval
The Miethke proSA® adjustable gravitational shunt was granted United States Food and Drug Administration (FDA) 510(k) clearance in May 2012 (510(k) number: K120559)\(^2\) and has also received a CE mark.\(^8\)

Australian Therapeutic Goods Administration approval
There is one ARTG number listed for valve, hydrocephalic with B. Braun Australia Pty Ltd as the sponsor. According to a representative from the company, this Therapeutic Goods Administration number covers all their gravitational shunts, including the various Miethke proSA® adjustable gravitational shunt combinations (personal communication, B. Braun Australia Pty Ltd).

☐ Yes ARTG number (s): 181718
☐ No
☐ Not applicable

Technology type Device
Technology use Therapeutic

Patient Indication and Setting

Disease description and associated mortality and morbidity
Hydrocephalus is a disturbance in the formation, flow or absorption of CSF leading to an increase in CSF volume in the central nervous system.\(^9\) It can result from inherited genetic abnormalities, developmental disorders, complications from premature birth, disease (for
example, meningitis), tumours, head injury or subarachnoid haemorrhages that block the exit of CSF from the brain ventricles.\textsuperscript{10}

The accumulation of excess CSF in the central nervous system causes abnormally high pressure within the skull. If this pressure is not relieved it can damage the tissues of the central nervous system and dangerously restrict blood flow throughout the brain and skull. Ultimately, the prognosis is dependent on the underlying cause and the timeliness of diagnosis. Left untreated, progressive hydrocephalus is generally fatal.\textsuperscript{10}

Hydrocephalus can be congenital or acquired. Congenital hydrocephalus is present at birth either due to genetic abnormalities or events that occur during foetal development. Acquired hydrocephalus develops at the time of birth or at some point afterward, and may be caused by injury or disease.\textsuperscript{11} Hydrocephalus is further classified as communicating or non-communicating. Communicating hydrocephalus occurs when the flow of CSF is blocked after it exits the ventricles. This form is most commonly due to defective absorption of CSF and occasionally due to venous drainage insufficiency. Non-communicating hydrocephalus occurs when the flow of CSF is blocked along one or more of the passages connecting the ventricles. This can be caused by an intraventricular or extraventricular mass. There are two other forms of hydrocephalus that primarily affect adults: normal pressure hydrocephalus and hydrocephalus ex vacuo. People with normal pressure hydrocephalus experience a build-up of CSF in the brain without necessarily experiencing a significant increase in intracranial pressure. This form of hydrocephalus rarely occurs in patients younger than 60 years. In at least half of patients the cause is unknown. Hydrocephalus ex vacuo occurs when stroke or traumatic injury causes damage to the brain and potential shrinkage of brain tissue.\textsuperscript{9, 11, 12}

Symptoms of hydrocephalus are influenced by the patient’s age, the cause of the hydrocephalus, and the location of the obstruction, its duration, and rapidity of onset.\textsuperscript{9} The main symptoms are headache, nausea and vomiting. Additional symptoms for babies (0 to 18 months) include an increase in head size or rate of head growth, a soft spot on the head, poor feeding, drowsiness, eyes turning downwards or inwards, and seizures or fits. Additional symptoms for older children or adults may include blurred or double vision, poor concentration, loss of muscle coordination, confusion, incontinence, and seizures or fits.\textsuperscript{10, 11}

The tests used to diagnose hydrocephalus will depend on the patient’s age, symptoms and medical background. The key test for someone suspected of having hydrocephalus is to capture an image of the brain (either computerised tomography or magnetic resonance imaging). The image can show signs of a build-up of CSF and increased pressure in the brain as well as rule out other possible causes of the symptoms, such as a stroke or brain tumour. A lumbar puncture, where a needle is passed between two vertebrae at the lower end of the spine into the space containing the CSF, may be also be performed. During this
procedure a sample of the CSF is extracted and its pressure checked. In infants, an ultrasound of the brain through the anterior fontanelle can be conducted.10,13

**Number of patients**

Each year in Australia one in every 1000 children is born with hydrocephalus.10 According to the latest public hospital records available from the Australian Institute of Health and Welfare (AIHW), there were 1,136 separations between 2008 and 2009 for people diagnosed with hydrocephalus and 1,137 separations between 2009 and 2010 (Table 1).14

**Table 1** Separation statistics from the AIHW for hydrocephalus (ICD-10-AM G91) from 2008 to 201014

<table>
<thead>
<tr>
<th>Year</th>
<th>2008–09 Separations</th>
<th>2009–10 Separations</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICD Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G91.0</td>
<td>125</td>
<td>110</td>
</tr>
<tr>
<td>G91.1</td>
<td>166</td>
<td>152</td>
</tr>
<tr>
<td>G91.2</td>
<td>458</td>
<td>487</td>
</tr>
<tr>
<td>G91.3</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>G91.8</td>
<td>43</td>
<td>57</td>
</tr>
<tr>
<td>G91.9</td>
<td>329</td>
<td>315</td>
</tr>
</tbody>
</table>

Private hospital statistics from the Medicare Benefits Schedule showed that over the last four years (2010 to 2013) the number of services for item 40006 (lumbar shunt diversion, insertion of) ranged from 22 to 34 per year.15

No New Zealand data was identified on the number of people with hydrocephalus.

**Speciality** Neurology and Neurosurgery

**Technology setting** General hospital

**Impact**

**Alternative and/or complementary technology**

The current standard treatment for hydrocephalus is the use of a shunt. The Miethke proSA® adjustable gravitational shunt is, therefore, a substitute technology as it provides an alternative to current shunt systems. It does not replace the use of a shunt, but represents advancement in existing shunt technology. It can be implanted as part of a new shunt system or added to an existing system.

**Current technology**

In a limited number of individuals whose hydrocephalus is caused by a blocked connection between the third and fourth ventricles of the brain, an endoscopic third ventriculostomy can be performed. In this procedure, a small hole is made in the floor of the third ventricle,
allowing the CSF to bypass the obstruction and flow toward the site of resorption. However, the most common and widely used treatment for hydrocephalus is the placement of a shunt.

Shunts are thin tubes implanted into the brain to drain away excess CSF. There are two types of shunt systems, indirect and direct. An indirect shunt diverts the flow of CSF from the central nervous system to another area of the body (the abdomen, a chamber of the heart, or the lung cavity) to drain and be absorbed into the bloodstream. A direct shunt, which is less common, bypasses blockages and enables CSF to flow within existing channels. It may involve making a hole in the third ventricle to allow CSF to flow or using a catheter to divert CSF from the ventricles to the subarachnoid space.

Shunts are made up of three parts: two catheters (an inflow and an outflow) and a one-way valve that regulates the amount, flow direction and pressure of CSF out of the brain’s ventricles. Shunt systems come in a variety of configurations and models. There are two main types of shunt valves: fixed pressure and adjustable pressure. Fixed pressure valves regulate the flow rate of CSF based on a predetermined pressure setting. In adjustable valves, the flow of CSF can be adjusted from outside the body by a clinician using specially designed magnetic tools. Once adjusted to the required setting, these valves operate like a fixed pressure valve until they are re-adjusted by a clinician. In addition to fixed and adjustable valves, valves can have different operating mechanisms for regulating the flow of CSF. These mechanisms include differential pressure, gravity actuated and controlled flow. A range of accessory devices are available which can be added to shunts to modify the valve function. These include anti-siphon devices, which minimise drainage of CSF when a patient stands up, and reservoirs that provide external access to the shunt system for taking CSF samples and pressure measurements. Valve selection is based on the age of the patient, the size of the ventricles, the amount of pressure, the experience of the neurosurgeon and other clinical factors.

**Diffusion of technology in Australia**

According to a representative of B. Braun Australia Pty Ltd, the Monash Medical Centre has recently implanted two Miethke proSA® adjustable gravitational shunts and the Westmead hospital in Sydney has implanted a Miethke proGAV®-proSA® shunt combination (personal communication, B. Braun Australia Pty Ltd). No indication was provided in terms of the outcomes of these local cases, and no trials are currently underway in Australia.
International utilisation

<table>
<thead>
<tr>
<th>Country</th>
<th>Trials underway or completed</th>
<th>Limited use</th>
<th>Widely diffused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

*Level of use information provided by B. Braun Australia Pty Ltd.

Cost infrastructure and economic consequences

The Miethke proSA® adjustable gravitational shunt was listed on the Commonwealth Department of Health prostheses list (BB339 and BB340) in February 2014. The first listing (BB339) refers to the Miethke proSA® adjustable gravitational shunt combined with a differential pressure shunt (Miethke miniNAV®) and distal catheter; the second listing (BB340) refers to the Miethke proSA® and differential pressure shunt combination without the catheter. The minimum benefit for the BB340 is $2,870, which is the same as for other adjustable shunts currently available on the prosthesis list. Based on correspondence with B. Braun Australia Pty Ltd, the sponsor for this device in Australia, the price stated on the prostheses list for the standard combination of the Miethke proSA® adjustable gravitational shunt plus the Miethke miniNAV® differential pressure shunt is the price they intend to charge for this device. A range of other shunt combinations are available (for example, the Miethke proSA® adjustable gravitational shunt plus Miethke proGAV® adjustable differential shunt) and costs for these will differ (personal communication, B. Braun Australia Pty Ltd).

Ethical, cultural or religious considerations

None identified.

Evidence and Policy

Safety and effectiveness

Three case series (level IV interventional evidence) on the Miethke proSA® adjustable gravitational shunt were identified and included in this technology brief; two of these were only available in the form of a conference abstract (Table 2).
Table 2  Details of the included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Tschan et al, 2013&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Kehler and Kiefer, 2012&lt;sup&gt;17&lt;/sup&gt;</th>
<th>Tschan et al, 2012&lt;sup&gt;18&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of evidence</strong></td>
<td>Retrospective single centre case series (level IV interventional evidence)</td>
<td>Multicentre prospective case series (level IV interventional evidence)</td>
<td>Prospective case series&lt;sup&gt;a&lt;/sup&gt; (level IV interventional evidence)</td>
</tr>
<tr>
<td><strong>Number of patients enrolled</strong></td>
<td>64</td>
<td>120</td>
<td>40</td>
</tr>
<tr>
<td><strong>Duration of follow-up</strong></td>
<td>One year</td>
<td>One year</td>
<td>NR</td>
</tr>
<tr>
<td><strong>Number of patients lost to follow-up at one year</strong></td>
<td>9</td>
<td>29</td>
<td>NR</td>
</tr>
<tr>
<td><strong>Patient details</strong></td>
<td>Hydrocephalus patients (aged 1.8 to 41.4 years) undergoing shunt revision surgery owing to clinical and/or radiological overdrainage.</td>
<td>Hydrocephalus patients in the PROSAIKA registry undergoing shunt revision or first time shunt implantation. Age not specified</td>
<td>Children (aged 0.4 to 18 years) with hydrocephalus</td>
</tr>
<tr>
<td><strong>Conflicts of interest</strong></td>
<td>Three authors received some financial compensation from Aesculap Miethke AG (Tuttlingen, Germany) for attending medical conferences. The authors note no financial interest in the technique and report that no financial donations were associated with the study.</td>
<td>NR</td>
<td>NR</td>
</tr>
</tbody>
</table>

<sup>a</sup>Not stated whether it was a single or multicentre study; NR: not reported; PROSAIKA: proSA initial clinical application

**Tschan et al, 2013<sup>3</sup>**

A single centre retrospective case series evaluated the efficacy of the Miethke proSA® adjustable gravitational shunt inserted in 64 consecutive hydrocephalus patients (1.8 to 41.4 years old; 33 men and 31 women) undergoing revision surgery between April 2009 and September 2011 for clinical and/or radiological overdrainage in conjunction with previous unsuccessful conservative treatment.<sup>3</sup> Conservative treatment consisted of analgesic therapy and stepwise increases in the opening pressure of adjustable differential pressure valves. The patients, who had varying aetiologies, already had one of the following shunt combinations:

- non-adjustable differential pressure valves alone (13/64)
- non-adjustable differential pressure valves combined with an anti-siphon device or a non-programmable Miethke ShuntAssistant® (25/64)
- adjustable differential pressure valves alone (13/64)
- adjustable differential pressure valves in series with an anti-siphon device or a Miethke ShuntAssistant® (13/64).

During the shunt revision, adjustable differential pressure valves and Miethke ShuntAssistant® valves were left in situ and the Miethke proSA® adjustable gravitational valve was added to the system. Thirteen of the non-adjustable differential pressure valves were replaced by adjustable units and in 11 of these the previous opening pressures were
modified (four to a lower pressure and seven to a higher pressure). Anti-siphon devices were removed prior to implantation of the Miethke proSA® valve. The initial pressure settings of the Miethke proSA® valves were based on each patient’s clinical history, imaging study results, height, weight, age, differential pressure valve setting and, in some cases, the pressure setting of the existing Miethke ShuntAssistant®.

Postoperative follow-up occurred at 6 weeks, 3 months and 1 year after insertion of the Miethke proSA® valve at which the following were documented:

- the pumping function of the shunt valve (well pumpable/no or slow filling)
- the executed valve adjustments (step-up/step-down)
- any shunt complications and related surgical revisions
- the current clinical course compared with the preoperative state.

Clinical state was categorised as follows:

- symptom free: overdrainage – associated complaints totally resolved
- improvement: implantation of the gravitational valve counteracted overdrainage symptoms to a degree with improvement or increase in daily life activities; noticeable reduction of headaches with only occasional need for analgesics; and little or no time absent from school for children
- no change/deterioration: headaches and other signs of shunt overdrainage were unchanged and consecutively restricted mobility and daily life activities. Regular use of analgesics. This category also included deterioration due to aggravated overdrainage or new underdrainage with signs of elevated intracranial pressure.

**Efficacy**

Of the 64 patients, 55 (86%) completed the study as planned and had one-year follow-up data. Reasons for the losses to follow-up of the nine patients included change of residence or cancellation of follow-up appointments without giving specific reasons.

At one-year follow-up, 50 of the 55 patients (91%) reported resolution of symptoms and five (9%) reported acceptable improvement. With respect to the asymptomatic patients (n=13) (overdrainage conditions identified radiologically), two patients experienced temporary worsening of symptoms because of a too high pressure selection on the Miethke proSA® valve. This was rectified by a reduction in the opening pressure setting.

A total of 136 readjustments of the Miethke proSA® valve were made among the 64 patients, equating to an average of 2.1 postoperative adjustments per patient (range 0 to 6). Most of the adjustments involved increasing the pressure setting to correct overdrainage (106 adjustments in one year). The other 30 adjustments involved lowering the pressure to alleviate intracranial pressure headaches. In seven of the 64 patients (11%) no postoperative adjustments of the Miethke proSA® valve were made.
Ninety per cent of the valve chambers had adequate CSF refilling and sufficient pumping function one year after implantation of the Miethke proSA® shunt. In comparison, more than 85 per cent of the valve chambers showed no or very slow refilling with intracranial CSF preoperatively. Eleven of the 13 asymptomatic patients (85%) who had valve chamber dysfunction before surgical revision exhibited normal pumping function at the end of the study. In addition, among the 36 patients in whom re-evaluation of ventricular function could be carried out one year after implantation, 27 (75%) showed obvious enlargement of former slit ventricles.

Safety

No deaths occurred. None of the Miethke proSA® adjustable gravitational shunt valves had to be surgically revised. During the one-year follow-up period a total of 14 surgical shunt revisions in 12 different patients (three interventions in one patient) were required for the following reasons:

- peripheral shunt-catheter disconnection or fracture (four events)
- shunt infection (four events)
- migration of the distal catheter out of the peritoneal cavity (three events)
- obstruction of the ventricular catheter (one event)
- mechanical valve defects (two events).

The surgical revisions did not affect the pre-selected pressure levels of the implanted valves. The Miethke proSA® shunt was not affected by the valve defects, which involved the replacement of two differential pressure valves.

Kehler and Kiefer, 2012

A case series reported in a conference abstract discussed the first results of 120 patients in the PROSAIKA registry which is a multicentre prospective data registry aimed at assessing the safety and efficacy of the Miethke proSA® adjustable gravitational shunt. The patients had been entered into the registry between March 2009 and July 2010 and included those receiving their first shunt implant or undergoing a shunt revision. It is not stated whether they were consecutive. A total of 91 of the 120 patients (76%) completed 12 months of follow-up with clinical examination. Two patients died (reported as unrelated to the Miethke proSA® or shunt), 13 patients needed a shunt revision within 12 months, and 14 patients were lost to follow-up.

After 12 months 78 of 91 patients (86%) were clinically improved, eight (9%) were unchanged and three (3%) had deteriorated. The shunt needed readjustment due to suspected suboptimal function in 81 patients (89%). In two cases readjustment failed. The revision rate of the shunt with the Miethke proSA® (besides shunt dislocation and disconnections) was 12 per cent in 12 months. Complications deemed potentially related to the shunt (overdrainage or underdrainage) were seen in eight cases (5%).
Tschan et al, 2012\textsuperscript{18}

Also reported in a conference abstract was a case series involving 40 children aged from 0.4 to 18 years who underwent implantation of the Miethke proSA\textsuperscript{®} adjustable gravitational valve in addition to an existing programmable differential pressure valve (15 children) or in combination with the Miethke proGAV\textsuperscript{®} adjustable differential valve (25 children).\textsuperscript{18} The initial opening pressure was chosen according to experience with non-adjustable shunt assistants or with common programmable differential pressure valves. In 15 children, increasing the differential valve pressure setting was not enough to alleviate headaches related to overdrainage. Consequently, the opening pressure of the Miethke proSA\textsuperscript{®} was adjusted incrementally, which resulted in patients having fewer headaches after longer periods of being upright. Headaches that occurred overnight or in the morning prior to getting out of bed were reported in eight patients (20\%). These were successfully treated with long-time telemetric intracranial pressure monitoring at home, and by lowering the differential pressure valve and raising the Miethke proSA\textsuperscript{®} valve pressure settings to avoid overdrainage.

**Economic evaluation**

No studies evaluating the cost-effectiveness of the Miethke proSA\textsuperscript{®} adjustable gravitational shunt were identified.

**Ongoing research**

One ongoing trial involving the Miethke proSA\textsuperscript{®} adjustable gravitational shunt was identified from a search of ClinicalTrials.gov and the Australian New Zealand Clinical Trials Registry (Table 3). The trial will be conducted across four centres in the United States, namely Ohio State University, Rhode Island Hospital, Virginia Commonwealth University, together with the lead centre at Johns Hopkins University.

**Table 3  Current clinical trials evaluating the Miethke proSA\textsuperscript{®} adjustable gravitational shunt**

<table>
<thead>
<tr>
<th>Trial Identifier/Location</th>
<th>Trial status</th>
<th>N</th>
<th>Details</th>
<th>Diagnosis</th>
<th>Interventions</th>
<th>Estimated completion date</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCT01798641/USA</td>
<td>Recruiting</td>
<td>48</td>
<td>Randomised controlled trial/crossover design</td>
<td>Normal pressure hydrocephalus</td>
<td>The Miethke proGAV\textsuperscript{®} or proSA\textsuperscript{®} will be open for the first six weeks then closed for the remaining six weeks</td>
<td>March 2015</td>
</tr>
</tbody>
</table>

The goal of this study is to determine the effectiveness of the proGAV\textsuperscript{®} or proSA\textsuperscript{®} shunt and to identify the optimal surgical candidates. Primary outcomes include the difference in Kiefer and Kudo scores (measures gait/balance, cognition, urinary function and headache and dizziness) and Tinettie scores, timed up and go scores and motor conduction velocity.
gait grade (measures of walking and balance). The change in scores is determined during optimal (open) vs. suboptimal (closed) drainage. No secondary outcomes are reported.

Other issues
In the retrospective case series study by Tschan et al (2013)³, three of the authors received some financial compensation from Aesculap Miethke AG (Tuttlingen, Germany) for attending medical conferences. However, the authors declared that they did not receive financial donations associated with the study and that they have no financial interest in the current technique.

In the study by Kehler and Kiefer (2012) there are anomalies and a lack of clarity in the reporting of their results. They report that ‘after 12 months, 78 out of 91 patients were clinically improved (86%), 8 were unchanged (n=9%) and 3% (n=3) had deteriorated’. The figures they report (78, 8 and 3) only add up to 89 patients. They also report that ‘complications possibly related to the proSA were seen in 8 cases (5%)’ but it is not clear how this calculation was made (for example, whether more than one case was observed in a given patient). It is also unclear how the revision rate of the shunt with proSA® (12 per cent in 12 months) was calculated, or whether this figure included any of the 13 patients who required a shunt revision within 12 months and who were not included in the 91 patients who finished the 12 month follow-up.

Summary of findings
Three case series were available for inclusion in the technology brief which reported on the results of implantation of the Miethke proSA® adjustable gravitational shunt in a total of 224 patients. Two of the studies were only available in the form of conference abstracts and the third was a retrospective case series. The retrospective case series consisted of children and adults all undergoing revision surgery for overdrainage. Of the other case series one included patients (age not provided) who were undergoing either new shunt implantation or shunt revision, whilst the other, which was entirely on paediatric patients, did not state the inclusion criteria. Follow-up for two of the studies was 12 months and losses to follow-up ranged from 14 to 24 per cent. The case series of paediatric patients did not report the duration of follow-up or losses to follow-up.

Efficacy observations made by the two studies with 12 months follow-up included an 86 per cent clinical improvement (78/91 patients) in one study and a 91 per cent resolution of symptoms (50/55 patients) in the other. One of the studies further reported that adequate CSF refilling and sufficient pumping function improved from 15 per cent of valve chambers at baseline to 90 per cent following implantation of the Miethke proSA® adjustable gravitational shunt. The proportion of patients requiring postoperative adjustments was 89 per cent in both studies (57/64 patients in one study and 81/91 patients in the other). In one study no surgical revision of the Miethke proSA® shunt was required in the 64 patients,
whilst the other reported that the revision rate of the shunt with the proSA® was 12 per cent over 12 months but did not state what the revisions were.

The paediatric study, which did not report duration of follow-up, stated that after adjustment for overdrainage or underdrainage the children were symptom free. The number of adjustments made was not reported, nor was the time it took for patients to become symptom free.

Only two of the studies reported on safety. One study reported that complications, possibly owing to the Miethke proSA® adjustable gravitational shunt, occurred in eight cases (5%). This study also reported two deaths, but these were considered to be unrelated to the Miethke proSA® shunt. No deaths were reported in the other study.

**HealthPACT assessment**

The current available evidence on the Miethke proSA® adjustable gravitational shunt is limited and of a low level with short-term follow-up. Therefore, no judgement can be made on the efficacy and safety of this new type of hydrocephalus valve in comparison with other models currently available. Randomised controlled trials comparing the Miethke proSA® adjustable gravitational shunt to other shunts over a longer follow-up period are required. Together with other adjustable shunts the Miethke proSA® is available through the Prosthesis List and can therefore be considered an established device which may benefit certain selected patients due to a reduction in adverse events, therefore it is recommended that no further research on behalf of HealthPACT is warranted at this time.

**Number of studies included**

All evidence included for assessment in this Technology Brief has been assessed according to the revised NHMRC levels of evidence. A document summarising these levels may be accessed via the HealthPACT web site.

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<tr>
<th>Total number of studies</th>
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<tr>
<td>Total number of Level IV studies</td>
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**Search criteria to be used (MeSH terms)**

1. Hydrocephalus (tw)
2. gravitational OR gravity (tw)
3. valve OR shunt (tw)
4. 2. AND 3.
5. 1. AND 4.

**References**

1. Aesculap (2012). proSA. The adjustable gravitational valve for the treatment of hydrocephalus. [Internet]. Aesculap. Available from:


