

Spinal fusion surgery blood loss: a narrative review abstract

Perda de sangue em cirurgia de fusão espinhal: uma revisão narrativa

Pérdida de sangre en la cirugía de fusión espinal: resumen de una revisión narrativa

Received: 11/13/2022 | Revised: 11/20/2022 | Accepted: 11/22/2022 | Published: 11/29/2022

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Abstract

Spinal fusion surgeries are commonly associated to great blood losses that, besides being able to directly harm the procedure, can be associated to a higher risk of serious complications due to the blood transfusion needed afterwards. Therefore, the present study aims to review the literature towards blood loss in different techniques of spinal fusion. For this, nine studies were selected, being two of them about cervical spine fusion, two of them about thoracic spine fusion and five of them about lumbar spine fusion, to compare and analyze twelve different techniques. The spinal fusion in thoracic and lumbar interbody arthrodesis were the ones that shown greatest blood loss.

Keywords: Arthrodesis; Surgical blood loss; Spine.

Resumo

As cirurgias de fusão espinhal são comumente associadas a grandes perdas sanguíneas que, além de poderem prejudicar diretamente o procedimento, podem estar associadas a um maior risco de complicações graves devido à necessidade de transfusão sanguínea posteriormente. Portanto, o presente estudo tem como objetivo revisar a literatura sobre a perda sanguínea em diferentes técnicas de fusão espinhal. Para isso, foram selecionados nove estudos, sendo dois deles sobre fusão da coluna cervical, dois deles sobre fusão da coluna torácica e cinco deles sobre fusão da coluna lombar, para comparar e analisar doze técnicas diferentes. A fusão espinhal na artrodese intersomática torácica e lombar foram as que apresentaram maior perda sanguínea.

Palavras-chave: Artrodese; Perda cirúrgica de sangue; Coluna.

Resumen

Las cirugías de fusión espinal se asocian comúnmente a grandes pérdidas de sangre que, además de poder perjudicar directamente el procedimiento, pueden estar asociadas a un mayor riesgo de complicaciones graves debido a la necesidad de transfusión de sangre posterior. Por lo tanto, el presente estudio tiene como objetivo revisar la literatura sobre la pérdida de sangre en diferentes técnicas de fusión espinal. Para ello, se seleccionaron nueve estudios, siendo dos de ellos sobre fusión de columna cervical, dos de ellos sobre fusión de columna torácica y cinco de ellos sobre

fusión de columna lumbar, para comparar y analizar doce técnicas diferentes. Las fusiones vertebrales en artrodesis intersomática torácica y lumbar fueron las que presentaron mayor pérdida de sangre.

Palabras clave: Artrodesis; Hemorragia quirúrgica; Columna.

1. Introduction

Spinal fusion surgeries are commonly used to treat different spine diseases, being able to be performed in any vertebral segment, such as cervical, thoracic or lumbar (Aoude et al., 2016). However, those procedures are associated to a significant blood loss, being in the top ten surgeries that need blood transfusion (Ristagno et al., 2018). Intraoperative blood loss of 500mL or higher, increases mortality and can disrupt the procedure by resulting in bad visibility during the surgery and the collection of an epidural hematoma that can, by itself, increase the risk of nerve lesion (Lu et al., 2017; Hui et al., 2021; Huang, & Ou, 2015).

The hemorrhage percentage in spinal fusion surgeries is estimated in 50-80% and blood, platelets or other blood factors transfusion incidence is around 30% (Aoude et al., 2016). Although blood transfusions have become considerably safer thought the years, they are still associated to a higher risk of superficial and deep infections, they can also cause severe complications, such as acute pulmonary lesion, hemolytic reaction, venous thromboembolism and make hospitalization longer and the procedure more expensive (Rahmani et al., 2021; Ristagno et al, 2018)

A lot of surgical factors can contribute to blood loss in the spinal arthrodesis, some of them can be long lasting surgery, cancellous bone exposure, skeletal muscles removal, multilevel procedures and correction of deformities (Ristagno et al., 2018). Besides that, thoracic and lumbar fusion techniques are associated to higher blood losses, when compared to cervical fusion (Aoude et al., 2016; Ristagno et al, 2018).

The present study objective is to review available literature about intraoperative blood loss in diverse spinal fusion procedures, comparing the bleeding volume among different vertebrae segments arthrodesis and the technique used in the same segment.

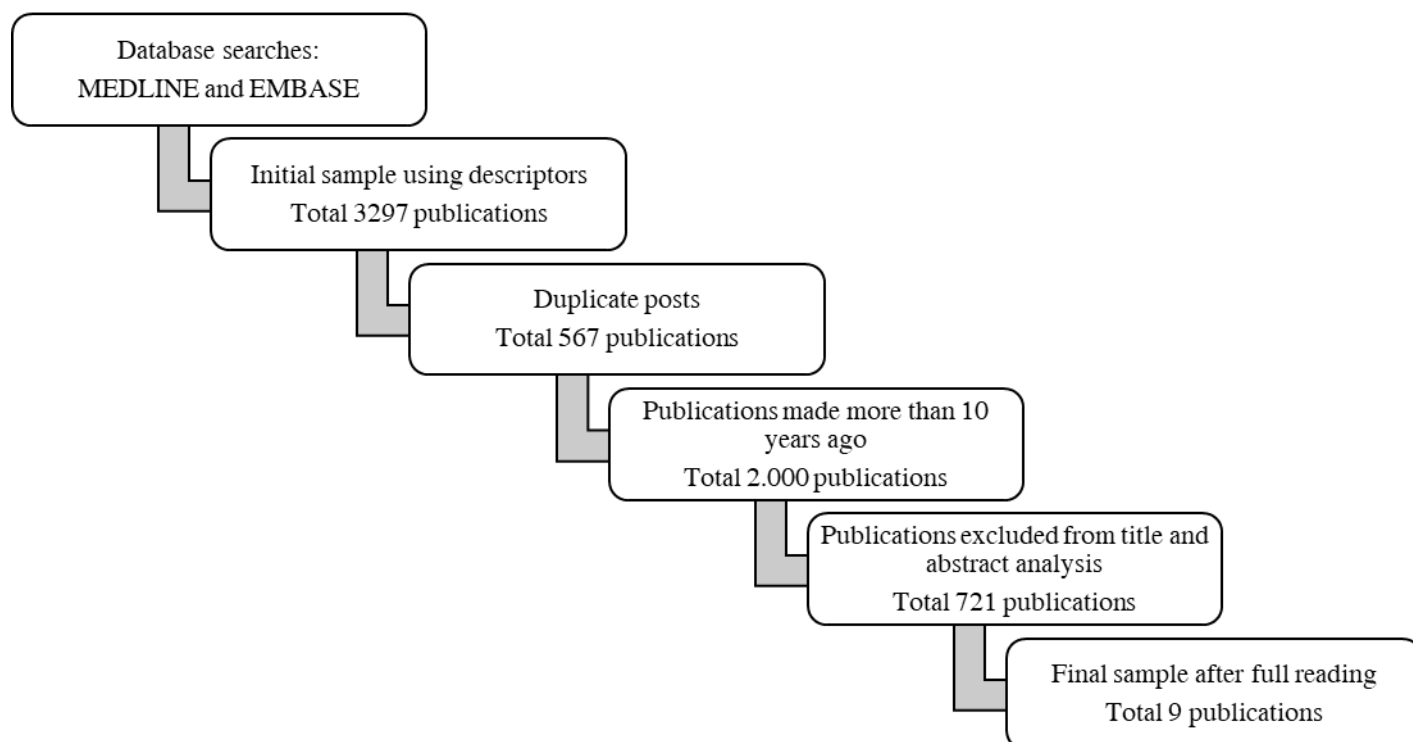
2. Methodology

In August 2022, a literature narrative review for original studies or high scientific evidence studies was made in Medical Literature Analysis and Retrieval System Online (MEDLINE) and EMBASE databases. The Medical Subject Headings (MeSH) terms used were: arthrodesis, surgical blood loss, spine and hemorrhage. Also, manual research were made in the selected studies reference list.

The narrative review makes it possible to synthesize knowledge on a given subject, promoting the deepening of knowledge and leading to critical thinking, relevant points to daily practice in health (Barros & Lehfeld, 2000).

The inclusion criteria used for sample selection were: articles published in the period from 2011 to 2021, with themes focused bleeding during spinal arthrodesis surgery on. The following were excluded during the search: duplicate productions, editorials and letters to the editor. The inclusion criteria adopted were applied after reading the selected texts in full, Figure 1, below, presents a flowchart that demonstrates the step by step taken to reach the number of articles established for the review.

Figure 1 - Trajectory articles found, 2022.



Source: Authors (2022).

There was no financial incentive, conflict of interests or need of the ethics committee approval to conduct this study. The detailed research strategy is detailed in Table 1.

Table 1 - Trajectory articles found, 2022.

Database	Mesh Terms	Filter	Results
MEDLINE	#1: Arthrodesis and (surgical blood loss or hemorrhage) and spine	Since 2012 Free full text Comparative study	833
	#2: Arthrodesis and surgical blood loss	Controlled clinical trial Meta-analysis	
	#3: Surgical blood loss and spine	Observational study Randomized controlled clinical trial Systematic review	
EMBASE	#1: Arthrodesis and surgical blood loss and spine	Since 2012 Meta-analysis Systematic review Controlled clinical trial Randomized controlled trial	464

Source: Authors (2022).

3. Results

There were selected nine studies about different techniques of spine arthrodesis, being two of them (Cao et al., 2020; Bydon et al., 2014) about cervical fusion, two (Liu et al., 2014; Li et al., 2019) of them about thoracic fusion and five (Fujimori et al., 2014; Hung et al., 2021; Campbell et al., 2018; Goodnough et al., 2019; Kim et al., 2021) of them about

lumbar fusion. When analyzing the spine pathology treated, two of the studies were about spondylosis (Fujimori et al., 2014; Campbell et al., 2018), another two were about spondylolisthesis (Hung et al., 2021; Goodnough et al., 2019), two were about spinal tuberculosis (Liu et al., 2014; Li et al., 2019), two were about adjacent segment disease (ASD) (Cao et al., 2020; Bydon et al., 2014), and one of the studies did not specify the disease (Kim et al., 2021).

Just to give a parameter of the “Research Corpus”, Table 2 entitled - “List of studies selected for analysis according to the order: author, country, type of study and surgical procedure” is presented below in a synthetic way and discussed in the analytical aspect in the theoretical foundation of this article.

Table 2 - List of studies selected for analysis according to order: author, country, type of study and surgical procedure.

Author	Country	Study design	Surgical Procedure
Cao et al. ⁸	China	Retrospective Study	ACDF and PDF
Bydon et al. ⁹	Unites States	Retrospective Study	ACDF and PDF
Liu et al. ¹⁰	China	Retrospective Study	AA, PA and CAPA for debridement and thoracic fusion
Li et al. ¹¹	China	Prospective Study	AA and PA for debridement and thoracic fusion
Fujimori et al. ¹²	United States	Retrospective Study	TLIF and PLF
Hung et al. ¹³	Taiwan	Retrospective Study	OLIF
Campbell et al. ¹⁴	United States	Retrospective Study	LLIF
Goodnough et al. ¹⁵	United States	Retrospective Study	XLIF and ALIF
Kim et al. ¹⁶	South Korea	Prospective double-blind randomized study	PLIF

ACDF: Anterior Cervical Discectomy and Fusion; **PDF**: Posterior Decompression and Fusion; **AA**: Anterior Approach; **PA**: Posterior Approach; **CAPA**: Combined Anterior-Posterior Approach; **TLIF**: Transforaminal lumbar interbody fusion; **PLF**: Posterolateral lumbar fusion; **OLIF**: Oblique lumbar interbody fusion; **XLIF**: Extreme Lateral Interbody Fusion; **ALIF**: Anterior lumbar Interbody Fusion; **PLIF**: Posterior Lumbar Interbody Fusion. Source: Authors (2022).

Cao et al (2020) compared 18 patients that underwent anterior cervical discectomy and fusion (ACDF) to 14 patients that underwent posterior decompression and fusion (PDF), being the medium blood loss of 186 ± 57 mL and 498 ± 176 mL, respectively. Bydon et al (2014) also analyzed patients (n = 77) that underwent ACDF and PDF (n = 31), those groups had the about of bleeding of $50 \pm 18,75$ mL and $550 \pm 262,5$ mL, respectively.

Liu et al (2015) conducted a study with 30 patients separated in three groups to evaluate the different debridement and thoracic fusion techniques. In the group that underwent anterior approach (AA) the blood loss was of $242,50 \pm 153,69$ mL, the group that underwent posterior approach (PA) the blood loss was of $199,20 \pm 62,46$ mL, at last, the group that underwent combined anterior-posterior approach (CAPA) the blood loss was of $499,20 \pm 333,73$ mL. Li et al (2019) also analyzed thoracic vertebrae fusion approaches. In the study, 39 patients underwent AA and 48 patients underwent PA, the medium blood loss was of $517,19 \pm 76,5$ mL and $714,6 \pm 57,4$ mL, respectively.

Fujimori’s et al (2014) study compared 24 patients that underwent a transforaminal lumbar interbody fusion (TLIF) to 32 patients that underwent posterolateral lumbar fusion (PLF). The estimated blood loss in the first group was of 368 ± 255 mL. while in the second group the blood loss was of 368 ± 156 mL. In Hung’s et al (2021) study a oblique lumbar interbody fusion (OLIF) was the procedure of choice to 21 patients and the blood loss was of $90,48 \pm 19,74$ mL. In Campbell’s et al (2018) study, the medium blood loss of 15 patients that underwent lateral lumbar interbody fusion (LLIF) was of 113mL. Goodnough’s et al (2019) study compared 21 patients that underwent extreme lateral interbody fusion (XLIF) to 54 patients that underwent anterior lumbar interbody fusion (ALIF), the medium blood loss was around 100mL and 250mL respectively.

At last, in Kim's et al (2021) study, 14 patients underwent posterior lumbar interbody fusion (PLIF) and had an amount of bleeding of $1757,1 \pm 1172,7$ mL.

4. Discussion

For decades, ACDF has been considered the golden standard procedure to treat cervical spine degenerative diseases due to its safety and efficacy, however, this procedure presents itself with some complications, such as rapid degeneration of the adjacent level (Cao et al., 2020; Bydon et al., 2014). Therefore, Cao et al (2020) and Bydon et al (2014) conducted studies to compare ACDF and PDF approaches to spine diseases. Both studies concluded that ACDF was a safer technique, since the blood loss in this procedure was considerably lower than the one in PDF procedure, adding to that, ACDF was a faster procedure and the patient's hospitalization time was also lower.

The studies (Liu et al., 2014; Li et al., 2019) included in the present review about thoracic fusion presented techniques to treat spinal tuberculosis. However, the surgical approach of this disease remains controversé (Zeng et al, 2019). Some authors believe that AA is more traumatic due to its need to resect part of the patient's ribs and the impact it causes to great vessels and lungs, other authors presented opposite results and considered that in AA the debridement is easier and the procedure duration is lower (Wang et al, 2017; Dunn & Ben Husien, 2018).^{18,19} In Li's et al (2019) study the PA had shown a higher blood loss and the procedure lasted longer than AA ($183,7 \pm 14,1$ min vs $158,2 \pm 10,7$ min). In Liu's et al (2010) study, AA had higher bleeding than PA, but the procedure did not last for long ($94,9 \pm 25,66$ min vs $104,18 \pm 53,51$ min). In that study, CAPA was also evaluated and, besides being considered the golden standard to treat severe cases, it is limited because of its higher risk and greatest blood loss (Gao et al., 2017)

The lumbar spinal fusion is widely used as treatment to spine injuries, however the associated risk to the open arthrodesis, such as substantial blood loss, brings out the question of whether or not safer techniques should be persued (Goldstein et al., 2016). Out of the six different lumbar fusion techniques that were selected to be a part of the present study, PLIF was the one that showed a considerable bleeding difference when compared to the others. Even though this method has an effective access to the spine, it is also associated to higher bleeding levels, since the prone position alters hemodynamic and ventilation, possibly causing engorgement of vertebral veins (Kim et al., 2021). On the other hand, OLIF showed smaller bleeding. This approach maintains posterior spine structural integrity and presents itself as an alternative to solve possible traumas caused by other approaches (Hung et al., 2021).

In addition to what was analyzed so far, LLIF was the procedure that had also shown lower bleedings because of its minimally disrupted approach and undirect decompression (Campbell et al., 2018). Nonetheless, there are certain worries about the method, such as often neurologic complications, which makes its adhesion levels limited (Campbell et al., 2018). Another procedure for lateral approach that had lower blood loss was XLIF, however it is also associated to sensorial and motor changes (Goodnough et al., 2019). The XLIF technique is seen as an alternative to ALIF, since it allows access to the anterior spine and reduce the complications that are implied to direct approach (Goodnough et al., 2019). When analyzing TLIF and PLF, two of the most frequently chosen methods, they have shown similar blood losses (Fujimori et al., 2014). While TLIF provides an undirect foraminal decompression, PLF presents itself as having a lower complication index and being a simpler procedure, nevertheless its outcomes concerning the patient's health do not show significant difference (Fujimori et al., 2014).

5. Conclusion

Spine fusion surgeries are often followed by large blood losses. Even though some alternative techniques such as ACDF, OLIF, LLIF and XLIF reduce perioperative bleeding, others are still associated to worrying hemorrhages, like thoracic

arthrodesis and PLIF. Nonetheless, most of the procedures are heterogeneous in different studies, a fact that limits comparison.

It is also worth mentioning that given the vastness of the theme and the depth of the subject, this alone is not exhausted, thus, other studies and/or researchers may bring future contributions, with deepening in other methods of bibliographical research; such as: systematic, integrative, bibliometric, among others.

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