RATIONALE

Intracranial hypotension may develop after dural puncture or spinal surgery by accidental intraoperative opening of the dura. As a complication to this, several cases of accidental drainage after spinal surgery and application of negative pressure suction devices (NPSDs) have been reported [1–4]. Secondarily, intracranial hypotension may develop leading to tonsillar herniation, subdural hemorrhage, severe neurological sequel and even death.

Recently, Sporns et al. reviewed the literature published in reference to patients diagnosed with postsurgical or post-traumatic intracranial hypotension [1,4]. In 24 relevant reports that included 27 cases, in 15 cases a NPSD (including NPWT or pleural drainage after thoracic surgery or traumatism) was applied, ten had no negative pressure devices and two could not be determined for application of a suction drain. All patients with NPSD had severe neurological symptoms, while only mild symptoms were observed in cases without such devices. They concluded that the increasing use of NPSDs causes the reported condition and that acute intracranial hypotension should be considered as an explanation of postoperative neurological symptoms or coma after cranial or spinal surgery. A precise radiological examination (preferably with magnetic resonance imaging) can help to rule out intracranial hypotension and dural laceration.

In conclusion, in patients with spinal wounds, NPSDs (including pleural drainages) may be harmful and lead to more severe neurological sequel than those cases with liquoral hypotension secondary to dural laceration without negative pressure devices.

REFERENCES

[1] Sporns PB, Zimmer S, Hanning U, Zoubi T, Wölfer J, Herbort M, et al. Acute tonsillar cerebellar herniation in a patient with traumatic dural tear and VAC therapy after complex trauma. Spine J. 2015;15:e13–e16. doi:10.1016/j.spinee.2015.04.025.
[2] Grahovac G, Vilendecic M, Chudy D, Srdoc D, Skrlin J. Nightmare complication after lumbar disc surgery: cranial nontraumatic acute epidural hematoma. Spine. 2011;36:E1761–E1764. doi:10.1097/BRS.0b013e31821cb9fd.
[3] Jung YY, Ju CI, Kim SW. Bilateral subdural hematoma due to an unnoticed dural tear during spine surgery. J Korean Neurosurg Soc. 2010;47:316–318. doi:10.3340/jkns.2010.47.4.316.
[4] Sporns PB, Schwindt W, Cnyrim CD, Heindel W, Zoubi T, Zimmer S, et al. Undetected dural leaks complicated by accidental drainage of cerebrospinal fluid (CSF) can lead to severe neurological deficits. Rofo. 2016;188:451–458. doi:10.1055/s-0035-1567034.

Author: Barrett Boody

QUESTION 2: What are the risks and benefits for the use of vacuum-assisted closure (VAC) devices/PICO dressings following spine surgery?

RECOMMENDATION: The use of incisional VAC therapy (such as PICO dressings) is limited, but available literature supports its use in the prevention of dehiscence and surgical site infection (SSI) in posterior thoracolumbar deformity surgery.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 86%, Disagree: 14%, Abstain: 0% (Super Majority, Strong Consensus)

RATIONALE

Multiple case series and case reports have been published supporting the use of VAC therapy for staged treatment of deep/subfascial SSI in spine surgery, with the common use being at index or second debridement, followed by multiple VAC changes until the wound is suitable for closure [1–4]. The specific VAC techniques (such as fascia open or closed, number of suction devices, suction settings, etc.) is poorly described in available studies. Ploumis reported on 73 patients undergoing VAC therapy for deep SSI, noting an average of 1.4 procedures following VAC placement (including closure) and closure of wound at an average of 7 days. They noted that methicillin-resistant *Staphylococcus aureus* (MRSA) and polymicrobial wound infections were more likely to require subsequent debridement after index VAC placement prior to definitive closure [2]. Similarly, Mehbod described 20 similar patients with deep SSI following spine surgery treated with VAC therapy, with an average of 2.2 procedures (including closure) following index VAC placement and resolution of infection in all patients and closed wounds by 6 months [3]. Canavese described 33 pediatric patients treated with VAC therapy for deep SSI after thoracolumbar spine surgery, with only 1 case ultimately requiring partial removal of implants [5].

Complications for VAC therapy have also been widely described, including need for reoperation and/or revision of hardware, bleeding, flap closure or skin grafting, retention of foam sponge fragments and cerebrospinal fluid (CSF) leaks resulting in neurologic complications (coma, brain herniation and intracranial hemorrhage) [1,2, 6–8]. The use of VAC therapy in the setting of CSF leak should be avoided due to risks of tonsillar herniation [7]. While VAC therapy over dura has been described in cranial surgery, no publication specifically described the application of sponges over dura in spine surgery. Multiple cranial publications describe the technique for dural application as the use of the "white" sponge (polyvinyl foam), as it is hydrophilic and less adherent, with lower suction pressures (~ 50 mmHg) [9,10].

The only available paper on the application of incision VAC therapy (such as PICO dressings) for spine surgery was published by Adogwa et al., who reviewed 160 posterior thoracolumbar deformity surgeries, of which 46 used incisional negative pressure wound therapy for 3 days. The authors reported lower rates of wound dehiscence (6.38% vs. 12.28%) and lower SSI rates (10.63% vs. 14.91%) for the incisional negative pressure wound therapy group, both reaching statistical significance ($p < 0.05$) [11].

REFERENCES

[1] Jones GA, Butler J, Lieberman I, Schlenk R. Negative-pressure wound therapy in the treatment of complex postoperative spinal wound infections: complications and lessons learned using vacuum-assisted closure. J Neurosurg Spine. 2007;6(5):407–411.

[2] Ploumis A, Mehbod AA, Dressel TD, Dykes DC, Transfeldt EE, Lonstein JE. Therapy of spinal wound infections using vacuum-assisted wound closure: risk factors leading to resistance to treatment. J Spinal Disord Tech. 2008;21(5):320–323.
[3] Mehbod AA, Ogilvie JW, Pinto MR, et al. Postoperative deep wound infections in adults after spinal fusion: management with vacuum-assisted wound closure. J Spinal Disord Tech. 2005;18(1):14–17.
[4] Watt JP, Dunn RN. The use of vacuum dressings for dead space management in deep surgical site infections allows implant and bone graft retention. Global Spine J. 2017;7(8):756–761.
[5] Canavese F, Krajbich JI. Use of vacuum assisted closure in instrumented spinal deformities for children with postoperative deep infections. Indian J Orthop. 2010;44(2):177–183.
[6] Dessy LA, Serratore F, Corrias F, Parisi P, Mazzocchi M, Carlesimo B. Retention of polyurethane foam fragments during VAC therapy: a complication to be considered. Int Wound J. 2015;12(2):132–136.
[7] Sporns PB, Zimmer S, Hanning U, et al. Acute tonsillar cerebellar herniation in a patient with traumatic dural tear and VAC therapy after complex trauma. Spine J. 2015;15(7):e13–e16.
[8] Sporns PB, Schwindt W, Cnyrim CD, et al. Undetected dural leaks complicated by accidental drainage of cerebrospinal fluid (CSF) can lead to severe neurological deficits. RoFo. 2016;188(5):451–458.
[9] Prince N, Blackburn S, Murad G, et al. Vacuum-assisted closure therapy to the brain: a safe method for wound temporization in composite scalp and calvarial defects. Ann Plast Surg. 2015;74 Suppl 4:S218–S221.
[10] Mohammed-Ali RI, Khurram SA, Nahabedian V, Smith AT. Vacuum-assisted dressing for promoting granulation over the dura: technical note. British J Oral Maxillofac Surg. 2012;50(1):88–89.
[11] Adogwa O, Fatemi P, Perez E, et al. Negative pressure wound therapy reduces incidence of postoperative wound infection and dehiscence after long-segment thoracolumbar spinal fusion: a single institutional experience. Spine J. 2014;14(12):2911–2917.

Author: Jeffrey A. Rihn

QUESTION 3: What type of surgical dressing is most effective for lowering rates of surgical site infection (SSI) in patients undergoing spine surgery?

RECOMMENDATION: There are no randomized studies comparing the use of incisional negative pressure wound therapy (NPWT) to standard dry dressings in spine surgery. The World Health Organization (WHO) recommends the use of incisional NPWT for high risk surgical wounds to reduce the risk of SSI.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 86%, Disagree: 0%, Abstain: 14% (Super Majority, Strong Consensus)

RATIONALE

Incisional NPWT in the form of commercially available incisional suction dressings has recently gained popularity in the management of high-risk wounds in orthopaedic surgery.

These dressings are used at the time of index surgery primarily, with the aim of preventing wound complications such as SSI. Incisional NPWT protects the healing wound by preventing wound edge motion, improving of blood supply, removing of excess fluid and stimulating granulation tissue. A recent meta-analysis of all randomized and case-controlled trials comparing incisional NPWT to standard of care showed a reduction in SSI (50%), wound dehiscence and hospital length of stay [1]. In a pig spine model, Glaser showed improved early biomechanical properties as well as cosmesis in wounds dressed with incisional NPWT compared to standard dry dressings [2].

There are only two studies that have investigated incisional NPWT after spine surgery. A single-institution retrospective case-control study from Duke University showed a 50% decrease in wound dehiscence and a 30% decrease in SSI after a change to incisional NPWT dressing for thoracolumbar deformity wounds [3]. Similarly, a small randomized trial by Nordmeyer et al. showed a decrease in seroma and the need for nursing wound care intervention in patients who were treated with incisional NPWT [4]. The authors hypothesized that a decrease in seroma may lead to decreased SSI, but the study was underpowered to show this difference.

The 2016 WHO recommendations on intraoperative and postoperative measures for SSI prevention proposed prophylactic NPWT on primarily closed surgical incisions in high-risk wounds to reduce the incidence of SSI [5]. This recommendation drew on evidence from abdominal, thoracic and orthopaedic surgery.

In the absence of high-quality randomized trials and given the WHO recommendation, it would be reasonable to use incisional NPWT in settings where the surgeon believes the wound is at risk of infection or breakdown. Spine wounds at high risk of infection include those in patients with diabetes, increased BMI, extended operative times and chronic steroid use [6,7]. In the pediatric spine population, risk factors for SSI include high weight centile, neuromuscular scoliosis, greater comorbidities and prolonged operative time [8].

REFERENCES

[1] Strugala V, Martin R. Meta-analysis of comparative trials evaluating a prophylactic single-use negative pressure wound therapy system for the prevention of surgical site complications. Surg Infect (Larchmt). 2017;18:810–819. doi:10.1089/sur.2017.156.
[2] Glaser DA, Farnsworth CL, Varley ES, Nunn TA, Sayad-Shah M, Breisch EA, et al. Negative pressure therapy for closed spine incisions: a pilot study. Wounds. 2012;24:308–316.
[3] Adogwa O, Fatemi P, Perez E, Moreno J, Gazcon GC, Gokaslan ZL, et al. Negative pressure wound therapy reduces incidence of postoperative wound infection and dehiscence after long-segment thoracolumbar spinal fusion: a single institutional experience. Spine J. 2014;14:2911–2917. doi:10.1016/j.spinee.2014.04.011.
[4] Nordmeyer M, Pauser J, Biber R, Jantsch J, Lehrl S, Kopschina C, et al. Negative pressure wound therapy for seroma prevention and surgical incision treatment in spinal fracture care. Int Wound J. 2016;13:1176–1179. doi:10.1111/iwj.12436.
[5] Allegranzi B, Zayed B, Bischoff P, Kubilay NZ, de Jonge S, de Vries F, et al. New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. Lancet Infect Dis. 2016;16:e288–e303. doi:10.1016/S1473-3099(16)30402-9.
[6] Olsen MA, Mayfield J, Lauryssen C, Polish LB, Jones M, Vest J, et al. Risk factors for surgical site infection in spinal surgery. J Neurosurg. 2003;98:149–155.
[7] Sebastian A, Huddleston P, Kakar S, Habermann E, Wagie A, Nassr A. Risk factors for surgical site infection after posterior cervical spine surgery: an analysis of 5,441 patients from the ACS NSQIP 2005-2012. Spine J. 2016;16:504–509. doi:10.1016/j.spinee.2015.12.009.
[8] Croft LD, Pottinger JM, Chiang HY, Ziebold CS, Weinstein SL, Herwaldt LA. Risk factors for surgical site infections after pediatric spine operations. Spine. 2015;40:E112–E119. doi:10.1097/BRS.0000000000000693.