

# Blood Loss of Pedicle Subtraction Osteotomy for Sagittal Imbalance Spinal Deformity

ABU AWWAD AHMED<sup>1</sup>, RADU PREJBEANU<sup>1</sup>, DINU VERMESAN<sup>1\*</sup>, IOAN BRANEA<sup>2</sup>, BOGDAN DELEANU<sup>1</sup>, SORIN FLORESCU<sup>1</sup>, CRISTINA VLAD-DALIBORCA<sup>3</sup>

<sup>1</sup> Victor Babes University of Medicine and Pharmacy Timisoara, Department of Orthopedics and Trauma, 2 Eftimie Murgu Sq., 300041, Timisoara, Romania

<sup>2</sup> Department of Spine Surgery SRH Klinikum Karlsbad -Langensteinbach, Germany

<sup>3</sup> Victor Babes University of Medicine and Pharmacy Timisoara, Department of Pharmacology, 2 Eftimie Murgu Sq., 300041, Timisoara, Romania

*Pedicle subtraction osteotomies (PSO) have been used in the treatment of multiple spinal conditions involving a fixed sagittal imbalance. It is a complex, extensive surgery most often performed in the revision settings. The aim of our study is to review the major complications of this surgical technique with a focus on blood loss. Twenty patients were included, treated using PSO for sagittal imbalance, out of 255 corrective surgeries. Of the 12 female patients included in the study, the mean age was 64.33. Of the 8 male patients included in the study, the mean age was 51.85. For female patients, the mean blood loss was 2122.5 mL in comparison with male patients, with mean blood loss 1737.5 mL. The female patients had an operating time of 357.25 minutes in comparison with male patients with an 328.5 minute operating time. Eight (5 female and 3 male) had postoperative neurological deficits and 6 (5 female and 1 male) had pseudarthrosis of adjacent levels.*

**Keywords:** pedicle subtraction osteotomy; spinal deformity; corrective surgery; blood loss

PSO is successful in restoring sagittal balance in selected patients. It can be technically demanding, lengthy, with relatively high blood loss and complications such as neurologic deficit, pseudarthrosis and mechanical failure, which can require additional surgery or revision of fixation.

Pedicle subtraction osteotomies (PSOs) have been used in the treatment of multiple spinal conditions involving a fixed sagittal imbalance, such as degenerative scoliosis, idiopathic scoliosis, posttraumatic deformities, iatrogenic flat-back syndrome, and ankylosing spondylitis [1, 2].

It is a complex, extensive surgery most often performed in the revision settings. Multiple authors have described the technique for PSO [1, 3]. There are significant technical challenges and many complications, including neurologic deficits, pseudarthrosis of adjacent levels, and wound infections. Short-term challenges include a large loss of blood, 2.4 L on average. Time of closure of the osteotomy gap is a crucial point in the surgery. Blood loss, often large, slows only after the gap is closed and stabilized [1, 4].

The aim of our study is to review the major complications of this surgical technique with a focus on blood loss.

## Experimental part

During a pedicle subtraction osteotomy, the facet joints at the back of the target vertebra and the vertebrae above and below, the pedicles that attach the back of the target vertebra to its front, the laminae, and also a portion of the target vertebral body are removed, then the spine is realigned and stabilized in its new alignment [1, 5].

Twenty patients were included (12 F and 8 M), treated in the SRH Klinikum Karlsbad - Langensteinbach, Germany, from 2008 to 2017 using PSO, out of 255 corrective surgeries: 2008: 32 patients; 2009: 23 patients; 2010: 22 patients; 2011: 7 patients; 2012: 16 patients; 2013: 22 patients; 2014: 14 patients; 2015: 18 patients; 2016: 42 patients and 2017: 59 patients. One patient was 11 years old, being the youngest patient included in this study (table 1).

Patients enrolled in the study were diagnosed with Sagittal Imbalance, a syndrome in which the patient is only able to stand with the weight bearing line in front of the sacrum or to correct certain deformities of the spine and were consequently surgically treated according to current guidelines.

No.	Gender	Age	Blood loss (ml)	OP time (min)
1.	F	11 y	850 ml	282 min
2.	F	75 y	2550 ml	435 min
3.	F	65 y	2500 ml	450 min
4.	F	54 y	2350 ml	318 min
5.	F	69 y	2400 ml	450 min
6.	F	79 y	2500 ml	390 min
7.	F	73 y	2000 ml	307 min
8.	F	77 y	1600 ml	375 min
9.	F	54 y	1700 ml	285 min
10.	F	71 y	3500 ml	360 min

**Table 1**  
SYNTHETIC PRESENTATION OF THE STUDY GROUP

\* email: vermesan@gmail.com, Phone: +4074833126

11.	F	68 y	1220 ml	205 min
12.	F	76 y	2300 ml	430 min
13.	M	53 y	1200 ml	240 min
14.	M	58 y	1450 ml	410 min
15.	M	40 y	3300 ml	425 min
16.	M	74 y	1700 ml	402 min
17.	M	54 y	1350 ml	305 min
18.	M	44 y	2500 ml	320 min
19.	M	41 y	1200 ml	276 min
20.	M	51 y	1200 ml	250 min

**Table 1**  
Continued

Gender	Avr. Age	Avr. blood loss (ml)	Avr. op time (min)	Neurological deficits (no.)	Adjacent pseudarthrosis (no.)
F	64.33	2122.5	357.25	5	3
M	51.85	1737.5	328.5	5	1

**Table 2**  
COMPARATIVE PRESENTATION  
OF COMPLICATIONS

## Results and discussions

Of the 12 female patients included in the study, the mean age was 64.33. Of the 8 male patients included in the study, the mean age was 51.85. For female patients, the mean blood loss was 2122.5 mL in comparison with male patients, with mean blood loss 1737.5 mL. The operating time was also different. The female patients had an operating time of 357.25 min in comparison with male patients with an 328.5 min operating time.

The main postoperative complications were neurological deficits and pseudarthrosis of adjacent levels. Of the 20 patients included in the present study, 8 of them had postoperative neurological deficits and 6 had pseudarthrosis of adjacent levels. Of the 8 patients with neurological deficits, 5 of them were female and 3 male. And of the 6 patients with adjacent pseudarthrosis, 5 of them were female and only one male (table 2).

The most common pathologies, with PSO treatment, are degenerative. Patients who fail to improve their quality of life under conservative treatment are potential candidates for intervention. Careful selection and weigh of benefits versus risks should be applied, even with the use of patient reported outcomes [6, 7]. Most postoperative complications are found among diabetic, elderly and obese patients and are proportional to the extent of injury or surgery [8-11].

In this study, we analyzed 20 selected patients out of a total of 255 corrective surgeries. We tried to make an association between the high time of surgery and the amount of blood lost, this being also evidenced in the results of this study. Neurological complications were observed in 10 of the patients included in the study, the number being equal in both genders, with no apparent association with the duration of the intervention or the amount of blood lost during this intervention.

In the case of adjacent pseudarthrosis, a higher number of cases was found among female patients, probably due to osteoporosis, all 3 patients having osteoporotic status, compared to the same complication occurred in only one case in male patients with no osteoporosis status.

Other authors have looked at outcomes of PSO in the lumbar spine in the treatment of large sagittal deformities of the lumbar spine. In the literature, PSO complications are generally analyzed as 2 types: minor or major complication [12, 13].

Common major complication are neurologic deficit, mechanical failure and adjacent pseudarthrosis [14].

A series of 15 patients (mean age 63.8±12.82) operated for sagittal imbalance by means of one-level PSO, noted

two minor (one dural tear with no clinical consequences and one transient radicular deficit) and six major complications with re-intervention. The main cause of mechanical complications was insufficient sagittal correction [1]. To limit the risk of mechanical complications and to achieve a good balance, corrective procedures should also take into consideration the patient characteristics, the anatomic region and fixation methods [15, 16].

Neurological complications have been observed in multiple studies, making even a correlation between the time required for surgical intervention and neurological acquired postoperative deficiencies, or neurological deficits before surgery they continued even after surgery [17]. Another complication, in some cases even as common as neurological deficiency, is adjacent pseudarthrosis. This in turn has been analyzed in several studies, concluding that the surgical technique used is the defining feature of this process [18].

Solutions to diminish these complications can be addressed plurifactorial. Chemical substances such as tranexamic acid have been shown to reduce blood loss in major orthopedic surgery [19-21].

## Conclusions

PSO is successful in restoring sagittal balance in selected patients. It can be technically demanding, lengthy, with relatively high blood loss and complications such as neurologic deficit, pseudarthrosis and mechanical failure, which can require additional surgery or revision of fixation.

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