BLOOD SALVAGE TECHNIQUES IN CHILDREN AND TEENAGERS IN SPINAL SURGERY

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Spinal surgery for scoliosis has been performed on 76 children and teenagers in the years 1983 to 1989. 54 girls between 7 and 20 years of age (average : 14 and a half) and 22 boys between 9 and 18 years of age (average : 14) were operated on.

Blood salvage techniques such as differed autotransfusion hemodilution, controlled hypotension and the use of a cell-saver allowed a decrease in the amount of homologous blood transfusions, thereby reducing the risks of transmitted diseases such as hepatitis and AIDS. 48 % of the patients in this series received no homologous blood on the whole. Since the introduction of a complete program of blood salvaging techniques, homologous blood transfusions have been necessary in less than 28% of the patients.

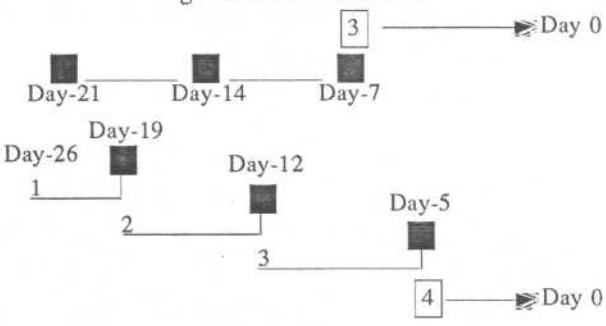
Key Words : Blood salvage, spinal surgery.

The aim of this study is to review the various blood salvaging methods and to evaluate their applications and limits.

1. Differed autotransfusion requires blood predeposition 3 to 5 weeks prior to surgery (4,15,24) and may be performed in one or two ways: either by collecting blood sequentially (two to four units at a time) or by the "leapfrog" sampling transfusion technique (fig. 1). The latter has serious limitations in spinal surgery due to the various associated pathologies such as cardiovascular malformations, chronic anemia, cerebral palsy. It is required that hemoglobin be equal or superior to 11 g/100 ml. and that hematocrit be equal or inferior to 12% of the blood volume. (1)

Eventually, iron supplements are prescribed to every patients entering the blood salvage program (23). Large scale studies disclose that complications vary from 0 to 5 % (23,11). A reduction in platelet count and coagulation factors, a lowering of oxygen transport capacity, a lowering of pH as well as an increase in serum potassium are often reported.

Fig. 1 : Predonated blood



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2 . Normovolcmic hemodilution can be associated to autotransfusion and implies collecting blood at the beginning of the operative procedure followed by cell-free plasma-like solutions fluid replacement (acute he modilution). Hemotrocrit values and blood losses are then estimated at regular intervals and fluids adminis trated accordingly.

The same cell-free solutions may be used for volume per volume blood replacement, physiopathology of hemodilution is well known : lowering of the hematocrit induces a decrease in blood viscosity, an increase in cardiac output and in venous return to the hears. Hence the inrease in capillary blood perfusion compensates for the decrease of oxygenation due to hemodilution (1, 18, 19).

3 . Controlled hypotension aims at maintening a mean systolic pressure of approximately 60 to 80 mmHg through the operation. Children and teenagers withstand better tissue anoxia than adults but the risk of spinal cord ischemia must not be overlooked. Ac cording to various authors, controlled hypotension re duces blood loss by approximately 40 to 50%. For some (10,14,17) it may also shorten the operation it self, a view that remains controversial (6).

4. The cell-saver has been devised to harvest blood in the operating field and to perform autologous blood replacement after filtering and of old and fragile cells.

In spinal surgery, this device allows a return of 30 to 60 % of the red cells mass lost intraoperatively (6,12,20). Figures that are lower than in cardiac surgery for several reasons : smaller motion tubes are used in spinal surgery with a higher risk of red cells destruction; there is less blood pooling in body cavities in orthopaedic than in vascular surgery; more blood is lost in sponges during packing-off in spinal deformity surgery (16). Surgery for cancer and intes-

tine contra-indicates the use of the cell-saver, although infections hazards are limited.

The acquisition of a cell-saver is economical, sound in view to avoid the need for homologous blood replacement (6,7). Moreover, it is the only means of blood replacement accepted by Jehovah's witnesses (25).

5 . Great care must be taken in patients positioning in order to avoid unnecessary abdominal pressure of an elevation in the inferior vena cave pressure (20,21).

Additionnaly, infiltracting the operative scar with diluted adrenalin (1.500.00) significatly reduces local bleeding. Dissection must be subperiosteal and bone wax used in bony bleeding (33). Autologous iliac graft sampling and posterolateral grafting procedures are the most important bleeding sourcess and must be therefore the last procedures to be performed.

Somesthesic evoked potcntiels safely allow to manitor the spinal cord function during surgery and effectively saves time by avoiding unnecessary intraoperative awakening of the patient (2,8).

MATERIAL AND METHODS :

Spinal surgery for scoliosis has been performed on 76 children and teenagers in the years 1983 to 1989. 54 girls between 7 and 20 years of age (average : 14 and a half) and 22 boys between 9 and 18 years of age (average: 14) were operated on.

The group included the following pathologies : idiopathic scoliosis (35), Marfan syndrome (2), Pradcr-Willi (1), neurofibromatosis (2), myopathies (4), neurological scoliosis (10), congenital deformities (7), Lobstein (1), spondylo-epiphyseal dysplasia (2), kyphotic Pott's disease (3), others (9).

Most surgical procedures were anterior and for posterior fusions with Cotrel-Dubousset instrumentation (52), Harrington-Luque rods (20), others (4). Combined anterior and posterior fusions were performed as single stage operations on six patients, as two stage operation on five patients. Wherever possible, deferred autotransfusion, normovolemic hemodilulion, controlled hypotension and the cell-saver have been employed, as well as evoked potential monitoring. Homologous blood was used only when hcmoglogin value fell below 8 g/100 ml. in spite of the blood salvage.

RESULTS :

Out of the 76 patients which were operated on, 48% received no homologous blood. The average operating time was 5 hours and twenty minutes (extreme : 1 - 13h.).

The cell-saver was employed 52 times and allowed an average blood volume salvaging of 30%. Mean blood losses were 50,4 ml/kg (extreme : 12-146).

There were no significant correlation between blood losses and the number of vertebrae involved in the fusion (correlation coefficient : R = 0,44, fig. 2) nor between blood losses and duration of surgery (R=0,3, fig. 3)

The various blood salvaging procedures have been used more extensively in 1988 and 1989 (fig. 4). In these last two years, 45 spinal fusions were performed; 22 children entered a complete blood salvaging program and only 4 eventually had to receive homologous blood replacement (18%) (fig. 5.).

Fig.2 Intraoperative blood loss related to extent of fusion

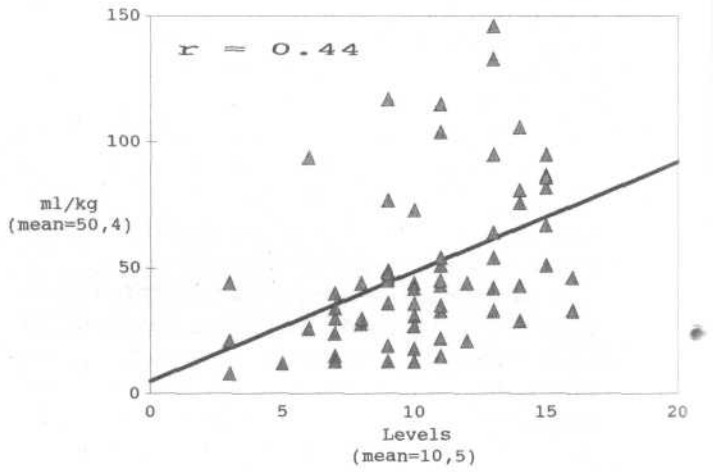


Fig.3 Intraoperative blood loss related to operation time

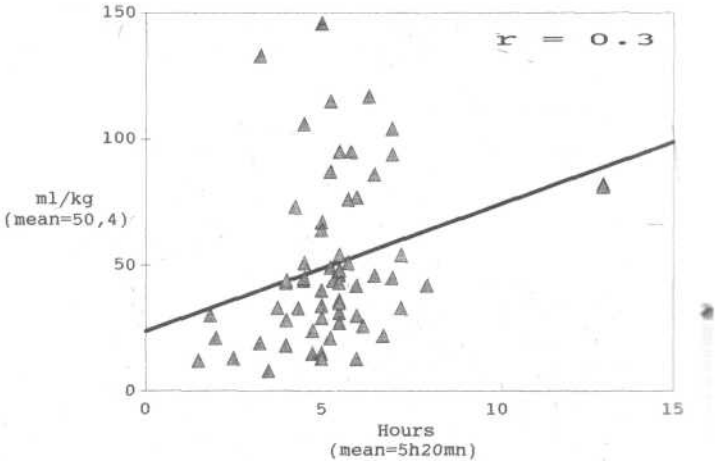


Fig. 4 : Blood Salvage Techniques

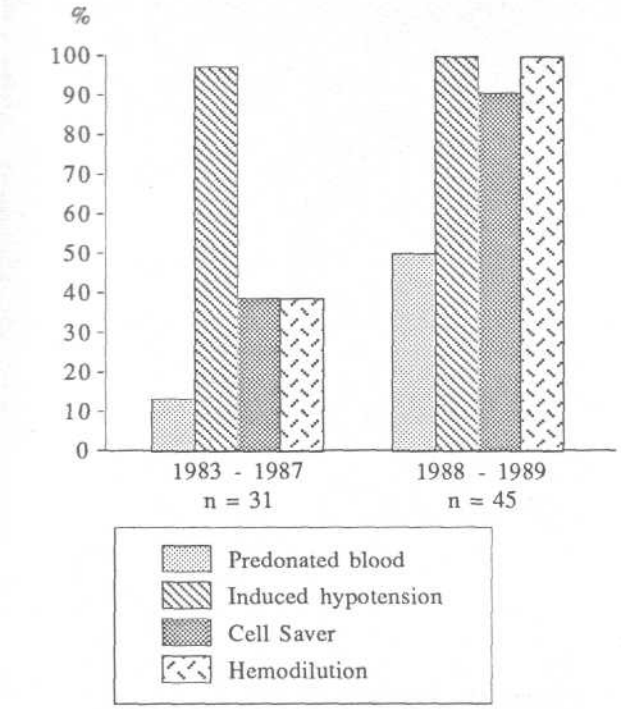
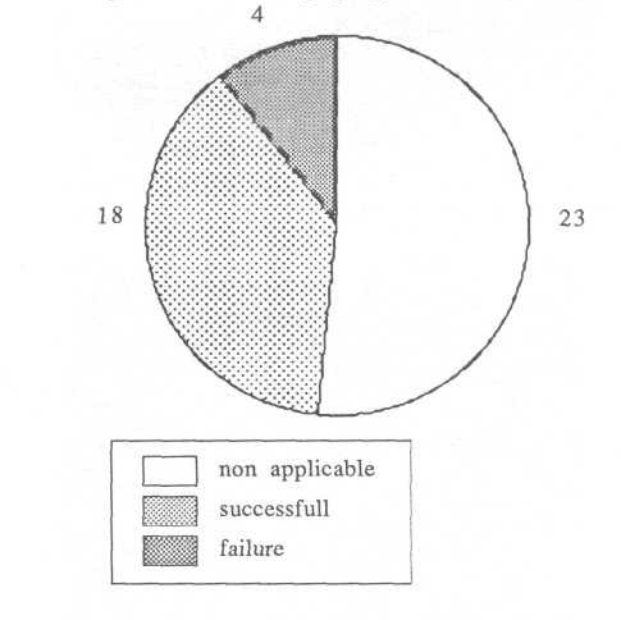


Fig. 5. : Blood salvage program 1988 - 1989



DISCUSSION :

Because of the risks of homologous blood transfusions, patients undergoing major spinal surgery are increasing included in blood salvaging programs, which rely a coordinated medical team and well organized predepositing of blood.

The study indicates that a complete blood salvaging program has been applied 9 times more often in the surgery of idiopathic scoliosis than in deformities of other origins, because of the many contra-indications associated in the latter cases such as cardiac malformations and chronic anemia.

REFERENCES :

1 . Bornicre, J., Traineau R., Scemama M.P., Cranados M.: Interet de l'hemodilution et dos auto transfusions diffcrces dans la chirurgie du rachis de l'enfant et de l'adolescent. Revue Francaise de Transfusion et Immunohcmatologie. Tome XXVI n° 2, 1983.

2 . Bunch Wilton M., Scarff Timothy B., Trimble John : Current concepts review spinal cord monitoring. J. Bone Joint Surg., 65 A, 707-71, 1983.

3 . Dubousset A.M., Dubousset J., Loose J.P.: Auto-transfusion per-operatoire et hemodilution aigue en chirurgie othopedique. Application du traitement chirurgical de la scoliose. Revue de Chirurgie Orthopedique. 67. : 609-615, 1981.

4 . Church J.J., Davidson G.M.: Partical anesthesia: the anesthesic management of major spinal surgery in children. Anesth. Intens. Care, VII: n° 2, May 1979.

5 . Du Toit Cuillaume, Relton John E.S., Gillepsie Robert : Acute Haemodilutional Autotransfusion in the surgical managenet of scoliosis. J. Bone Joint Surg. 60-B: 178-180, 1978.

6 . Flynn J.c, Metzger C.R., Csencsitz T.A. : Intraoperative autotransfusion (IAT) in spinal surgery. Spine 7 : 432-435, 1982.

7 . Gaudiche O., Loose J.P., Egu J.F., Dubousset J.: Autotransfusion per Cell-Saver III. Experience de 90 cas de chirurgie du rachis chez l'enfant et l'adolescent. Cahiers d'anesthesiologie, Tome 36, n°6, 451-457, 1988.

8 . Grundy B.L., Nash C.L., Brown R.H.B : Deliberate hypotension for spinal fusion : prospective randomized study with evoked potential monitoring. Can. Anesth. Soc. J., 29, n° 5, 452-461, 1982.

9 . Hate D.E.: Controlled hypotension by arterial bleeding during operation and anesthesia. Anesthe-siology, 9-498, 1948.

10. Kling R.F., Fergusson N.V., Leach A.B., Hensinger R.N., Lane G.A., Knight P.R. : The influence of induced hypotension and spine distraction on canine spinal cord blood flow. Spine 10: 878-883, 1985.
11 . Kruger Leon M., Colbert J.M. : Intraoperative autologus transfusion in children undergoing spinal surgery. J. of Pediatric Orthop. 5: 330-332, 1985.
12 . Lehner James T., Van Peteghem P.K., Leatherman K.D., Brink M.A.: Experience with an intraoperative autogenous blood recovery system in scoliosis and spinal surgery. Spine 7 : 131-133, 1981.
13 . Lennon R.B., Hosking M.P., Gray J.R., Klassen R.A., Popovski M.A., Warner M.A : The effect of intraoperative blood salvage and induced hypotension on transfusion requirements during spinal surgical procedures. Mayo Clin. Proc. 62: 1090-1094, 1987.
14 . Malcolm-Smith Nigel A., McMaster M.J.: The use of induced hypotension to control bleeding during posterior fusion for scoliosis. J. Bone Joint Surg. 65B: 255-258, 1983.
15 . Mandel Richard J., Brown Mark D., McCollough Newton C, Pallares V., Varlotta R.: Hypotcnsive anesthesia and autotransfusion in spinal surgery. Clin. Orthop. 154: 27-33, 1981.
16. Mann David C, Wilham M.R., Brower E.M., Nash C.L.: Decreasing homologous blood transfusion in spinal surgery by use of the cell-saver and predeposited blood. Spine 14 : 1296-1300, 1989.
17 . McNeill Thomas, DcWald R.L., Kuo K.N., Benett E.J., Salem M.R.: Controlled anesthesia in scoliosis surgery. J.Bone Joint Surg., 56A: 1167-1172, 1974.
18 . Mcssmer Konrad : Hcmodilution. Surg. Clinics Noths Am. 55 : 659-678, 1975.
19 . Mcssmcr Konrad : Les effets de l'hemadilution sur les proprietes rheologiques du sang et sur l'oxygenation des tissus. Anesth., Anal. Rean. 33-4 : 509-520, 1976.
20 . Philps William A., Hensinger R.N.: Control of blood loss during scoliosis surgery. Clin. Orthop. 229 : 88-93, 1988.
21 . Relton J.E.S., Hall J.E. : An operation frame for spinal fusion. J. Bone Joint Surg. 49-B: n° 2, 327-332, 1967.
22. Sorrenti S.J., Cumming W.J., Miller D., Path F.F. : Reaction of the human tibia to bone wax. Clin. Orthop, n° 182 : 293-296, 1984.
23. Thomson Jeffrey D., Callaghan J.J., Savory C.G., Stanton R.P., Pierce R.N. : Prior deposition of autologous blood in elective orthopedic surgery. J. Bone Surg. 69A : 3320-324, 1987.
24 . Viviani G.R., Sadler J.T.S., Ingham G.K. : Autotransfusion in scoliosis surgery. Review of 20 Harrington fusions. Clin. Orthop. 135 : 74-78, 1978.
25. Wong K.C., Webster L.R., Coleman S.S., Dunn H.K.: Hemodilution and induced hypotension for insertion of a Harrington rod in a Jehovah's witness patien. Clin. Orlhop. 152 : 237-240, 1980.