**University of
Zurich^{UZH}**

**Zurich Open Repository and
Archive**

University of Zurich
University Library
Strickhofstrasse 39
CH-8057 Zurich
www.zora.uzh.ch

Year: 2019

Introduction of a self-holding retractor for optimized abdominal visualization in ventriculoperitoneal shunt surgery: first experiences at a single center

Krauss, Philipp ; Oertel, Markus Florian ; Stieglitz, Lennart Henning

Abstract: **OBJECTIVE:** Ventriculoperitoneal shunt implantation is a common procedure in general neurosurgery. The patient population is often fragile, ranging from elderly to pediatric patients, and avoidance of perioperative complication is of utmost importance. Abdominal catheter dislocation has been found to be a common cause for early shunt dysfunction and needs to be avoided by optimal visualization of the abdominal catheter insertion zone. Here, we introduce a self-holding wound retractor system Alexis® and demonstrate its use for abdominal shunt surgery in a series of patients. **METHODS:** We explain the use of the Alexis® self-holding wound retractor during open ventriculoperitoneal shunt surgery in a series of 16 patients operated at our institution. **RESULTS:** The self-holding retractor consists of two polymer rings connected by a polymer membrane. The deep ring is easily placed on the internal fascia of the straight muscle and circular retraction is achieved by twisting the upper ring. Free hand working can then be performed by a single surgeon with good abdominal exposure. No case of abdominal dislocation or infection occurred in our series, although no properly powered statistical analysis can be performed regarding the sample size. **CONCLUSION:** We demonstrate the Alexis® Wound Retractor, which is an easy tool for optimal visualization of the abdominal catheter insertion zone. We believe it can facilitate surgical practice of shunt surgery, especially in obese patients.

DOI: <https://doi.org/10.1007/s00701-018-03794-0>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-161552>

Journal Article

Accepted Version

Originally published at:

Krauss, Philipp; Oertel, Markus Florian; Stieglitz, Lennart Henning (2019). Introduction of a self-holding retractor for optimized abdominal visualization in ventriculoperitoneal shunt surgery: first experiences at a single center. *Acta Neurochirurgica*, 161(7):1361-1365.

DOI: <https://doi.org/10.1007/s00701-018-03794-0>

TITLE PAGE

Title:

Introduction of a self holding retractor for optimized abdominal visualization in ventriculoperitoneal shunt surgery. First experiences at a single center.

Short title:

Self holding wound retractor for VP-Shunt surgery.

AUTHOR NAMES AND AFFILIATIONS:

Philipp KRAUSS, MD¹# (P.K.), Markus Florian OERTEL, MD¹ (M.F.O), Lennart Henning STIEGLITZ, MD¹ (L.H.S.)

¹Department of Neurosurgery, University Hospital of Zurich, Zurich, Switzerland

Corresponding author: Department of Neurosurgery, University Hospital of Zurich, Frauenklinikstrasse 10, 8091 Zurich, Switzerland; ph.krauss@gmx.de; Phone: 0041/44/2552660; Fax: 0041/44/255 45 05

Abstract word count:	221
Manuscript word count:	1521
Reference count:	15
Figure count:	2
Table count:	1

Key words:

hydrocephalus, ventriculoperitoneal shunt, wound retractor, surgical technique

DECLARATION OF AUTHORSHIP and CONTRIBUTION:

All authors confirm that the manuscript and the order of listed authors has been read and approved by all named authors. L.H.S. , M.F.O. and P.K. documented and analyzed the patient data, wrote the manuscript and performed surgeries.

Conflict of interest declaration:

All authors declare that the article content was composed in the absence of any commercial or financial relationships that could mean a potential conflict of interest. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

HIGHLIGHTS:

- Safe and easy visualization of the abdominal catheter insertion zone for VP-shunting.
- Optimizing minimal invasive exposure in obese VP-shunt patients.
- Facilitating single surgeon shunt implantation

ABSTRACT

Objective: Ventriculoperitoneal shunt implantation is a common procedure in general neurosurgery. The patient population is often fragile, ranging from elderly to pediatric patients and avoidance of perioperative complication is of utmost importance. Abdominal catheter dislocation has been found to be a common cause for early shunt dysfunction and needs to be avoided by optimal visualization of the abdominal catheter insertion zone. Here we introduce a self holding wound retractor system Alexis® and demonstrate its use for abdominal shunt surgery in a series of patients.

Methods: We explain the use of the Alexis® self holding wound retractor during open ventriculoperitoneal shunt surgery in a series of 16 patients operated at our institution.

Results: The self holding retractor consists of two polymer rings connected by a polymer membrane. The deep ring is easily placed on the internal fascia of the straight muscle and circular retraction is achieved by twisting of the upper ring. Free hand working can then be performed by a single surgeon with good abdominal exposure. No case of abdominal dislocation or infection occurred in our series, although no properly powered statistical analysis can be performed regarding the sample size.

Conclusion: We demonstrate the Alexis® wound retractor, which is an easy tool for optimal visualization of the abdominal catheter insertion zone. We believe it can facilitate surgical practice of shunt surgery, especially in obese patients.

Formatiert: Englisch (Vereinigte Staaten)

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29

Abbreviations: ASA score = American Society of Anesthesiologists physical status classification system, BMI = body mass index, CDG = Clavien-Dindo classification grade, CHF = swiss franc, CSF = cerebrospinal fluid, f = female, H. comm. = communicating hydrocephalus, ICH = intracerebral hemorrhage, iNPH = idiopathic normal pressure hydrocephalus, kg = kilogram, KPS = Karnofsky performance status scale, m = male, m² = square meter, min = minute, mRS = modified ranking scale, NPH = normal pressure hydrocephalus, OP = operation, SAH = subarachnoid hemorrhage, TBI = traumatic brain injury, VP = ventriculoperitoneal, y = years.

Formatiert: Englisch (Vereinigte Staaten)

MANUSCRIPT

Introduction:

Chronic Cerebrospinal fluid (CSF) diversion is a common treatment for hydrocephalic state in a variety of neurosurgical diseases ranging from congenital malformations to idiopathic normal pressure hydrocephalus.[16] If endoscopic third ventriculostomy is not an option, CSF diversion to a body cavity can be achieved via a shunting device. Nowadays, the ventriculoperitoneal (VP) shunting, a CSF diversion from the lateral ventricle to the intraperitoneal space represents the most common surgical technique and VP-shunt surgery is a standard neurosurgical intervention.[1]

As shunt surgery is regularly performed in fragile patients for various indications, safe surgery is of utmost importance in order to keep perioperative complications to a minimum. Up to 24% of VP-Shunt patients experience shunt related complications and the type of dysfunction can vary according to the shunt age.[13,5]

Abdominal shunt dislocation regularly leads to revision surgery and may occur in 0.5%-8% of patients.[9,12,7,11] It was shown, that during the early postoperative phase, abdominal catheter misplacement or dislocation can account for up to 22% of shunt dysfunctions.[13] During surgery, proper abdominal catheter insertion can be complicated by excessive abdominal subcutaneous fat or scarred tissue from prior abdominal surgery obscuring the catheter insertion zone. Accordingly, a high body mass index (BMI) was hypothesized to be associated with abdominal catheter misplacement.[8] Here we report our first experiences with a simple tool enabling optimized abdominal visualization and minimal invasive catheter placement for VP-shunt surgery in a series of patients.

1 **Technique:**

2 *The device: The Alexis® O Wound Retractor/Protector*

3 The Alexis® O Wound Retractor/Protector (Applied Medical Technology,
4 Modesto, CA, USA) is a self holding, single use wound retractor (Figure 1 A). It's
5 application has been described in different surgical procedures including thoracic,
6 visceral and maxillofacial surgery as well as cesarean section.[2,6,14,15] The retractor is
7 formed by two polyurethane rings, interconnected via a slack polymer membrane. By
8 placing the lower ring at the respective deep layer of the surgical site it creates a tunnel
9 via soft circular tissue retraction. At the same time, the polymer membrane seals and
10 protects the exposed tissue and even provides hemostasis of small venous bleedings. The
11 device exists in different ring sizes matching various surgical procedures. The model used
12 in this article has a 4 cm ring diameter.

13

14 *Application in abdominal VP-Shunt catheter insertion:*

15 VP-Shunt surgery at our department is regularly performed by a single or two
16 surgeons. The cranial catheter is mostly inserted via burrhole trepanation at Kocher's
17 point followed by subgaleal placement of a differential pressure valve and one additional
18 retroauricular incision to facilitate subcutaneous tunneling. A 2-3cm periumbilical skin
19 incision is performed followed by blunt exposure and perpendicular incision of the
20 anterior lamina of the rectus sheath. The rectus muscle is split atraumatically and the
21 posterior lamina of the rectus sheath, together with the parietal layer of the peritoneum
22 is visualized. The shunt catheter and valve are implanted subcutaneuosly and reach the
23 abdominal insertion zone. Now the Alexis® retractor is introduced by placing the deep
24 ring below the rectus muscle onto the parietal peritoneum (Figure 1 B and C). Placement
25 of the deep ring through a very small skin incision is facilitated by tearing it in an figure

1 of 8 shape for insertion (Figure 1 B). To ensure proper manipulation of the distal catheter
2 tip for insertion, it is mandatory to pull it through the device from deep to superficial once
3 before final retractor placement (Figure 1 C). Circular wound retraction and sealing is
4 achieved by twisting the upper ring and therefore rolling the polymer membrane around
5 it in order to tighten the membrane onto the exposed tissue (Figure 1 D). After retractor
6 placement, the distal catheter can easily be inserted under sight through a pinpoint
7 incision of the posterior lamina of the rectus sheath and parietal peritoneum (Figure 2).
8 To avoid catheter displacement, a semi-tight peritoneal suture is placed to increase
9 friction of the abdominal catheter without constriction. Now the retractor can be pulled
10 out using the string which is prefixed at the lower ring.

11

12 Case series:

13 Between 04/2018 and 11/2018 we operated on 16 patients for VP-Shunt
14 implantation using this technique (Table 1). The majority of patients were male (14 male
15 vs. 2 female), with a mean age of 67.4 ± 15.3 years at surgery. Three patients had prior
16 abdominal surgery (patients 4,8 and 9). From 16 patients 15 were first implantations and
17 one received a completely new shunt system for shunt dysfunction (patient 6). Patients
18 suffered from normal pressure hydrocephalus (NPH, $n = 10$) or malresorptive
19 communicating hydrocephalus (H. comm., $n = 6$). The patients median BMI was 25.9
20 (range 17.2-40.0) kg/m^2 . The median American Society of Anesthesiologists physical
21 status classification system-score (ASA) was 3 (2-4). Mean surgery time was 45 ± 8
22 minutes. All patients are continuously followed up after surgery at the outpatient clinic
23 including clinical examination or valve adjustment if needed (mean follow up time $80 \pm$
24 62 days after surgery). Complications were registered in a standardized manner during
25 hospitalization and follow up consultations according to the Clavien-Dindo Grading scale

(CDG) for complications in surgery.[3] Three out of 16 patients experienced complications including one cranial shunt misplacement (patient 9), one cranial catheter kinking (patient 11) and one overdrainage (patient 15). Patients 9 and 11 were reoperated immediately and developed no permanent deficits. Patient 15 received non invasive valve pressure adjustment and became free of symptoms. No infections or abdominal complications occurred in our series. Every patient received a postoperative abdominal radiography (antero-posterior and lateral) which confirmed a good intraabdominal catheter placement in all 16 patients.

Ethics:

All data and images mentioned in this manuscript were acquired from our institutions neurosurgical outcome quality and safety registry, based on local ethics committee approval (Kantonale Ethikkommission KEK-ZH 2012e0244). All patients signed an informed consent for the described procedures.

Discussion:

The Alexis® retractor demonstrated here, which has already been introduced to different surgical procedures, is now used for the first time in a neurosurgical procedure. In our series of 16 patients operated with this technique 25% had shunt or surgery related complications without permanent deficits (1 cranial misplacement, 1 cranial catheter kinking, 1 overdrainage and 1 local allergic skin reaction to the disinfectant). More importantly, no abdominal surgical complications or catheter dislocations occurred. Surgery was performed within a reasonable timeframe between 30-55 minutes duration. The retractor is easily used and provides excellent visualization of the catheter insertion zone in the region of the rectus muscle. This may enhance control for the risk of abdominal

Formatiert: Englisch (Vereinigte Staaten)

1 shunt complications s. a. extraperitoneal catheter placement or incidental incision of
2 superficial intestines. It's circular retraction provides a maximized field of vision even
3 through minimized skin incisions, enables minimal invasive catheter placement and
4 limits excessive focal tissue compression that could interfere with wound healing.
5 Moreover the tight polymer membrane seals the wound surface which has been claimed
6 to reduce surgical site infections in abdominal surgery.[4] Use of the device results in
7 moderate additional costs (185.50 CHF for a set of 5). A benefit in risk reduction by the
8 Alexis® retractor remains to be shown for VP-Shunt surgery to justify its regular use. The
9 present cohort consisted mostly of patients with a good Karnofsky performance score,
10 favourable BMI, a high proportion of idiopathic normal pressure hydrocephalus and only
11 three patients with prior abdominal surgery. Therefore this could not be considered as a
12 high risk population. Still, in special conditions s. a. severely obese patients, heavily
13 scarred abdominal tissue or surgery by a single surgeon, the Alexis® retractor can
14 provide easy and excellent visualization of the abdominal insertion zone. In these cases,
15 improving the visualization of the insertion point could sometimes be enough to ensure
16 proper catheter placement and therefore be a simple method before considering a
17 laparoscopy assisted approach, which needs more complex instrumentation and the
18 presence of an additional visceral surgeon.[7] Nevertheless, in very complex cases, the
19 use of an endoscopy assisted catheter placement can still be necessary to control for
20 extensive intraabdominal adhesions that cannot be handled from extraperitoneally.[10]
21 Given the actual rates of shunt dysfunction, and here especially abdominal dislocation,
22 our cohort is not sufficiently large to draw conclusions based on statistical analysis. With
23 the present series we aim to share our technique in a detailed way and demonstrate the
24 feasibility and safety of this approach. In order to properly investigate the impact of using
25 the Alexis® retractor for VP-Shunt surgery on abdominal dislocation and infection rates,

a prospective trial with a larger sample size will be needed. Still, we are convinced that this simple technique can be a helpful tool in the neurosurgeons armamentarium and should be considered in the surgical planning.

Conclusion:

The Alexis® Wound retractor represents a simple tool, that can improve the exposure of the abdominal catheter insertion zone during VP-Shunt surgery. It can be useful in cases of obese or heavily scarred patients, if abdominal exposure can be laborious or manual retraction by a second surgeon is not possible.

References

1. Bergsneider M, Black PM, Klinge P, Marmarou A, Relkin N (2005) Surgical management of idiopathic normal-pressure hydrocephalus. *Neurosurgery* 57:S29-39; discussion ii-v
2. Cheng KP, Roslani AC, Sehha N, Kueh JH, Law CW, Chong HY, Arumugam K (2012) ALEXIS O-Ring wound retractor vs conventional wound protection for the prevention of surgical site infections in colorectal resections(1). *Colorectal Dis* 14:e346-351. doi:10.1111/j.1463-1318.2012.02943.x
3. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 240:205-213
4. Edwards JP, Ho AL, Tee MC, Dixon E, Ball CG (2012) Wound protectors reduce surgical site infection: a meta-analysis of randomized controlled trials. *Ann Surg* 256:53-59. doi:10.1097/SLA.0b013e3182570372
5. Merkler AE, Ch'ang J, Parker WE, Murthy SB, Kamel H (2017) The Rate of Complications after Ventriculoperitoneal Shunt Surgery. *World Neurosurg* 98:654-658. doi:10.1016/j.wneu.2016.10.136
6. Mubeen S, Mubeen S, Falconer D (2014) Use of the Alexis ring retractor in oral and maxillofacial surgery. *Br J Oral Maxillofac Surg* 52:470-472. doi:10.1016/j.bjoms.2014.03.002
7. Naftel RP, Argo JL, Shannon CN, Taylor TH, Tubbs RS, Clements RH, Harrigan MR (2011) Laparoscopic versus open insertion of the peritoneal catheter in ventriculoperitoneal shunt placement: review of 810 consecutive cases. *J Neurosurg* 115:151-158. doi:10.3171/2011.1.JNS101492
8. Nagasaka T, Inao S, Ikeda H, Tsugeno M, Okamoto T (2010) Subcutaneous migration of distal ventriculoperitoneal shunt catheter caused by abdominal fat pad shift--three case reports. *Neurol Med Chir (Tokyo)* 50:80-82
9. Nigim F, Critchlow JF, Schneider BE, Chen C, Kasper EM (2014) Shunting for hydrocephalus: analysis of techniques and failure patterns. *J Surg Res* 191:140-147. doi:10.1016/j.jss.2014.03.075

10. Nigim F, Thomas AJ, Papavassiliou E, Schneider BE, Critchlow JF, Chen CC, Siracuse JJ, Zinn PO, Kasper EM (2014) Ventriculoperitoneal shunting: Laparoscopically assisted versus conventional open surgical approaches. *Asian J Neurosurg* 9:72-81. doi:10.4103/1793-5482.136717
11. Schenker P, Stieglitz LH, Sick B, Stienen MN, Regli L, Sarnthein J (2018) Patients with a Normal Pressure Hydrocephalus Shunt Have Fewer Complications than Do Patients with Other Shunts. *World Neurosurg* 110:e249-e257. doi:10.1016/j.wneu.2017.10.151
12. Schucht P, Banz V, Trochsler M, Iff S, Krahenbuhl AK, Reinert M, Beck J, Raabe A, Candinas D, Kuhlen D, Mariani L (2015) Laparoscopically assisted ventriculoperitoneal shunt placement: a prospective randomized controlled trial. *J Neurosurg* 122:1058-1067. doi:10.3171/2014.9.JNS132791
13. Spirig JM, Frank MN, Regli L, Stieglitz LH (2017) Shunt age-related complications in adult patients with suspected shunt dysfunction. A recommended diagnostic workup. *Acta Neurochir (Wien)* 159:1421-1428. doi:10.1007/s00701-017-3237-6
14. Theodoridis TD, Chatzigeorgiou KN, Zepiridis L, Papanicolaou A, Vavilis D, Tzeveleki F, Tarlatzis BC (2011) A prospective randomized study for evaluation of wound retractors in the prevention of incision site infections after cesarean section. *Clin Exp Obstet Gynecol* 38:57-59
15. Tsunazuka Y, Oda M, Moriyama H (2006) Wound retraction system for lung resection by video-assisted mini-thoracotomy. *Eur J Cardiothorac Surg* 29:110-111. doi:10.1016/j.ejcts.2005.10.027
16. Wu Y, Green NL, Wrensch MR, Zhao S, Gupta N (2007) Ventriculoperitoneal shunt complications in California: 1990 to 2000. *Neurosurgery* 61:557-562; discussion 562-553. doi:10.1227/01.NEU.0000290903.07943.AF

Table 1 | List of patient characteristics. ASA score = American Society of Anesthesiologists physical status classification system; BMI = body mass index; OP = operation; y = years; m = male; m² = square meter; min = minute; f = female; KPS = Karnofsky performance status scale; mRS = modified ranking scale; CDG = Clavien-Dindo classification grade; NPH = normal pressure hydrocephalus; iNPH = idiopathic normal pressure hydrocephalus; H. comm. = communicating hydrocephalus; kg = kilogram; TBI = traumatic brain injury; ICH = intracerebral hemorrhage; SAH = subarachnoid hemorrhage.

Figure 1 | Placement of the Alexis® Wound Retractor/ Protector. **A)** The device consists of 2 semi rigid polymer rings (white: superficial, dark: deep) connected by a transparent polymer membrane and an extraction wire fixed to the deep ring. **B)** Insertion of the deep ring is facilitated by forming a figure of 8 shape. **C)** After insertion of the inner ring the membrane is still slag. Note that the catheter has to be inserted in the membrane tunnel from inside (dark / not visible) to outside (white). **D)** The membrane is spanned to induce retraction by rolling the outer ring.

Figure 2 | The abdominal exposure after installation of the Alexis® Wound Retractor / Protector. Subcutaneous fat/tissue, outer rectus fascia and muscle are retracted. The distal catheter can easily be inserted intraabdominally. (*: parietal leave of the peritoneum, #: abdominal shunt catheter, †: superficial wound retractor ring).

Formatiert: Englisch (Vereinigte Staaten)

Formatiert: Englisch (Vereinigte Staaten)

1
2
3
4
5
6
7
8
9
10
11
12