North American Spine Society Journal (NASSJ) 16 (2023) 100280

Contents lists available at ScienceDirect

North American Spine Society Journal (NASSJ)

journal homepage: www.elsevier.com/locate/xnsj

Clinical Studies

Utility of routine type and cross for anterior cervical discectomy and fusion: A retrospective review

Nicole Russell, MD[a,*], Nadeem Al-Adli[a], Christopher Shank, MD[a,b], Shannon Carey, DNP, ACNP-BC[b], Olaide Ajayi, MD[a,b]

[a] Anne Burnett School of Medicine, Texas Christian University, TCU Box 297085, Fort Worth, TX 76129, United States
[b] Department of Neurosurgery, Texas Health Harris Methodist Hospital, Fort Worth, TX 76104, United States

ARTICLE INFO

Keywords:
Transfusion
Crossmatch
Cervical spine
ACDF
Degenerative
Minimally invasive

ABSTRACT

Background: Preoperative type and screen and type and cross are routinely obtained in patients undergoing elective cervical spine surgeries. This is despite low perioperative transfusion rates, particularly in patients undergoing anterior cervical discectomy and fusion (ACDF).

Methods: We conducted a retrospective cohort study at a single tertiary medical center of all patients 18 years of age or older undergoing elective ACDF for degenerative cervical spine disease between January 2016 and January 2021. Our primary outcome measures included the frequency of type and screen/crossmatch orders, rate of perioperative transfusion, and crossmatch to transfusion (C/T) ratio. Secondary outcomes included differences between preoperative and postoperative hemoglobin and hematocrit.

Results: In total, 1,162 patients were identified. There were no cases of intraoperative transfusion. The overall transfusion rate was less than 1%, with only 1 patient receiving a blood product transfusion during their hospital admission. This patient received 2 units of platelets for severe preoperative thrombocytopenia. Yet, 961 patients (83%) received ABO/Rh blood typing and screening and 647 patients (56%) had their blood typed and crossed. A total of 1,318 units of blood were crossmatched, with no units of packed red blood cells (pRBCs) transfused and only 2 units of platelets transfused, achieving a high crossmatch to transfusion (C/T) ratio of 659:1.

Conclusions: Among 1,162 patients who underwent elective ACDF at our institution, there were no patients who required an intraoperative or emergent blood transfusion. Furthermore, routine type and screen and crossmatch in patients undergoing elective ACDF at our insitution is associated with a high C/T ratio, suggestive of inefficient usage of blood products.

Introduction

Cervical spine surgery has undergone numerous advancements since the 1950's including the development of advanced imaging techniques, instrumentation technologies, and minimally invasive techniques [1]. Anterior discectomy and fusion (ACDF) is now one of the most performed spine procedures in the world and is associated with low complication rates and high patient satisfaction [2–4]. In particular, ACDF has significantly lower perioperative transfusion rates and overall blood loss compared to posterior and combined anterior and posterior approaches [2].

Despite ACDF being associated with transfusion rates of less than 1 percent [5], surgeons still routinely order pretransfusion testing (blood typing, screening, and crossmatching) on these patients. The aim of this study is to evaluate the necessity of type and cross in patients undergoing elective ACDF for degenerative cervical spine disease. We hypothesized that routine type and cross is unnecessary in elective ACDF and can be eliminated without negatively impacting patient care. To achieve this,

FDA device/drug status: Not applicable.

Author disclosures: ***NR:*** Nothing to disclose. ***NAA:*** Nothing to disclose. ***CS:*** Nothing to disclose. ***SC:*** Nothing to disclose. ***OA:*** Nothing to disclose.

Abbreviations: ACDF, anterior discectomy and fusion; PRBCS, packed red blood cells; C/T, crossmatch to transfusion ratio; MSBOS, maximum surgical blood ordering schedule; EMR, electronic medical record.

* Corresponding author. Anne Burnett School of Medicine, Texas Christian University, TCU Box 297085, Fort Worth, TX 76129. Tel.: +1 978-806-6580; fax: 817-250-4281.

E-mail address: nicole.russell@tcu.edu (N. Russell).

https://doi.org/10.1016/j.xnsj.2023.100280
Received 18 August 2023; Received in revised form 18 September 2023; Accepted 18 September 2023
Available online 22 September 2023

our specific objectives were: (1) to determine the frequency of type and screen/crossmatch orders, (2) determine the rate of perioperative transfusion in elective ACDF for degenerative cervical spine disease, and (3) determine the overall transfusion rate and C/T ratio.

Materials and methods

Study design

After approval from the institutional review board, we retrospectively collected and analyzed data of all patients who underwent elective ACDF from January 2016 to January 2021 at a single tertiary medical center. The surgeries were performed by 9 neurosurgeons.

Data collection

Demographic, clinical, and laboratory data were manually collected from the electronic medical record (EMR). For preoperative assessment, we included laboratory values closest to the time of surgery within 6 weeks. We included postoperative laboratory values that were obtained within 24 hours after surgery. In addition to reviewing orders, operative notes and blood bank reports were reviewed to ensure we accurately captured the rate of transfusion. We defined perioperative transfusion as any blood product transfusion that occurred intraoperatively or within 24 hours following surgery.

Statistical analysis

Statistical analysis was performed using R software (version 4.2). Significance cut off was defined as $p<.05$ for all analyses. Categorical data is reported as count and percentage (%). Continuous data was assessed for normality using the Shapiro-Wilk test and reported as mean and standard deviation (SD) or median and interquartile range (IQR) for normally and non-normally distributed data, respectively. For categorical data, chi-square or Fisher's exact tests were used. Continuous data were analyzed using 2-sample paired *t* tests or Wilcoxon signed-rank test.

Table 1
Summary statistics of entire cohort.

Characteristic	N = 1,162*
Age (Y)	61 (52, 69)
Female	645 (56%)
Length of stay (d)	2.18 (18.01)
Type and screen	961 (83%)
Type and cross	647 (56%)
Units crossed	1.14 (1.07)
Preoperative hematocrit (%)	41.1 (38.2, 43.9)
Preoperative hemoglobin (g/dL)	13.70 (12.60, 14.70)
Preoperative platelet count (/uL)	235 (199, 280)
Postoperative hematocrit (%)	37.9 (35.0, 40.4)
Postoperative hemoglobin (g/dL)	12.40 (11.40, 13.40)
Postoperative platelet count (/uL)	223 (186, 266)
Transfused	1 (0.1%)
ASA grade	
I	12 (1%)
II	427 (37%)
III	623 (54%)
IV	98 (8%)
Operated levels	
1	305 (26%)
2	460 (40%)
3	308 (27%)
4	88 (8%)
Coagulation studies	
Prothrombin time (s)	13.2 (12.8, 13.7)
Partial thromboblastin time (s)	29.4 (27.5, 31.8)
International normalized ratio	1.02 (0.98, 1.07)

* Median (IQR); n (%); mean (SD).

Results

A total of 1,162 patients (median [IQR] age, 61 [52,69] years; 645 [56%] female) were included in the study (Table 1). A total of 305 (26%), 460 (40%), 308 (27%), and 88 (8%) patients underwent a 1, 2, 3, and 4 level ACDF, respectively. Our patient population represented patients with varying degrees of baseline health status and comorbidities. 12 (1%), 427 (37%), 623 (54%), and 98 (8%) patients had an ASA grade of I, II, III, and IV. A total of 778 (67%) patients were on anticoagulant or antiplatelet therapy prior to ACDF surgery. All patients underwent an elective ACDF, and as such, all patients included in this study discontinued their anticoagulant or antiplatelet therapy 1 to 2 weeks prior to surgery. Preoperative and postoperative hemoglobin and hematocrit values were collected and analyzed (Table 2). Overall, median preoperative hemoglobin (PR-HGB) was 13.70 (IQR, 12.60, 14.70), which was significantly higher than median postoperative hemoglobin (PO-HGB; 12.40; IQR, 11.40, 13.40; $p<.001$) (Fig. 1). Median hematocrit was also higher preoperatively (median [IQR] 41.1 [38.2, 43.8]) compared to postoperative (median [IQR], 37.9 [35.1, 40.4]) levels ($p<.001$) (Fig. 2).

A type and screen (TAS) were performed in 961 (83%) patients and a crossmatch was performed in 647 (56%). A total of 1,318 units of blood were crossmatched, with no pRBCs transfused and only 2 units of platelets transfused, achieving a C/T ratio of 659:1.

One patient received a blood product transfusion during their hospital admission. This patient received 2 units of platelets preoperatively for severe thrombocytopenia of 59 platelets per microliter of blood. Change in preoperative hematocrit and hemoglobin were 4.8 g/dL and 1.4, respectively. There were no intraoperative or postoperative complications necessitating emergent blood product transfusion.

Discussion

The incidence of blood product transfusion and degree of blood loss during degenerative cervical spine surgery, including ACDF, has been well documented [4,6]. However, there has only been 1 report assessing the necessity of pretransfusion testing in degenerative cervical spine surgery [6]. To our knowledge, there have been no prior reports evaluating the utility of pretransfusion testing in ACDF only. To ensure efficient usage of blood products and hospital resources, it is important to evaluate the prevalence and need for preoperative pretransfusion testing. Updated data can be used to improve institutional maximum surgical blood order schedule (MSBOS) protocols.

Several parameters exist to evaluate the efficiency of blood utilization and ultimately the effectiveness of MSBOS protocols [7–9]. The widely used crossmatch to transfusion (C/T) ratio suggests efficient blood product usage if the ratio is 2.5:1 and below, with a ratio of 1:1 being ideal [10]. In our study, a total of 1,318 units of blood were crossmatched, with no pRBCs transfused and only 2 units of platelets transfused, achieving a C/T ratio of 659:1. This is much higher than other reports of high C/T ratios in the literature. A retrospective analyses of patients undergoing colorectal surgery and total knee arthroplasty reported elevated C/T ratios of 3.4 and 17.5, respectively [10,11]. An evaluation of all elective general surgical procedures over a 6-month period found significant variation in the C/T ratio, depending on the type of surgery performed with the adjusted C/T ratio ranging from 3.65 to 37 [12]. Implementation and/or adaptions of MSBOS protocols have been shown to reduce C/T ratios [13–15], which may prove to be particularly beneficial for ACDF surgeries.

While our C/T ratio is high, the rate of transfusion in our study is consistent with previous studies reporting low incidence of blood product transfusion in degenerative cervical spine surgery, particularly ACDF. In a retrospective analysis of 11,588 cervical spine surgeries, including 10,613 ACDF's, the American College of Surgeons National Surgical Quality Improvement Project (ACS-NSQIP) reported an overall transfusion rate of 1.47%, and a transfusion rate of 0.77% in ACDF [4]. Maning et al., in a retrospective analysis of 332 patients who underwent an

Table 2
Difference in pre- and postoperative laboratory values.

Characteristic	Preoperative, N = 1,119*	Postoperative, N = 588*	Difference†	95% CI†,‡	p-value†
Hematocrit (%)	41.1 (38.2, 43.9)	37.9 (35.0, 40.4)	3.4	3.0, 3.8	<.001
Hemoglobin (g/dL)	13.70 (12.60, 14.70)	12.40 (11.40, 13.40)	1.3	1.1, 1.4	<.001
Platelets (/uL)	235 (199, 280)	223 (186, 266)	13	5.7, 19	<.001

* Median (IQR).
† Welch 2 sample *t* test.
‡ CI, confidence interval.

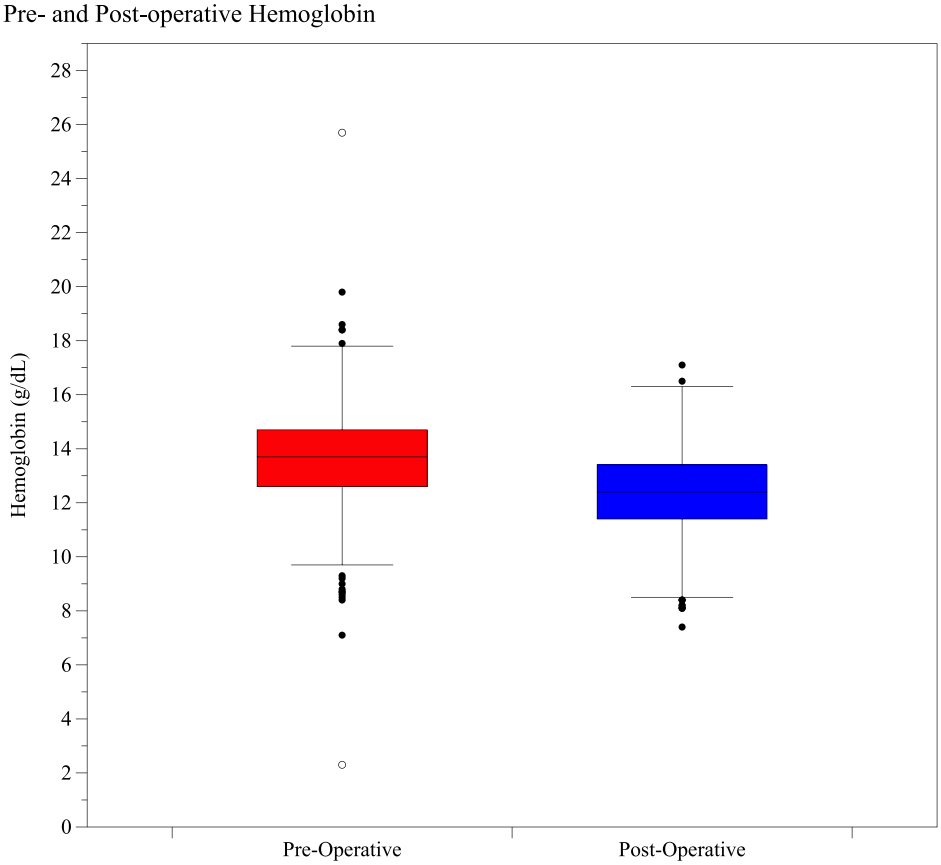

Fig. 1. Comparison of preoperative hemoglobin to postoperative hemoglobin in patients undergoing elective ACDF. Median preoperative hemoglobin was 13.70 (IQR, 12.60, 14.70). Median postoperative hemoglobin 12.40 (IQR 11.40, 13.40) (p<.01).

ACDF for degenerative cervical spine, found that no patients required an intraoperative or postoperative transfusion [16].

To our knowledge, there is only 1 other article that has evaluated the necessity for pretransfusion testing in degenerative cervical spine surgery patients. In a retrospective analysis of 372 patients who underwent either an anterior or posterior surgical approach, Nùñez et al. reported an overall transfusion rate 1.9%, and decreases between preoperative and postoperative hemoglobin and hematocrit were 1.4 (SD 1.1) g/dL and 7.2 (SD 4.1)%, respectively [6]. This is consistent with our data showing decreases between preoperative and postoperative hemoglobin and hematocrit of 1.2 (SD 2.0) g/dL and 3.4 (SD 2.8)%, respectively.

Nùñez et al. concluded that routine pretransfusion testing in patients undergoing degenerative cervical spine surgery is unnecessary in all patients except those with preoperative hemoglobin lower than 12 g/dl [6]. In our study of patients only undergoing ACDF, 163 patients had preoperative Hgb of <12 g/dL, only 1 patient required a blood product transfusion. This patient was admitted with preoperative thrombocytopenia with a platelet count of 59 necessitating transfusion of 2 units of platelets. Preoperative and postoperative were 11.5 g/dL and 10.1 g/dL (Δ 1.4), respectively. Only 83/163 patients (51%) had a completed CBC within 24 hours postoperatively. Among these patients, the mean preoperative and postoperative hemoglobin was 11 g/dL and 10.2 g/dL, respectively. The mean change in hemoglobin was 0.1 g/dL. Therefore, recommendations of pretransfusion testing for all patients undergoing degenerative cervical spine surgery with a Hgb < 12 g/dL may not be generalizable to ACDF.

Finally, only 567/1,162 (49%) of our patients received preoperative CBC within 6 weeks of their surgery, and a postoperative CBC within 24 hours of their surgery. This is consistent with a study by Maning et al. which concluded that routine postoperative complete blood counts do not change postoperative management after an ACDF unless significant intraoperative bleeding is noted, or the patient carries risk factors for postoperative hemorrhagic anemia [16].

Further research may be needed to determine optimal patient selection for preoperative type and screen and type and cross in patients undergoing ACDF to reduce the likelihood of unnecessary transfusions. Conversely, O negative blood can be used in the rare instances when perioperative blood transfusion is needed during elective ACDF.

Our study has several important limitations. First, retrospective analysis of data involves the possibility of encountering incomplete and

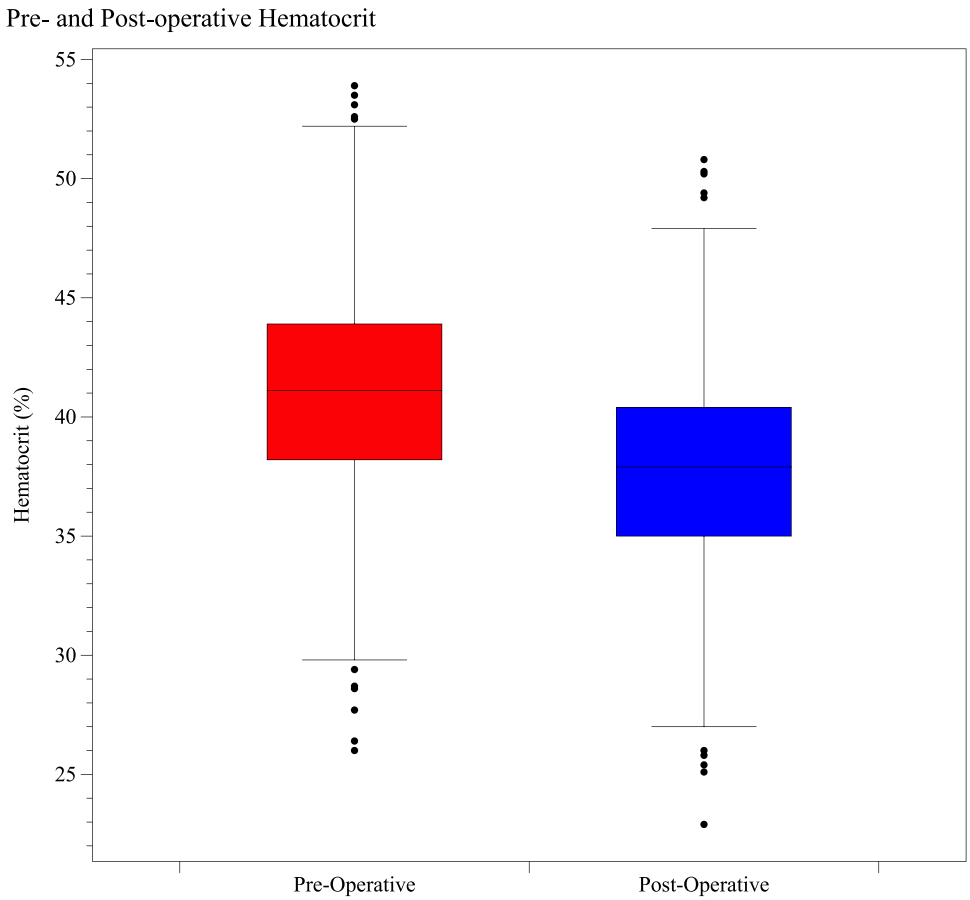

Fig. 2. Comparison of preoperative and postoperative hematocrit in patients undergoing elective ACDF. Medianpre-operative hematocrit was 41.1 (IQR 38.2, 43.8). Median postoperative hematocrit was 37.9 (IQR 35.1, 40.4) (p<.001).

inaccurate data. Specifically, only 567/1,162 (49%) of our patients had both a preoperative and postoperative CBC. Preoperative CBC collection ranged from 6 weeks preoperatively to the morning of surgery. Therefore, our results may not reflect the actual median hemoglobin, hematocrit, and platelets of patients at the time of surgery. Additionally, all our data was obtained from a single center surgical subspeciality hospital and all surgeries were performed by attending neurosurgeons. Our results may not be generalizable to academic hospitals with surgeries performed by residents or fellows or to nonsurgical subspeciality hospitals.

Conclusion

Routine type and screen and crossmatches in patients undergoing elective ACDF at our institution is associated with a high crossmatch to transfusion ratio, indicative of inefficient usage of blood products. In this cohort, ASA grades were not associated with increased rates of perioperative transfusion. Our results also suggest that these results may be generalizable to patients who appropriately discontinue anticoagulant and antiplatelet therapy prior to elective ACDF. Furthermore, routine postoperative CBC's did not change postoperative management in our patients. Routine pretransfusion testing and postoperative CBC's in elective ACDF may possibly be eliminated without negatively impacting patient care. However, more studies are needed to confirm this conclusion.

Declaration of competing interests

The authors report no conflicts of interest in this work. No funding was received to facilitate conduction of this work.

References

[1] Dweik A, Van den Brande E, Kossmann T, Maas AI. History of cervical spine surgery: from nihilism to advanced reconstructive surgery. Spinal Cord 2013;51(11):809–14. doi:10.1038/sc.2013.107.
[2] Campbell PG, Yadla S, Malone J, et al. Early complications related to approach in cervical spine surgery: single-center prospective study. World Neurosurg 2010;74(2–3):363–8. doi:10.1016/j.wneu.2010.05.034.
[3] Sheperd CS, Young WF. Instrumented outpatient anterior cervical discectomy and fusion: is it safe? Int Surg 2012;97(1):86–9. doi:10.9738/CC35.1.
[4] Aoude A, Aldebeyan S, Fortin M, et al. Prevalence and complications of postoperative transfusion for cervical fusion procedures in spine surgery: an analysis of 11,588 patients from the American College of Surgeons National Surgical Quality Improvement Program Database. Asian Spine J 2017;11(6):880–91. doi:10.4184/asj.2017.11.6.880.
[5] Katz AD, Mancini N, Karukonda T, Cote M, Moss IL. Comparative and predictor analysis of 30-day readmission, reoperation, and morbidity in patients undergoing multilevel ACDF versus single and multilevel ACCF using the ACS-NSQIP dataset. Spine (Phila Pa 1976) 2019;44(23):E1379–87. doi:10.1097/BRS.0000000000003167.
[6] Núñez JH, Bosch-García D, Escudero B, et al. Is routine blood typing and screening necessary for degenerative cervical spine surgery patients in specialty surgical hospitals? Transfusion 2022;62(6):1199–207. doi:10.1111/trf.16889.
[7] White MJ, Hazard SW 3rd, Frank SM, et al. The evolution of perioperative transfusion testing and blood ordering. Anesth Analg 2015;120(6):1196–203. doi:10.1213/ANE.0000000000000619.
[8] Friedman BA. An analysis of surgical blood use in United States hospitals with application to the maximum surgical blood order schedule. Transfusion 1979;19(3):268–78. doi:10.1046/j.1537-2995.1979.19379204208.x.
[9] Chan AH, Chan JC, Wong LY, Cheng G. From maximum surgical blood ordering schedule to unlimited computer crossmatching: evolution of blood transfusion for surgical patients at a tertiary hospital in Hong Kong. Transfus Med 1996;6(2):121–4. doi:10.1046/j.1365-3148.1996.d01-60.x.
[10] Tay AYW, Thever Y, Bin Abd Razak HR, Hao Y, Tan AHC. Routine preoperative group crossmatching and postoperative check hemoglobin is not necessary in patients undergoing total knee arthroplasty. J Knee Surg 2021;34(12):1359–67. doi:10.1055/s-0040-1709488.
[11] Shaker H, Wijesinghe M, Farooq A, Artioukh DY. Cross-matched blood in colorectal surgery: a clinical waste? Colorectal Dis 2012;14(1):115–18. doi:10.1111/j.1463-1318.2010.02535.x.

[12] Hall TC, Pattenden C, Hollobone C, Pollard C, Dennison AR. Blood transfusion policies in elective general surgery: how to optimise cross-match-to-transfusion ratios. Transfus Med Hemother 2013;40(1):27–31. doi:10.1159/000345660.
[13] Boral LI, Henry JB. The type and screen: a safe alternative and supplement in selected surgical procedures. Transfusion 1977;17(2):163–8. doi:10.1046/j.1537-2995.1977.17277151923.x.
[14] Lowery TA, Clark JA. Successful implementation of maximum surgical blood order schedule. J Med Assoc Ga 1989;78(3):155–8.
[15] Subramanian A, Rangarajan K, Kumar S, Sharma V, Farooque K, Misra MC. Reviewing the blood ordering schedule for elective orthopedic surgeries at a level one trauma care center. J Emerg Trauma Shock 2010;3(3):225–30. doi:10.4103/0974-2700.66521.
[16] Manning BT, Sankaranarayanan S, Hassanzadeh H, et al. The utility of obtaining routine hematological laboratory values following an anterior cervical diskectomy and fusion. Spine (Phila Pa 1976) 2014;39(20):E1228–32. doi:10.1097/BRS.0000000000000512.