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Effectiveness of single and double predonation combined with postoperative recuperation for blood salvage in scoliosis surgery

Skuteczność pojedynczej i podwójnej predonacji łącznej z pooperacyjnym odzyskiem krwi w operacjach skolioz

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Summary

Introduction. The autotransfusion is promoted for patients undergoing scoliosis surgery as a recognized mean for reducing homologous transfusion need. There is a deficiency of studies which directly compare this procedure in similar groups of patients managed alternatively with or without autotransfusion.

Material and methods. Retrospective analysis with control group. Forty two consecutive patients (study group), mean age 15.1 years, underwent the autotransfusion program (subgroup 1.1 – 22 patients who had single and subgroup 1.2 – 20 patients who had double predonation) while having posterior instrumentation for idiopathic scoliosis. Preoperative donation and postoperative recuperation were performed in the study group. The number of instrumented segments varied from 6 to 14, mean 9.9 ± 1.9 ; the mean time of operation was 190.8 ± 36.7 minutes. The control group was adopted from Lisander et al. (1) and consisted of thirteen patients matched by age, sex, type of surgery, time of operation and the number of instrumented vertebrae. No autotransfusion was carried out in the control group.

Results. Predonated volume in subgroup 1.1 varied from 250 to 520 ml, mean 324 ml and in subgroup 1.2 respectively from 400 to 1040, mean 762. Postoperatively recuperated and retransfused blood volume in subgroup 1.1 varied from 200 to 1350 ml, mean 653 ml and in subgroup 1.2 from 320 to 950 ml, mean 681 ml. In subgroup 1.1 nine patients (41%) and in subgroup 1.2 eleven patients (55%) avoided homologous transfusion. 5.5 homologous blood units on the average were transfused to patients from the control group while 1 unit to patients from the study group ($p < 0.001$).

Conclusions. Simple and costless procedures of single or double predonation and postoperative blood recuperation significantly reduced but not completely avoided homologous transfusion in adolescents undergoing surgery for scoliosis. More patients with double predonation than with single predonation avoided homologous transfusion.

Key words: autotransfusion, scoliosis, homologous transfusion

Streszczenie

Wstęp. Autotransfuzja jest zalecana u pacjentów podlegających zabiegom chirurgicznym kręgosłupa jako uznany środek redukujący potrzebę transfuzji krwi obcej. Istnieje niedobór badań, które mogłyby bezpośrednio porównać tę procedurę w podobnych grupach chorych leczonych alternatywnie z autotransfuzją lub bez autotransfuzji.

Materiał i metody. Retrospektywna analiza z grupą kontrolną. 42 kolejnych pacjentów (grupa badana), średnia wieku 15,1 lat, zakwalifikowano do programu autotransfuzji (podgrupa 1.1 – 22 pacjentów, którzy mieli jedną predonację i podgrupa 1.2 – 20 pacjentów, którzy mieli dwie predonacje), wykonując u nich stabilizację skoliozy idiopatycznej z dojscia tylnego. W grupie badanej zrealizowano predonację oraz pooperacyjny odzysk krwi. Liczba segmentów objętych instrumentacją wynosiła od 6 do 14, średnia $9,9 \pm 1,9$; średnia czasu operacji $190,8 \pm 36,7$ minut. Grupa kontrolna została zaadaptowana z pracy Lisandera i wsp. (1) i składała się z 13 pacjentów dobranych pod względem wieku, płci, typu zabiegu, czasu operacji i liczby segmentów objętych instrumentarium. W grupie tej nie przeprowadzono autotransfuzji.

Wyniki. Objętość predonacji w podgrupie 1.1 wahała się od 250 do 520 ml, średnia 324 ml, a w podgrupie 1.2 odpowiednio od 400 do 1040, średnia 762 ml. Odzyskana i przetoczona w okresie pooperacyjnym objętość krwi w podgrupie 1.1 wahała się od 200 do 1350 ml, średnia 653 ml, a w podgrupie 1.2 od 320 do 950 ml, średnia 681 ml.

W podgrupie 1.1 dziewięciu pacjentów (41%), a w podgrupie 1.2 jedenastu pacjentów (55%) uniknęło transfuzji krwi obcej. 5.5 jednostek krwi obcej przetoczono przeciętnie pacjentom z grupy kontrolnej przy 1 jednostce w grupie badanej ($p < 0,001$).

Wnioski. Prosta i niedroga procedura jedno- lub dwukrotnej predonacji oraz odzysku krwi znacząco ale nie całkowicie redukuje transfuzje krwi obcej u nastolatków przechodzących operacje skoliozy. Większa liczba pacjentów po podwójnej niż po pojedynczej predonacji uniknęła transfuzji krwi obcej.

Słowa kluczowe: autotransfuzja, skolioza, transfuzja homologiczna

INTRODUCTION

Surgery for scoliosis can cause an important intra- and postoperative blood loss, so transfusion can be required. Homologue transfusion risks consist of infectious and immunologic complications (2). Although blood tests eliminate contamination with hepatitis C or HIV viruses, the whole spectrum of potentially dangerous infectious agents is not screened. New viruses and prions can be involved and a long seroconversion time can be responsible for false negative results of blood tests (2). Immunization with allogeneic proteins in young females can cause later complications during pregnancy (3). Benefits of autotransfusion concern the reduction of the postoperative venous thromboembolism (4) and postoperative infection rate (5). Avoiding homologous blood transfusion is expected by patients and families.

Autotransfusion techniques comprise [1] pre-, [2] intra- and [3] postoperative period. [1] Preoperative donation is usually performed once a week and allows the collection of one to three blood units. Blood volume stored in each donation depends on the patient's weight; the folic acid and ferrous supplementation are simultaneously ordered. The advantage of preoperation comprises the stimulation of hematogenic function of the bone marrow within the days that immediately precede the operation (6-8). [2] The intra-operative techniques comprise normovolemic hemodilution of an anesthetized patient. This harmless procedure reduces the hematocrite so the intraoperative hemoglobin loss is diminished (9, 10). However it requires additional time spent in the preparation room and does not provide stimulation of hematopoiesis. During operation, the limitation of bleeding is assured with an atraumatic surgery and the use of electrocautery. Intraoperative blood recuperation systems are helpful, however they require important and expensive hardware and are considered advantageous only for very long and severe procedures. If the blood loss is moderate, it makes this technique less effective in limiting homologous transfusion (11, 12). [3] Finally the postoperative recuperation systems provide the blood collected from the drainage during the first postoperative hours.

At Department of Pediatric Orthopaedics and Traumatology the autotransfusion in the form of pre-donations and postoperative recuperation with the

BCC stryker (Stryker) is proposed systematically to all adolescents undergoing scoliosis surgery or any other planned operation at risk of important blood loss. The aim of the study was to evaluate the effectiveness of the autotransfusion in adolescents operated on for scoliosis by comparing this practice with control group.

MATERIAL AND METHODS

Forty two consecutive patients (study group) underwent the autotransfusion before surgery for scoliosis. Study group was divided into two subgroups 1.1 and 1.2 depending on the number of preoperation, respectively single or double. There were 39 girls and 3 boys, aged from 12 to 23 years, mean 15.1 years. All patients were operated on for idiopathic scoliosis. Idiopathic scoliosis pattern was single thoracic curve in 7 patients, double thoracic curve in 3 patients and double thoracic and lumbar curve in 18 patients. Posterior approach, spinal liberation, frame instrumentation with double side hooks and rods according to Cotrel and Dubousset (13), as well as meticulous decortication were performed by the same surgeon (T.K.). In 20 patients (11 in 1.1 and 9 in 1.2) the iliac bone autograft was derived. One or two suction drains were used in the main wound and one additional in the iliac crest. The drains were usually kept 48 hours, depending on the flow noted. Verticalisation after drains ablation was effected on the 3rd postoperative day.

Preoperative donation was performed in all patients. Following the preoperation a supplementation with ferrous sulfate and folic acid was ordered. Psychological preparation to the preoperation consisted of information provided to the patients in a talk before admission. Both patients and parents were addressed, all questions were answered, and a psychologist was engaged in difficult situations. Patients were encouraged to visit the department before admission in order to talk to the adolescents already hospitalized. Nurses and laboratory staff were engaged in motivation of the patients. The day of preoperation a lignocaine occlusion dressing was applied over the vein before the catheterization for local anesthesia. Written approval for the procedure was asked both from the parent and the patient. The amount of the preoperation varied from 250 to 520 ml, according to the body weight. The bags with

a suitable anticoagulant content were individually prepared in the Local Transfusion Center.

Positioning of the patient on the operation table respected the rules of protecting him from the overpressure on the perivertebral venous circulation. Surgical exposure was done carefully, cauthery and bone wax were used, and the final decortication immediately preceded wound closure. Postoperative autotransfusion was performed in all patients. Blood lost in suction drains during the first 6 hours after wound closure was recuperated in Blood Conservation System device (Stryker) and retransfused.

The control group consisted of thirteen scoliotic patients (12 girls and 1 boy) operated for scoliosis with posterior Harrington instrumentation. Scoliosis was idiopathic in all cases. The patients from the control group did not undergo autotransfusion and the blood loss was compensated with the homologous transfusion. The patients from the study and control groups were matched by age, gender, time of operation and the number of instrumented vertebrae. The values of analyzed parameters are listed in the table 3. The matching between subgroups concerning patients' age, operative time and the number of instrumented vertebrae was checked by the two-sided unpaired t test ($p > 0.05$).

Patients' height, weight, number and volume of preoperative donations, volume of operative lost, postoperative recuperation and postoperative loss were analyzed. Hemoglobin concentration (Hb) and hematocrite (Ht) were noted before preoperative donation, before the operation, immediately after

the operation and at the 1st and 3rd postoperative days. Decrease of blood hemoglobin concentration related to the predonation of 500 ml of blood was calculated. Total blood need was calculated for each patient by adding the homologous transfusion volume to the autologous predonated volume and the autologous drainage recuperated volume. This volume was related to the severity of operation by dividing the total transfused blood volume (ml) by the number of instrumented vertebrae multiplied by the operative time (hours). We described this value as blood demand formula (BDF). Finally the amount of homologous transfusion was compared with control group. W Shapiro test was used for verifying normal distribution. T Student test was used for normal range parameters, Mann-Whitney's for not normal.

RESULTS

The preoperative donation was performed once in 22 patients (subgroup 1.1), twice in 20 patients (subgroup 1.2). The predonated volume varied from 250 to 1040 ml, mean 532,6 ml. The children did not complain of any discomfort of donation. The next day they could normally participate to a specially designed program of exercises preparing for scoliosis surgery. The decrease of blood hemoglobin concentration related to the predonation of 500 ml of blood was 1.4 ± 0.9 g/100 ml (0.0 ÷ 2.8). The values of analyzed parameters are listed in the table 1.

In subgroup 1.1 nine patients (41%) and in subgroup 1.2 eleven patients (55%) avoided homologue

Table 1. The values of analyzed parameters in the study group, expressed as mean \pm standard deviation; minimum and maximum values are indicated in brackets. Hb – haemoglobin concentration (g/100 ml), Ht – hematocrit, N=42.

	Group 1.1 N = 22	Group 1.2 N = 20	p value
Body height (cm)	161.1 \pm 7 (147 ÷ 177)	164.8 \pm 7.8 (144 ÷ 177)	0,07
Body weight (kg)	51.8 \pm 9.3 (34 ÷ 70)	50.7 \pm 4.9 (42 ÷ 60)	0,55
Hb before predonation	13.6 \pm 0.9 (11.7 ÷ 15.6)	13.8 \pm 0.8 (12.1 ÷ 15.2)	0,2
Hb before operation	12.8 \pm 0.9 (11.5 ÷ 14.5)	12.0 \pm 0.7 (11 ÷ 13.4)	0,01
Hb postoperative	10.8 \pm 1.5 (7.8 ÷ 14.2)	9.5 \pm 1.0 (8.0 ÷ 11.8)	0,002
Hb the 1 st postop day	10.1 \pm 1.0 (8.1 ÷ 11.9)	10.4 \pm 1.4 (7.8 ÷ 12.9)	0,45
Hb the 3 rd postop day	10.4 \pm 1.2 (8.4 ÷ 12.4)	9.7 \pm 1.5 (6.4 ÷ 11.8)	0,14
Ht before predonation	40.5 \pm 2.5 (35.5 ÷ 44.2)	40.7 \pm 1.7 (37,7 ÷ 44,1)	0,81
Ht before operation	38.6 \pm 2.3 (35.5 ÷ 43.4)	35.2 \pm 2 (32.7 ÷ 38.6)	0,0006
Ht postoperative	32.2 \pm 5.8 (27.1 ÷ 47.8)	28.2 \pm 2.9 (23.2 ÷ 33.3)	0,002
Ht the 1 st postop day	29.9 \pm 3.3 (24.0 ÷ 36.2)	30.7 \pm 4.0 (22.9 ÷ 38.7)	0,41
Ht the 3 rd postop day	30.9 \pm 3.5 (25.0 ÷ 37.4)	28.5 \pm 4.6 (18.4 ÷ 36.1)	0,11

Table 2. The values of analyzed parameters in the study group, expressed as mean \pm standard deviation; minimum and maximum values are indicated in brackets.

	Group 1.1 N = 22	Group 1.2 N = 20	p value
Preop donation vol (ml)	324,1 \pm 104,7 (250 ÷ 520)	738 \pm 249,7 (400 ÷ 1040)	< 0,0001
Total drainage vol (ml)	1114,3 \pm 467,3 (470 ÷ 2230)	1169 \pm 369,9 (700 ÷ 2240)	0,58
Postop recup vol (ml)	653,2 \pm 300,6 (200 ÷ 1350)	681,6 \pm 164,9 (320 ÷ 950)	0,93
Homol transf vol (ml)	430,8 \pm 259,4 (200 ÷ 1000)	400 \pm 178,9 (200 ÷ 600)	> 0,999
Total transf vol (ml)	1231,8 \pm 491,1 (450 ÷ 2450)	1514,5 \pm 363 (800 ÷ 1990)	0,02
Number of instr verteb	10,2 \pm 2,1 (7 ÷ 14)	9,8 \pm 1,8 (6 ÷ 13)	0,78
Operation time (min)	188,4 \pm 37,8 (130 ÷ 255)	193,5 \pm 36,3 (130 ÷ 275)	0,36

transfusion. All of them had both pre-and postoperative autotransfusion. The remaining patients had to be transfused with one or more units of homologous blood. The mean of 1.7 homologous blood units was transfused to these patients. On the contrary, the control group patients had to be transfused with 5.5 homologous blood units on the average. The difference was highly significant ($p < 0.001$). The transfused and recuperated volumes are given in the table 2 and 3 respectively. The Blood Demand Formula in subgroup 1.1 varied from 16.7 to 70.1, mean 38.4 and in subgroup 1.2 was respectively from 32.2 to 91.8, mean 53.3. No complications related directly or indirectly to autologous or homologous transfusion were noted in both groups.

Table 3. The values of analyzed parameters in the control group, expressed as mean \pm standard deviation. Hb – haemoglobin concentration (g/100 ml), N=13.

	Group 2 N = 13
Body weight (kg)	50 \pm 8
Hb before operation	13.6 \pm 1
Postop recup vol (ml)	0
Homol transf vol (ml)	2475 \pm 990
Number of instr verteb	8 \pm 1
Operation time (min)	135 \pm 29

DISCUSSION

All patients who received only autologous transfusion underwent predonation and postoperative blood recuperation. The augmentative effect of combining two techniques was noted in concordance with opinion of Lisander et al. (1).

The formula of blood demand was prepared in order to estimate the needs of blood for a given scoliosis operation. The number of instrumented vertebrae was considered a practical indicator of the extension of tissue dissection which was believed to be directly related to the operative bleeding. Operative time, although related to the previous parameter, can additionally reflect the complexity of the correction of deformity. The obtained value of 40 ml of blood required for each instrumented segment and each operative hour may be considered an approximate indicator and used in planning of predonations. However a relatively wide dispersion of extremes of this parameter indicates that other factors play role in total operative blood requirements. On the contrary Shapiro et al. (14) noted blood loss 65-150 ml/segment for AIS posterior fusion.

In our experience, the psychological preparation to the predonation helped in a good course of the procedure. Full acceptance was originally observed in 6 patients only, while a spontaneous refusal of the predonation concerned as much as 12 of 42 patients at the first visit. The refusal rate was finally total reduced. Generally, the adolescent patients accepted the procedure more easily than their parents. It is to

mention, that in the period of the introduction of the autotransfusion into our department an effort had to be done to inform, instruct and persuade the whole therapeutic team.

Relatively important blood loss was noted in the postoperative drainage, in concordance to Keeling et al. findings (15). Technical details influencing the wound drainage (drain diameter, location of the drain, suction force) can be modified by the surgeon in order to minimize the postoperative blood loss. In our series the blood recuperation system allowed the reinfusion of as much as 50% of the total blood volume lost in the drainage.

Both our groups are comparable according to the deformity.

The percentage of patients that needed the homologous transfusion (53%) was higher than the value of about 30% reported in the literature (16). Further improvement of our results seems both possible and necessary and will require better logistics, stronger motivation of medical staff and increasing conscience of parents. Lisander et al. (1) reported a mean of 5.5 units transfused in controls without autotransfusion versus 2.4 units in the autotransfusion group (preoperative haemodilution, cell saver and hypotension anesthesia). Both the operation time and the number of instrumented vertebrae were higher in our series, what is caused by the operation technique and the amount of implants. The mean homologous transfusion was respectively 1 unit in the study group.

The predonation leads to reduced preoperative hematocrit levels. In our study group this values were respectively 38.6 \pm 2.3 in subgroup 1.1 and 35.2 \pm 2 in 1.2. and in control group 41.6 \pm 2.2. This is comparable with other authors – in the letter of Bess et al. (17) preoperative hematocrit level in group with autotransfusion was 37.8 \pm 3.4 and in group without predonation 40.2 \pm 2.6.

On the other hand, we believe that of blood loss in a longer period of time (double predonation in the subgroup 1.2) caused better regeneration rate of RBC, as revealed by Singbartl (18). In our study, 41% patients of the subgroup 1.1 and 55% patients of the subgroup 1.2 avoided homologue transfusion. In the control group 100% patients received homologous blood.

CONCLUSIONS

1. Psychological care of the girls helped to achieve a good toleration of the procedure of the preoperative donation.
2. Recuperation from the wound drainage allowed the restoration of about 50% of the postoperatively lost blood.
3. Avoiding homologous blood transfusion required a combination of the two autotransfusion techniques: predonation and recuperation.

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