

# Controlled hypotension combined with autotransfusion in patients with idiopathic scoliosis★

Yin Xiang, Wang Ai-min, Sun Hong-zhen, Du Quan-yin, Wang Zi-ming, Wang Yu

## Abstract

**BACKGROUND:** Idiopathic scoliosis is a common spinal deformity in teenagers, which is managed mainly by orthomorphia. However, due to great trauma, long operative duration and large blood loss, a great amount of blood transfusion is needed during the surgery. Allogeneic blood transfusion should be reduced in order to release blood insufficient, decline blood transfusion expense, as well as avoid transfusion diseases.

**OBJECTIVE:** To investigate the value of controlled hypotension combined with autotransfusion in idiopathic scoliosis orthomorphia.

**METHODS:** Intraoperative controlled hypotension was performed during posterior orthomorphia surgery on all the 46 cases of idiopathic scoliosis, 17 cases in which were served as the control group, who underwent allogeneic blood transfusion without autotransfusion, while the other 29 cases were served as the experimental group, who underwent autotransfusion that including reinfusion of preoperative deposited autologous blood and intra-operative salvaged autologous blood. The blood loss volume and transfusion status in two groups were observed.

**RESULTS AND CONCLUSION:** Blood loss volume in the control group was 400–1 000 (867±161) mL, and that in the experimental group was 350–1400 (842±376) mL, There was no marked difference between the two groups ( $P > 0.05$ ). The volume of allogeneic blood transfusion in the control group was 500–1 800 (845±332) mL, which was greater than that in the experimental group [0–1 300(423±237) mL] ( $P < 0.01$ ). The results suggested that controlled hypotension reduces intraoperative bleeding, and postoperative autotransfusion minimizes the need of allogeneic blood transfusion.

Department of Orthopedics, Research Institute of Surgery, Third Affiliated Hospital, Third Military Medical University of Chinese PLA, Chongqing 400042, China

Yin Xiang★, Master, Physician, Department of Orthopedics, Research Institute of Surgery, Third Affiliated Hospital, Third Military Medical University of Chinese PLA, Chongqing 400042, China  
yinx2000sw@tom.com

Received: 2010-01-15  
Accepted: 2010-04-15  
(20091015005/WL)

Yin X, Wang AM, Sun HZ, Du QY, Wang ZM, Wang Y. Controlled hypotension combined with autotransfusion in patients with idiopathic scoliosis. Zhongguo Zuzhi Gongcheng Yanjiu yu Linchuang Kangfu. 2010;14(26): 4933-4936.

[http://www.crter.cn  
http://en.zglckf.com]

## INTRODUCTION

Idiopathic scoliosis, a common spinal deformity among young people, is managed mainly by orthomorphia. However, orthomorphia surgery is associated with great trauma and prolonged operation time, and additionally the need of intraoperative exposure and extensive tissue stripping predisposes patients to heavy blood loss, thus requiring transfusion of a great amount of blood. To ease the tension of limited blood source, reduce the cost of blood transfusion, avoid transfusion diseases, and minimize allogeneic blood transfusion<sup>[1]</sup>, intraoperative controlled hypotension combined with autotransfusion were applied in idiopathic scoliosis orthomorphia surgery, as reported below.

## SUBJECTS AND METHODS

### Subjects

A total of 46 cases with idiopathic scoliosis, aged from 11 to 36 years (average 16 years) and weighed from 20 to 62 kg (average 42 kg) were included in this study. They were graded I–II according to the American Society of Anesthesiologists classifying system (no organ lesions, or there were only mild to moderate organ lesions but with good compensatory functions), with 42°–116° (average 86°) Cobb angle. All patients received intraoperative controlled hypotension, 17 cases among whom were served as the control group, who underwent allogeneic blood transfusion without autotransfusion, while the other 29 cases were served as the experimental group, who underwent autotransfusion, including reinfusion of the autologous blood deposited preoperatively and

that salvaged intra-operatively. In the experimental group, allogeneic blood transfusion was not applied unless autologous blood was insufficient.

Preoperative hemoglobin ranged from 96 to 144 g/L with an average of 122.4 g/L, and hematocrit ranged from 0.254 to 0.405 with an average of 0.325. None of the patients had any blood system diseases. All the patients underwent posterior idiopathic scoliosis orthomorphia surgery and bone graft fusion with internal fixation. Pedicle hook fixation was used for upper thoracic vertebrae in 3 cases, and pedicle screw insertion (7–10 screws) was used in the remaining 43 cases.

### Methods

#### Controlled hypotension procedures

All the patients received endotracheal intubation and intravenous combined anesthesia. Anesthesia was induced *via* intravenous injection of Midazolam 0.2 mg/kg, Fentanyl 5 µg/kg and Vecuronium Bromide 0.1 mg/kg, together with endotracheal intubation and mechanical ventilation. For maintenance of anesthesia, either intermittent intravenous injection of Vecuronium Bromide, Remifentanyl and Propofol, or intermittent inhalation of Isoflurane, was applied during mechanical ventilation. In the course of operation, all the patients were administered 0.01% Sodium Nitroprusside intravenously 0.5–5.0 µg/kg per minute for controlled hypotension, maintaining systolic pressure levels at (90±5) mm Hg.

#### Collection of autologous blood

Autologous blood was collected by means of preoperative autologous blood deposit and intraoperative autologous blood salvage. Prior to operation, patients in the experimental group

who indicated for preoperative autologous blood deposit were asked for a consent and signed an consent form of autologous blood transfusion (patient selection was based on a comprehensive assessment of general data, body weight, blood routines, etc). At 1–2 weeks before orhomorpha operation, the patients without any blood collection contraindications began to undergo blood collection from the median cubital vein. Blood collection volume ranged from 200 to 400 mL per session, dependent on the individual’s weight and general conditions. Between two collection sessions, there was an interval of over 3 days, and blood collection was stopped at 3 days before operation. The collected blood was processed with anticoagulant sodium citrate and then stored at 4 °C, and was re-warmed to 38–40 °C before re-infused into patients intra-operatively or postoperatively. Patients who underwent preoperative blood deposit were given an injection of erythropoietin after atuologous blood collection<sup>[2]</sup>, as well as oral ferrous sulfate tablets 0.3 g, taken three times per day. The patients who did not undergo autologous blood collection were also given an injection of erythropoietin, together with oral ferrous sulfate tablets 0.3 g, taken 3 times per day. For intraoperative autologous blood salvage, ZITI 3000 blood salvaging system was utilized to collect the oozing blood from the wound into a blood reservoir. Anticoagulant heparin was added during the blood suctioning, and the salvaged blood was centrifuged and washed before re-infused into the patients in the experimental group. When the operation was completed, all patients were sutured intradermically using absorbable suture lines. No postoperative drainage was applied. At 24 hours after the operation, patients’ vital signs were observed, oxygen saturation and urine volume were measured, and blood routines, hepatic, renal and coagulation functions were tested.

**Statistical analysis**

All data of the study were processed by SPSS 10.0 software. The data expressed by Mean±SD. A P value of < 0.05 was considered significant.

**RESULTS**

Preoperative and postoperative general data (including age, weight, Cobb angle, hemoglobin, hematocrit, incision length, the number of vertebrae exposed, etc) were not significantly different ( $P > 0.05$ ) between the two groups (Tables 1–2). In the experimental group, 20 cases received preoperative deposited autologous blood and 16 cases received intraoperative salvaged autologous blood, 7 cases of which received both. The autologous blood volume collected in the experimental group: preoperative deposited autologous blood volume was 200–1 200 (277.5±51.3) mL, while intraoperative salvaged autologous blood volume was 250–500 (325.0± 33.7) mL. Blood loss volume included both the blood suctioned into the reservoir intraoperatively and the blood in the gauze. Blood loss volume in control group was 400–1 000 (867±161) mL, and that in experimental group was 350–1 400 (842±376) mL ( $P > 0.05$ ). The volume of allogeneic blood transfusion in control group was 500–1 800 (845±332) mL, and 0–1 300 (423±237) mL in experimental group, there was significant difference between the two groups ( $P < 0.01$ ) (Table 3).

Table 1 Comparison of preoperative general data between the control group and experimental group ( $\bar{x}\pm s$ )

Item	Experimental group	Control group
Age (yr)	16.5±5.9	15.7±3.1
Weight (kg)	42±8.3	39±6.3
Cobb angle (°)	67±20.2	56.4±10.9
Hemoglobin (g/L)	121.5±10.1	117±10.8
Hematocrit	0.33±0.04	0.32±0.04

Table 2 Comparison of postoperative general data between the control group and experimental group ( $\bar{x}\pm s$ )

Item	Experimental group	Control group
Incision length (cm)	30.8±4.8	27.4±4.1
Vertebrae exposed (n)	10.9±1.4	9.5±1.9
Inserted screws (n)	7.4±2.1	7.9±1.4
Average blood loss (mL)	842±376	867±161

Table 3 Autologous and allogeneic blood transfusion in the control group and experimental group ( $\bar{x}\pm s$ , mL)

Group	n	Intraoperative blood loss	Volume of autologous blood transfusion	Volume of allogeneic blood transfusion
Control	17	867±161	0	845±332
Experimental	29	842±376	348±249 <sup>a</sup>	423±237 <sup>a</sup>

<sup>a</sup> $P < 0.01$ , vs. control group

Blood transfusion reactions: None of the patients showed transfusion reactions. At 24 hours and 7 days after operation, both groups showed decreased hemoglobin and hematocrit as compared with the preoperative values, and the difference was significant ( $P < 0.05$ ); all patients had mild anemia but did not manifest related clinical symptoms, with insignificant difference between two groups (Table 4). As drainage devices were not placed in the patients after operation, it is impossible to include such hidden blood loss as wound oozing and internal bleeding. The need of blood capacity supplementation was determined according to a comprehensive evaluation of patients’ 24-hour postoperative vital signs, oxygen saturation and urine volume, blood routines, liver and kidney functions.

Table 4 Preoperative hemoglobin and hematocrit in the control group and experimental group ( $\bar{x}\pm s$ )

Time	Hemoglobin (g/L)		Hematocrit	
	Control group	Experimental group	Control group	Experimental group
Before operation	117.0±10.8	121.5±10.1	0.32±0.04	0.33±0.04
1 d after operation	94.5±11.8	86.9±10.1	0.26±0.04	0.24±0.08
7 d after operation	97.7±8.6	104.0±7.4	0.27±0.04	0.29±0.04

$P < 0.05$ , vs. preoperative data of the same group

## DISCUSSION

Idiopathic scoliosis is a common deformity of the spinal column, with orthomorphia surgery being its essential treatment. The preparation of graft bed (including decortication and V-osteotomy of small articular process) and the thoracoplasty require that a great amount of cancellous bone tissues be bitten away and the vertebral lamina surface be decorticated, causing heavy bleeding. In order to avoid the need of transfusion of a great amount of allogeneic blood and to minimize transfusion complications like allergic reactions, the spread of hepatitis and AIDS, immune suppression and complications associated with heavy transfusion<sup>[3-4]</sup>, our department carried out, based on intraoperative controlled hypotension performed in all the patients both in the experimental group and the control group, autologous blood collection on the patients in the experimental group, including preoperative autologous blood deposit and intraoperative autologous blood salvage.

### Significance of controlled hypotension

Scoliosis orthomorphia surgery is associated with heavy blood loss, ranging from 800 mL to 4 100 mL as reported by literature<sup>[5-6]</sup>; by contrast, results of this study showed the blood loss in the control group was 400–1 000 (867±161) mL and that in the experimental group was 350–1 400 (842±376) mL. As can be seen, controlled hypotension has the potential to reduce bleeding and provide a clearer surgical field, quite beneficial for the performance of surgical procedures. Nevertheless, the application of controlled hypotension presents certain risk to vital organs. It can lead to unexplained reduced blood capacity and vasoconstriction in the course of surgery, anemia, hidden coronary artery diseases, or sudden hemorrhage and tension pneumothorax which make patients susceptible to myocardial ischemia or cardiac arrest. Furthermore, controlled hypotension may also lead to insufficient local blood supply to the optic nerves, greatly increasing the possibility of unilateral or complete visual impairment<sup>[7-8]</sup>. Therefore, in the process of controlled hypotension, when blood oozing in the surgical field has been obviously reduced, it is not proper to further lower the blood pressure for a “bloodless surgical field”, otherwise, blood perfusion of the vital organs will become insufficient. Study of Shear *et al*<sup>[9]</sup> have showed that a blood pressure level lower than 55–65 mm Hg after controlled hypotension would affect blood perfusion of the brain and cause corresponding complications.

### Application of autologous blood transfusion

Transfusion of preoperative deposited blood is limited for patients who will undergo selected surgery, including: ①patients who have good preoperative general conditions not requiring emergent operation; ②patients whose intraoperative blood loss and postoperative blood transfusion needs are predictable; ③patients whose blood type is rare; ④patients with a past history of adverse reactions associated with allogeneic blood transfusion; ⑤patients who refuse allogeneic blood transfusion because of religious belief; ⑥in areas with allogeneic blood shortage. According to American Association of Blood Bank (AABB), the pre-collection concentration of hemoglobin should be higher than 110 g/L and that of hemocrit

should be higher than 0.33. Blood collection volume per session shall not exceed (450±45) mL, or 12% of the circulating blood volume; for patients whose weight is less than 50 kg, the blood collection volume should be less than 8 mL per kg body weight. Blood collection should be started 1 week before surgery, with an inter-session interval not less than 3 days, and the time of the last collection session should precede the surgery at least 72 hours. The patients undergoing preoperative autologous blood deposit require supplementation of iron, an essential element for production of red blood cells. As routine, patients were given erythropoietin and oral ferrous sulfate tablets. Blood collection went smooth in all the patients without any adverse reactions. Current technology only allows the autologous blood to be preserved for 3 weeks, and in addition patients are prone to experience decline of preoperative hemoglobin and hematocrit after blood collection, therefore, it is impossible to collect a great volume of autologous blood. In this sense, autologous blood transfusion cannot completely replace the extensive clinical application of allogeneic blood transfusion. The intraoperative autologous blood salvage procedures involved the use of a blood recovering system to suction the oozing blood from the wound into a blood reservoir with heparin added during blood suctioning for anticoagulation purpose, the processing of the recovered blood by centrifugation and washing, and then the reinfusion of the salvaged red blood cells into the patients. As the recovery rate of blood from surgical field was 60%–80% and the recovery rate of red blood cells from the blood processing procedure was 60%–70%, intra-operative autologous blood reinfusion was not necessary for patients in whom the blood loss volume was less than 500 mL. In addition, because the washing process removes free hemoglobin, blood potassium, fibrin degradation products, platelet activation and degradation products, complement activation products, micro-thrombus, and cell and tissue fragments, transfusion of washed red blood cells alone may lead to coagulation disorders. Tawes *et al*<sup>[10]</sup> believed that platelets and clotting factors in the washed blood are markedly decreased, thus re-infusing plenty autologous blood is likely to dilute the blood and cause clotting disorders, consequently leading to bleeding tendency. Li *et al*<sup>[11]</sup> suggested that the appropriate autologous blood transfusion volume should be within 3 000 mL, and if the volume exceeds 4 000 mL, infusion of fresh frozen plasma is warranted. Autologous blood reinfusion has been increasingly used in clinics. There have been studies<sup>[12-14]</sup> demonstrated that autologous blood reinfusion not only raised postoperative hemoglobin level, reduces occurrence of SIRs and infection, but also increases serum CK-MB level, playing a certain role in myocardial cell repairing. As regards the cost of blood transfusion, transfusion in the control group cost averagely 3 450 Chinese Yuan (1 650–6 000 Chinese Yuan, a standard cost in Chongqing, China), while the transfusion cost in the experimental group averaged at 2 250 Chinese Yuan (160–5 290 Chinese Yuan) which included the preoperative autologous blood deposit cost 160 Chinese Yuan, the intra-operative blood salvage cost 1 000 Chinese Yuan and the allogeneic blood transfusion cost (if any). The transfusion costs between the two groups were significantly different, indicating autologous blood reinfusion can promise a great relief of financial burden. Therefore, it is concluded that in patients who undergo

idiopathic scoliosis orthomorphia surgery, controlled hypotension combined with autotransfusion not only promises milder intraoperative bleeding, less allogeneic blood transfusion, minimized transfusion-related complications and absence of blood-borne diseases, but also avoids wasting the autologous blood, which is especially meaningful for patients with RH negative blood type, reducing financial burden to patients. Controlled hypotension combined with autotransfusion is of high value in idiopathic scoliosis orthomorphia.

REFERENCES

[1] Schreiber BG. The risk of transfusion-transmitted viral infection. N Engl J Med. 1996;334(26):1685-1690.  
 [2] Aksoy MC, Tokgozozlu AM. Erythroietin for autologous blood donation in total hip arthroplasty patients. Arch Orthop Trauma Surg. 2001;121(3):162-165.  
 [3] Corash L. Inactivation of infectious pathogens in labile blood components:meeting the challenge. Transfus Clin Biol. 2001;8(3):138-145.  
 [4] Prins HA, Houdijk AP, Nijveldt RJ, et al. Arginase release from red blood cells:possible link in transfusion induced immune suppression. Shock. 2001;16(2):113-115.  
 [5] Liang Z, Yu L, Yanping L. Application of controlled hypotension in correction of idiopathic scoliosis by C-D instruments (with a report of 26 cases). New Medicine. 1996;27(10):525-526.

[6] Sun CL, Zhang ZL, Guo J, et al. Application of autotransfusion in scoliosis operation. Zhongguo Shuxue Zazhi. 2003;16(3): 184-185.  
 [7] Murphy MA. Bilateral posterior ischemic optic neuropathy after lumbar spine surgery. Ophthalmology. 2003,110(7):1454-1457.  
 [8] Dilger JA, Tetzlaff JE, Bell GR,et al. Ischaemic optic neuropathy after spinal fusion. Can J Anaesth. 1998,45(1):45-63.  
 [9] Shear T, Tobias JD. Cerebral oxygenation monitoring using near infrared spectroscopy during controlled hypotension. Paediatr Anaesth. 2005;15(6):504-508.  
 [10] Tawes RL, Sydorak GR, Duvall TB, et al. Avoiding coagulopathy in vascular surgery. Am J Surg.1990;160(2): 212-216.  
 [11] Li J, Zhu TY, Ma ZT, et al. Clinical application of blood recovery during and after orthopedic operation. Zhonghua Guke Zazhi. 2001;21(2):87-89.  
 [12] Murphy GJ, Rogers CS, Lansdowne WB, et al. Safety, efficacy, and cost of intraoperative cell salvage and autotransfusion after off-pump coronary artery bypass surgery: a randomized trial. J Thorac Cardiovasc Surg. 2005;130(1):20-28.  
 [13] Mercer KG, Spark JI, Berridge DC, et al. Randomized clinical trial of intraoperative autotransfusion in surgery for abdominal aortic aneurysm. Br J Surg. 2004;91(11):1443-1448.  
 [14] Pleym H, Tjomsland O, Asberg A, et al. Effects of autotransfusion of mediastinal shed blood on biochemical markers of myocardial damage in coronary surgery. Acta Anaesthesiol Scand. 2005;49(9):1248-1254.

控制性降压联合自体血回输在特发性脊柱侧弯矫形中的应用\*

殷翔, 王爱民, 孙红振, 杜全印, 王子明, 王雨(解放军第三军医大学第三附属医院野战外科研究所骨科, 重庆市 400042)

殷翔★,男,1982年生,湖北省钟祥市人,汉族,2007年解放军第三军医大学毕业,硕士,医师,主要从事脊柱外科的研究。

摘要

背景:特发性脊柱侧凸是青少年较为常见的脊柱畸形,手术矫形是其重要的治疗手段。但手术创伤大、时间长,矫形过程中暴露、剥离组织较多,出血量大,需较大的输血。为缓解血源紧张,减少输血费用,避免输血性疾病的发生,尽量减少输注异体库存血。目的:观察控制性降压联合自体血回输在特发性脊柱侧弯矫形中的作用。

方法:对46例特发性脊柱侧弯患者行后路矫形时均进行术中控制性降压。其中17例

未进行自体血回输,作为对照组,矫形后全部输异体库存血;另外29例均使用自体血液回输,包括矫形前预存自体血及矫形过程中自体血回输,作为实验组。观察两组患者失血量及输血情况。

结果与结论:失血量:对照组400~1000(867±161)mL,实验组350~1400(842±376)mL,两组相比差异无显著性意义(P>0.05)。输入库存血量:对照组500~1800(845±332)mL,明显多于实验组0~1300(423±237)mL(P<0.01)。提示控制性降压可减少矫形过程中出血量,同时矫形后采用自体血回输可明显减少异体库存血的需要量。

关键词:自体血;输血;特发性脊柱侧弯;矫形;控制性降压

doi:10.3969/j.issn.1673-8225.2010.26.045

中图分类号:R318 文献标识码:B

文章编号:1673-8225(2010)26-04933-04

殷翔,王爱民,孙红振,杜全印,王子明,王雨.控制性降压联合自体血回输在特发性脊柱侧弯矫形中的应用[J].中国组织工程研究与临床康复,2010,14(26):4933-4936.

[http://www.crter.org http://cn.zglckf.com]

(Edited by Zhao LJ/Wang L)