



Clinical Studies

The role of the plastic surgeon in wound repair after spinal surgery

Ashley M Brown^a, Salah Rubayi^{a,b,*}^a Division of Plastic and Reconstructive Surgery, Keck School of Medicine of USC, 1510 San Pablo Street, Suite 415, Los Angeles 90033, CA, United States^b Department of Surgery, Rancho Los Amigos Hospital, Rancho Los Amigos Hospital, 7601 E Imperial Highway, Downey 900242, CA, United States

ARTICLE INFO

Keywords:

Wound
Dehiscence
Myocutaneous
Obesity
Trauma

ABSTRACT

Background: Wound complications, including dehiscence and surgical site infections, following spinal surgery have the potential to be devastating both to the patient and to the hospital system. Complications can occur in a wide range of patients including diabetics, those of low or high BMI and those of old age. Obese patients and those with increased subcutaneous fat are at particularly high risk for wound complications, which may be mitigated through use of local flap reconstruction by a Plastic Surgeon.

Case Description: A 28 year-old female with morbid obesity presents with multiple lumbar transverse process fractures and complex sacral and pelvic fractures requiring closed reduction and percutaneous fixation of the pelvic ring followed by posterior spinal fusion. The patient was closed tension-free by the neurosurgery team and ultimately dehisced requiring consultation and management by Plastic Surgery.

Outcome: The patient underwent debridement and reconstruction with a gluteus maximus myocutaneous flap advancement without complication.

Conclusions: Wound management after spinal surgery is a complex problem, which may be prophylaxed through early identification of high-risk patients and preoperative consultation of Plastic Surgery. Patients with increased thickness of subcutaneous fat are at particularly high risk for postoperative complications, including infection and dehiscence, secondary to increased tissue manipulation and necrosis.

Background

The incidence of complication after spinal surgery, including wound dehiscence and surgical site infection, is reported to be between 2 and 20% [1–4]. This number increases to 40% in high-risk patients, including those with a high BMI, multiple medical comorbidities, a history of radiation, a history of spinal surgery, long operative times and multilevel surgery [2,5–9]. Wound complications following spinal surgery have the potential to be devastating and, in severe cases, may lead to hardware exposure, multiple reoperations, increased resource use, long-term disability and even death [10–14]. To mitigate risk for these post-operative complications, closure after spinal surgery in high-risk patients is more and more frequently performed by a Plastic Surgeon at the index spinal surgery. Closure options range from multilayer closure to local muscle and fasciocutaneous flaps [15, 16]. Use of these techniques is associated with decreased post-operative wound complications and readmission rates [17,18].

In the case presented below, a tension-free closure was initially performed by the Neurosurgery team. The patient's wound ultimately dehisced, requiring Plastic Surgery consultation and management. We pro-

pose an explanation for failure of the surgical closure in this otherwise low-risk patient and offer suggestions for future prophylaxis.

Case description

Presentation

The patient is a 28 year-old morbidly obese (BMI 46) female with history of schizophrenia who was struck by a train while standing on the tracks. The patient sustained injuries including left L2 through L5 transverse process and right L4 transverse process fractures as well as complex sacral and pelvic fractures, including left acetabulum, superior pubic ramus root, the inferior pubic ramus and zone 2 left hemi sacrum (Fig. 1 and 2). The patient was stabilized and placed in lower extremity skeletal traction until return to the operating room for combined surgery with the Orthopedic and Neurosurgery teams. The patient underwent closed reduction and percutaneous fixation of the posterior pelvic ring with transiliac and transsacral lag screws followed by L4 to pelvis posterior spinal fusion for complex sacropelvic fractures (Fig. 3). The wound was closed in layers over drains without complication. The patient's

DOI of original article: [10.1016/j.xnsj.2020.100031](https://doi.org/10.1016/j.xnsj.2020.100031)

* Corresponding author at: Department of Surgery, Rancho Los Amigos Hospital, 7601 E Imperial Highway, Downey 900242, CA, United States.

E-mail address: rubayi@dhs.lacounty.gov (S. Rubayi).

<https://doi.org/10.1016/j.xnsj.2020.100029>

Received 7 July 2020; Received in revised form 31 August 2020; Accepted 15 September 2020

Available online 17 September 2020

2666-5484/Published by Elsevier Ltd on behalf of North American Spine Society. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

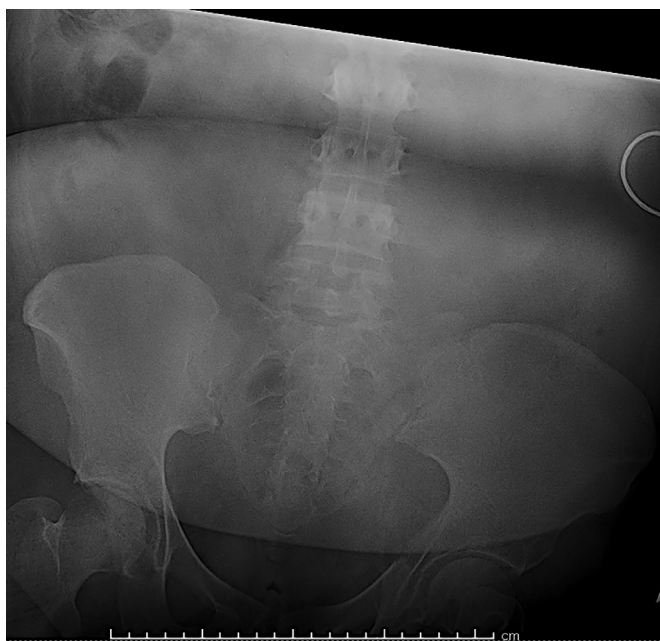


Fig. 1. Pelvic x-ray, AP view, status post traumatic injury resulting in multiple lumbar transverse process fractures and complex sacral and pelvic fractures.

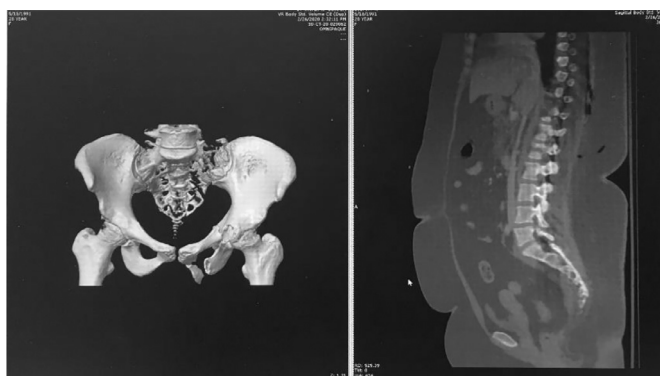


Fig. 2. 3D CT reconstruction of the pelvis (left) shows the pre-operative fracture pattern. Sagittal view of the lumbosacral area (right) demonstrates bony damage in lumbar spine is limited to transverse process fractures from L2 to L5.

postoperative course was uneventful and she was subsequently transferred to a rehabilitation hospital. At the time of transfer, the patient was noted to have a transverse superficial wound, running perpendicular to the lumbosacral surgical incision as well as a superficial linear wound running along the lateral aspect of the right gluteus. The wounds were initially managed conservatively with silvadene. Two weeks into rehabilitation, however, a small dehiscence was noted of the spinal closure with some cloudy drainage. Plastic Surgery was consulted for evaluation and management. On initial evaluation, we noted a midline lumbosacral incisional dehiscence measuring 4 cm x 1.5 cm x 3 cm with liquefying necrotic fat drainage. The patient had a mildly elevated procalcitonin of 0.10, and the white blood cell (WBC) count was normal. Blood cultures and erythrocyte sedimentation rate (ESR) were not obtained. The patient was placed on temporary bedrest and transitioned to a low air-loss mattress. The wound was treated with half-strength Dakin's soaked Kerlix twice daily and serial bedside debridements. Drainage from the wound was sent for culture and resulted positive for *Enterobacter cloacae* sensitive to Ceftriaxone, which was initiated. Though there was no

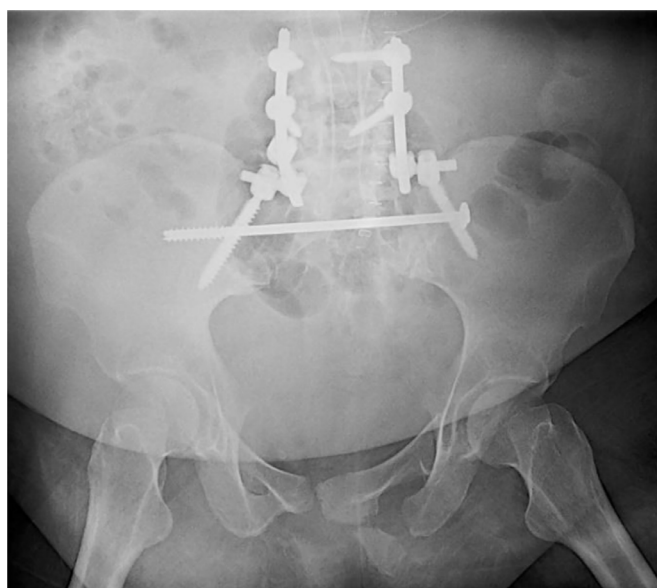


Fig. 3. Pelvic x-ray, AP view, status post reduction and percutaneous fixation of the posterior pelvic ring with transiliac and transsacral lag screws followed by L4 to pelvis posterior spinal fusion.

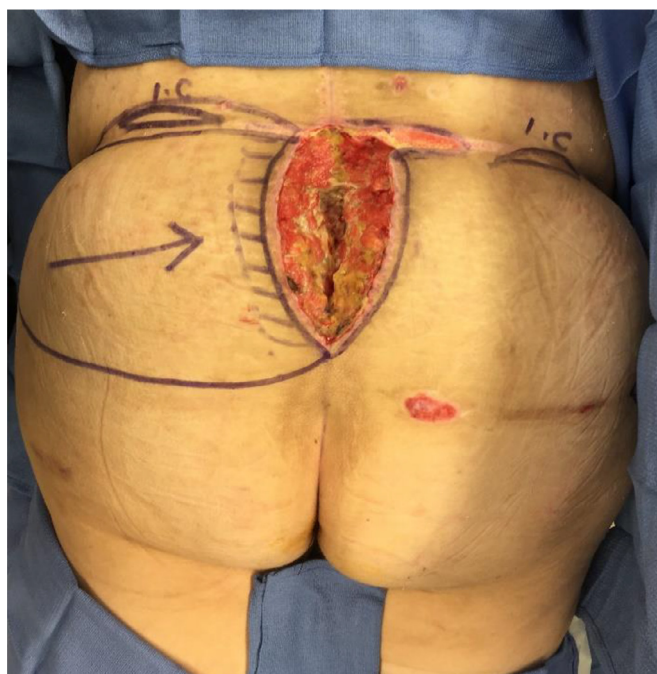


Fig. 4. Pre-operative lumbosacral wound status post serial bedside debridement.

exposure of hardware, the dehiscence continued to enlarge in all dimensions. The wound measured 15 cm x 7 cm x 4 cm (Fig. 4) when the decision was made to take the patient to surgery for washout and flap closure.

Operative technique

The patient was placed under general anesthesia and positioned prone on the operating room table. We first excised the exposed sub-



Fig. 5. Lumbosacral wound status post surgical debridement. Of note, there was no evidence of exposed hardware.



Fig. 6. Once the gluteus maximus musculocutaneous flap was dissected and mobilized to cover the defect, the redundant medial portion of the flap was deepithelialized.

cutaneous tissue, scar, and necrotic fat and debrided the wound down to healthy bleeding tissue (Fig. 5). The resulting defect measured 15 by 15 cm. The wound was irrigated with pulse lavage and hemostasis



Fig. 7. The flap was advanced medially, and the deepithelialized skin was secured to the contralateral base of the wound, covering the area of previous defect.

achieved with electrocautery. We then proceeded to elevate a musculocutaneous flap overlying the left gluteus maximus muscle. The edges of the flap were dissected down to the plane immediately superficial to the gluteus maximus. The muscle was preserved laterally, superiorly and inferiorly in this ambulatory patient. The gluteus maximus was freed from its origin medially on the sacrum, allowing for flap advancement. Once the flap was sufficiently released to slide medially beyond midline, the medial aspect of the flap was de-epithelialized (Fig. 6). This edge was then secured to the contralateral deep fascia, simultaneously providing coverage over the spine and filling the wound defect (Fig. 7). Two drains were placed within the base of the wound, and the edges of the flap were inset with interrupted fascial and deep dermal stitches. The skin was approximated with running monocryl, which was oversewn with running prolene (Fig. 8A and 8B). The right lateral gluteal wound was similarly excised and closed primarily in layers.

Outcome

The patient was maintained on bedrest for four weeks post-operatively on a specialty air-fluidized bed. The surgical site was inspected and dressed with bactroban and xeroform twice weekly. The patient was treated with seven days of Vancomycin and Ceftriaxone post-operatively. Retention sutures and drains were removed on post-operative day eight. A superficial separation was noted of the lateral flap suture line three weeks after surgery. This was treated with daily wound care, and the surgical site went on to heal without further complication (Fig. 9). At the end of her four-week stay, the patient was started on a progressive sitting program before being transferred to rehabilitation. She continues to heal without evidence of recurrent dehiscence or infection.

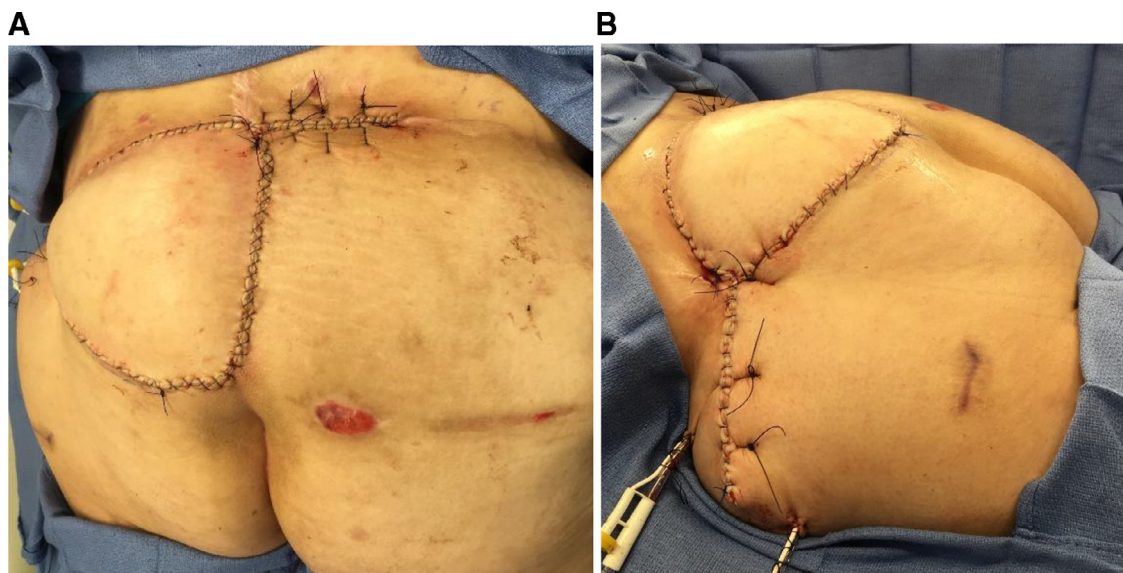


Fig. 8. A: and 8B: On table result after inset of the gluteus maximus myocutaneous advancement flap.



Fig. 9. The healed lumbosacral wound, five weeks status post flap reconstruction.

Conclusions

Spinal wounds are at particularly high risk for complication due to presence of deadspace, increased tension at midline, and repetitive stress on the surgical site with motion of the torso. In order to prophylax against wound dehiscence and SSI, it is important to minimize factors that may contribute to tissue necrosis including: increased surgical time, prolonged tissue retraction and hypoperfusion from anemia or hypotension. Obese and morbidly obese patients are therefore particularly challenging, as they require additional time for positioning, dissection and closure with increased tissue manipulation. A correlation exists between high BMI and increased perioperative complications, with major and minor postoperative complication rates reported to be over 40% in the obese and morbidly obese patient populations [4,5,8,19–21].

The initial closure in the case described above was performed tension-free in a young healthy patient who would otherwise be considered low risk. Our patient's high BMI (46) and depth of subcutaneous fat, however, increase her risk for postoperative complication significantly. In fact, a nationwide study conducted by Shamji et al. found that patients with morbid obesity treated from a posterior approach sustained twice as many wound complications as normal habitus controls [20]. This idea was further explored by Mehta et al. who revealed that fat distribution is more predictive for SSI than BMI [8, 22]. The authors identified thickness of subcutaneous fat and the distance from the lamina to skin measured at L4 as two significant independent factors for infection after spinal surgery [8]. The average thickness of fat between patients with infection and those without was reported to be 30.2 mm and 23.9 mm, respectively. Our patient's thickness of fat was measured to be greater than 50 mm. Her lamina to skin distance, furthermore, was measured to be greater than 120 mm, which is significantly greater than the 74.8 mm and 67.4 mm measurements reported in their infected and uninfected cohorts [8].

With this increase in subcutaneous fat comes an increased risk for tissue necrosis, dead space and subsequent infection. Studies suggest that negative outcomes in these patients and those considered high risk may be mitigated with use of local tissue flaps [15,23]. Reconstructive options include muscle, musculocutaneous and fasciocutaneous flaps, which have been shown to decrease skin necrosis and bacterial growth after inoculation [15,24]. Appropriate flap selection depends primarily on the location of the wound. Paraspinal muscle flaps are the most frequently used local flaps for spinal closure [23,17]. Paraspinal flaps and regional pedicled flaps have limited reach in the lumbar and sacral regions, however, and closure often requires more complex techniques including superior gluteal artery turnover flaps, reverse flow latissimus dorsi flaps or even free flap reconstruction [23, 25]. A recent article published by Mukherjee and colleagues describes the use of a technique, similar to the one described above, using a buried island transposition flap for wound dehiscence of the midline posterior spine with large subcutaneous tissue defects [25]. The technique utilizes a crescent-shaped island of skin, mobilized and de-epithelialized from the wound edge, to fill the dead space. Similar to the technique utilized above, the de-epithelialized skin is then sutured to the contralateral deep fascia. Fifteen out of 15 of the cases included in the series went on to heal without complication and required no re-operation or flap revision. The success of this series and our case described above supports use of de-epithelialized fasciocutaneous flaps in regions where use of

pedicled flaps is limited – in midline wounds with large defects in the lumbosacral and lower cervical regions [25].

Finally, in the case presented, the patient was cleared for unrestricted inpatient rehabilitation less than two weeks after her index surgery. Though there's a paucity of data regarding the optimal method and timing of rehabilitation after lumbar spinal surgery, there's some evidence to suggest that immediate or early rehabilitation may be associated with worse outcomes [26–30]. At the rehabilitation hospital of the senior author, patients are placed on bed rest for four to six weeks after flap surgery. The goal is to maximize pressure relief, through the use of specialty a mattress and strict activity precautions, to minimize occlusion of capillary skin circulation, prevent sores and minimize mechanical interference on healing wounds [16]. Other factors important in the postoperative care of the patient include adequate drainage, to prevent seroma or hematoma formation, hemodynamics and nutritional support.

Secondary wound management after spinal surgery is a complex problem, which may be prophylaxed through early identification of high-risk patients and preoperative consultation of Plastic Surgery. Patients with increased thickness of subcutaneous fat are at particularly high risk for postoperative complications, including infection and dehiscence, secondary to increased tissue manipulation and necrosis. Patients with large midline subcutaneous defects in the lumbosacral region may be reconstructed using de-epithelialized fasciocutaneous flap techniques that serve to simultaneously fill the dead space and close the wound. mmc1.pdf mmc2.pdf

Declaration of Competing Interest

The authors have nothing to disclose. No funding was received for this article.

Patient Informed Consent Statement

The authors declare that informed patient consent was taken from all the patients.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2020.100029.

References

- [1] Nasser R, Yadla S, Maltenfort MG, Harrop JS, Anderson DG, Vaccaro AR, Sharan AD, Ratliff JK. Complications in spine surgery: a review. *J Neurosurg: Spine* 2010;13(2):144–57.
- [2] Bekelis K, Desai A, Bakhoun SF, Missios S. A predictive model of complications after spine surgery: the National Surgical Quality Improvement Program (NSQIP) 2005–2010. *Spine J* 2014;14(7):1247–55.
- [3] Weinstein MA, McCabe JP, Cammisa Jr FP. Postoperative spinal wound infection: a review of 2,391 consecutive index procedures. *Clin Spine Surg* 2000;13(5):422–6.
- [4] Fang A, Hu SS, Endres N, Bradford DS. Risk factors for infection after spinal surgery. *Spine* 2005;30(12):1460–5.
- [5] Olsen MA, Mayfield J, Lauryssen C, Polish LB, Jones M, Vest J, Fraser VJ. Risk factors for surgical site infection in spinal surgery. *J Neurosurg: Spine* 2003;98(2):149–55.
- [6] Kimmell KT, Algattas H, Joynt P, Schmidt T, Jahromi BS, Silberstein HJ, Vates GE. Risk modeling predicts complication rates for spinal surgery. *Spine* 2015;40(23):1836–41.
- [7] Basques BA, Ibe I, Samuel AM, Lukasiewicz AM, Webb ML, Bohl DD, Grauer JN. Predicting postoperative morbidity and readmission for revision posterior lumbar fusion. *Clin Spine Surg* 2017;30(6):E770–5.
- [8] Mehta AI, Babu R, Karikari IO, Grunch B, Agarwal VJ, Owens TR, Friedman AH, Bagley CA, Gottfried ON. 2012 Young Investigator Award winner: the distribution of body mass as a significant risk factor for lumbar spinal fusion postoperative infections. *Spine* 2012;37(19):1652–6.
- [9] Picada R, Winter RB, Lonstein JE, Denis F, Pinto MR, Smith MD, Perra JH. Postoperative deep wound infection in adults after posterior lumbosacral spine fusion with instrumentation: incidence and management. *Clin Spine Surg* 2000;13(1):42–5.
- [10] Deyo RA, Mirza SK, Martin BI, Kreuter W, Goodman DC, Jarvik JG. Trends, major medical complications, and charges associated with surgery for lumbar spinal stenosis in older adults. *JAMA* 2010;303(13):1259–65.
- [11] Hultman CS, Jones GE, Losken A, Seify H, Schaefer TG, Zapiach LA, Carlson GW. Salvage of infected spinal hardware with paraspinous muscle flaps: anatomic considerations with clinical correlation. *Ann Plast Surg* 2006;57(5):521–8.
- [12] Calderone RR, Garland DE, Capen DA, Oster H. Cost of medical care for postoperative spinal infections. *Orthop Clin North Am* 1996;27(1):171–82.
- [13] Whitmore RG, Stephen J, Stein SC, Campbell PG, Yadla S, Harrop JS, Sharan AD, Maltenfort MG, Ratliff JK. Patient comorbidities and complications after spinal surgery: a societal-based cost analysis. *Spine* 2012;37(12):1065–71.
- [14] Maruo K, Berven SH. Outcome and treatment of postoperative spine surgical site infections: predictors of treatment success and failure. *J Orthop Sci* 2014;19(3):398–404.
- [15] Calderon W, Chang N, Mathes SJ. Comparison of the effect of bacterial inoculation in musculocutaneous and fasciocutaneous flaps. *Plast Reconstr Surg* 1986;77(5):785–94.
- [16] Rubayi S. Wound management in spinal infection. *Orthop Clin North Am* 1996;27(1):137–53.
- [17] Xu H, Rozanski C, Taub PJ. The value of plastic surgery spinal closures: a review of 782 spine cases. *Ann Plast Surg* 2019;83(2):201–5.
- [18] Cohen LE, Fullerton N, Mundy LR, Weinstein AL, Fu KM, Ketner JJ, Härtl R, Spector JA. Optimizing successful outcomes in complex spine reconstruction using local muscle flaps. *Plast. Reconstr. Surg.* 2016;137(1):295–301.
- [19] Vaidya R, Carp J, Bartol S, Ouellette N, Lee S, Sethi A. Lumbar spine fusion in obese and morbidly obese patients. *Spine* 2009;34(5):495–500.
- [20] Shamji MF, Parker S, Cook C, Pietrobon R, Brown C, Isaacs RE. Impact of body habitus on perioperative morbidity associated with fusion of the thoracolumbar and lumbar spine. *Neurosurgery* 2009;65(3):490–8.
- [21] Patel N, Bagan B, Vadera S, Maltenfort MG, Deutsch H, Vaccaro AR, Harrop J, Sharan A, Ratliff JK. Obesity and spine surgery: relation to perioperative complications. *J Neurosurg: Spine* 2007;6(4):291–7.
- [22] Jiang J, Teng Y, Fan Z, Khan S, Xia Y. Does obesity affect the surgical outcome and complication rates of spinal surgery? A meta-analysis. *Clin Orthop Relat Res* 2014;472(3):968–75.
- [23] Dumanian GA, Ondra SL, Liu J, Schafer MF, Chao JD. Muscle flap salvage of spine wounds with soft tissue defects or infection. *Spine* 2003;28(11):1203–11.
- [24] Hallock GG. Reconstruction of posterior trunk defects. In: *In: Seminars in plastic surgery*, 25. Thieme Medical Publishers; 2011. p. 78.
- [25] Mukherjee S, Thakur B, Morris R, Tolias C, Cavale N. Buried island transposition flap for joint Plastic-Neurosurgical management of spinal wound dehiscence—a technical note and single Centre experience. *Br J Neurosurg* 2019;1–5.
- [26] Oestergaard LG, Nielsen CV, Bünger CE, Sogaard R, Fruensgaard S, Helmig P, Christensen FB. The effect of early initiation of rehabilitation after lumbar spinal fusion: a randomized clinical study. *Spine* 2012;37(21):1803–9.
- [27] Marchand AA, O'Shaughnessy J, C   Ch  tillon, Sorra K, Descarreaux M. Current practices in lumbar surgery perioperative rehabilitation: a scoping review. *J Manip Physiol Ther* 2016;39(9):668–92.
- [28] Rushton A, Eveleigh G, Petherick EJ, Heneghan N, Bennett R, James G, Wright C. Physiotherapy rehabilitation following lumbar spinal fusion: a systematic review and meta-analysis of randomised controlled trials. *BMJ Open* 2012;2(4):e000829.
- [29] Christensen FB, Laurberg I, B  nger CE. Importance of the back-c  fe concept to rehabilitation after lumbar spinal fusion: a randomized clinical study with a 2-year follow-up. *Spine* 2003;28(23):2561–9.
- [30] Kern D, Strojnik V. Early initiation of a strength training based rehabilitation after lumbar spine fusion improves core muscle strength: a randomized controlled trial. *J Orthop Surg Res* 2018;13(1):151.