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Original Article

Peri-Operative Blood Loss and Extent of Fused Vertebrae in Surgery for Adolescent Idiopathic Scoliosis

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Abstract

Purpose : The goal of this study was to elucidate the features of peri-operative blood loss during the posterior surgery for adolescent idiopathic scoliosis and to examine the effectiveness of homologous blood transfusion and intra-operative cell salvage.

Methods : Sixty-one adolescent idiopathic scoliosis patients who have undertaken posterior fusion surgery were recruited for the study. A homologous blood transfusion was performed in all cases. Intra-operative cell salvage was also performed in all cases. The following items were investigated : 1) pre-operative and post-operative Cobb angle ; 2) the extent of the fused vertebral body 3) ; length of the operation ; 4) intra-operative and post-operative estimated blood loss ; and 5) the need for allogenic transfusion.

Results : The mean pre-operative Cobb angle was 68.2, and the post-operative Cobb angle was 21.8 degrees. The mean correction rate was 70.4 %. The extent of fused vertebrae was 5 to 15 (mean 10.3). The length of the operation was 359 ± 98 minutes. The fusion extent and length of the operation were correlated. Intra-operative blood loss was 1554 ± 1106 ml, and post-operative blood loss was 709 ± 321 ml. Allogenic transfusion was not performed in any of the cases. Peri-operative blood loss correlated with the length of the operation, extent of fused vertebrae and pre-operative Cobb angle.

Conclusion : The peri-operative estimated blood loss correlated with the extent of fused vertebrae during posterior scoliosis surgery. Homologous transfusion and intra-operative cell salvage were considered to be effective for avoiding the need for allogenic transfusion.

Key words : scoliosis, surgical blood loss, homologous transfusion

Introduction

Recently, good surgical corrections can be achieved even in cases of severe scoliosis[1]. However, operations for scoliosis correction are often associated with major blood loss[2]. Homologous blood transfusion and intra-operative cell salvage can help eliminate the need for allogenic transfusion[3)4)]. Intra-operative and post-operative blood loss may be influenced by many factors, such as the severity of scoliosis, anesthesia factors, and the skill of the surgeon. It is helpful to predict the blood loss when planning surgery for scoliosis. The purpose of this study was to elucidate the features of peri-operative blood loss in relation to the extent of fused vertebrae, pre-operative Cobb angle and the length of the operation during the posterior surgery for idiopathic adolescent scoliosis, and to examine the efficacy of homologous blood transfusion and intra-operative cell salvage.

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Materials and Methods

We carried out a retrospective review of 61 posterior instrumentation surgeries carried out for adolescent idiopathic scoliosis (15 male and 47 female, mean age at time of surgery : 16.0 ± 3.4, range : 10 to 26 years) performed at Kyushu University Hospital from 1999 to 2010. All the patients had their operations performed by 5 orthopaedic surgeons.

The Cobb angle before and after the operation was measured in standing AP view using a long cassette. Homologous blood transfusion (1200 to 2400 ml, mean : 1612 ml) was done in all cases. Generally, patients were encouraged to join the pre-operative homologous blood donation program, and patients tried to harvest 1600 ml in total. In cases where a difficult surgery was expected, such as a rigid curve and longer fusion, these patients were encouraged to have 2400 ml in total, and in the case of low body weight, it was decreased to 1200 ml. In one case, the reservation bag was damaged during blood collection, and it therefore was discarded.

For the surgery, hybrid constructs using pedicle screws, hooks, and wires were applied from 1999 to 2006 (31 patients), and posterior spinal fusion with segmental pedicle screw constructs were used from 2007 to 2010 (30 patients) (Fig. 1). A Haemonetics cell saver was used for intra-operative cell salvage. Post-operative closed suction drainage was performed for 2 days after the operation. The length of the operation and peri-operative blood loss was obtained from the medical records.

Spearman's rank correlation was applied for the correlation of perioperative blood loss to operation time, extent of fused level or pre-operative Cobb angel. The GraphPad Prism statistical software program (GraphPad Software, CA, USA) was used for statistical analysis. A p value of < 0.05 was considered to be significant.

Results

Correction rate and the extent of the fused vertebral body

The extent of fused vertebrae was 5 to 15 (mean : 10.3). The pre-operative Cobb angle was 42 to 122 (mean : 68.2) degrees. The pre-operative Cobb angel correlated with the extent of fused vertebrae ($r = 0.582$, $p < 0.0001$) (Fig. 2). The post-operative Cobb angle was 1 to 94 (mean 21.8) degrees, and the correction rate was 70.4 ± 16.4 %.

Length of the operation

The length of the operation was 359 ± 98 minutes. A positive correlation was found be-

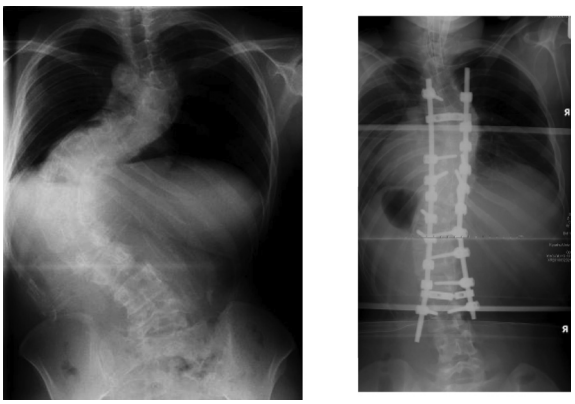

Fig. 1 Segmental pedicle screw constructs. The left thoracic curve between the T11 and L3 was corrected from 114 to 30 degrees.

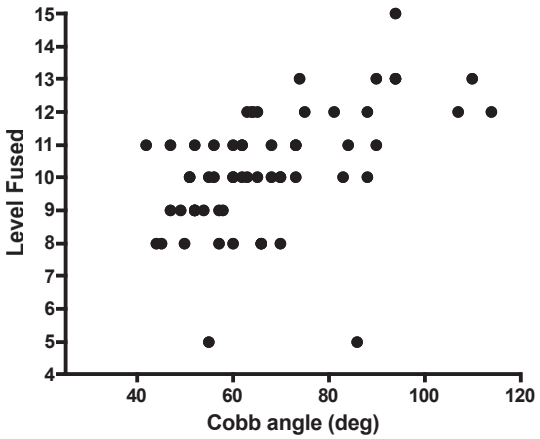

Fig. 2 The pre-operative Cobb angle correlated with the extent of fused vertebrae ($r = 0.582$, $p < 0.0001$).

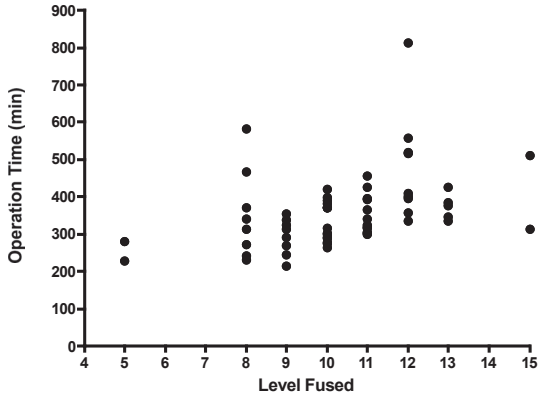

Fig. 3 The extent of fused vertebrae correlated with the length of the operation.

tween the length of the operation and the extent of fused vertebrae (r = 0.487, p < 0.0001) (Fig. 3).

Perioperative estimated blood loss and the need for allogenic transfusion

Intra-operative cell salvage was performed in all cases. Intra-operative blood loss was 1554 ± 1106 ml, and post-operative blood loss was 709 ± 321 ml. Allogenic transfusion was not performed in any of our cases. The extent of the fused vertebrae correlated with the peri-operative (r = 0.537, p < 0.0001), intra-operative (r = 0.421, p = 0.0007) and post-operative estimated blood loss (r = 0.481, p < 0.0001) (Fig. 4). Intra-operative blood loss also correlated with the length of the operation (r = 0.570, p < 0.0001) (Fig. 5). In addition, the Cobb angle before surgery correlated with the estimated blood loss (r = 0.370, p = 0.0033) (Fig. 6).

Discussion

Scoliosis surgery can correct even severe spinal deformities in AIS patients[1)5)]. Despite the development of surgical skills, new procedures, and spinal instrumentation, scoliosis corrective surgery can be associated with major blood loss. To avoid the need for allogenic transfusion, homologous blood transfusion[4)6)7)] and intra-operative cell salvage[3)8)] are considered effective for scoliosis surgery. For surgical planning, it is important to predict perioperative blood loss and preserve a supply of blood for homologous transfusion.

The extent of fusion is generally determined based on the curvature flexibility in supine side bending or the push-prone position[9)10)]. In our series, the Cobb angle was correlated with the

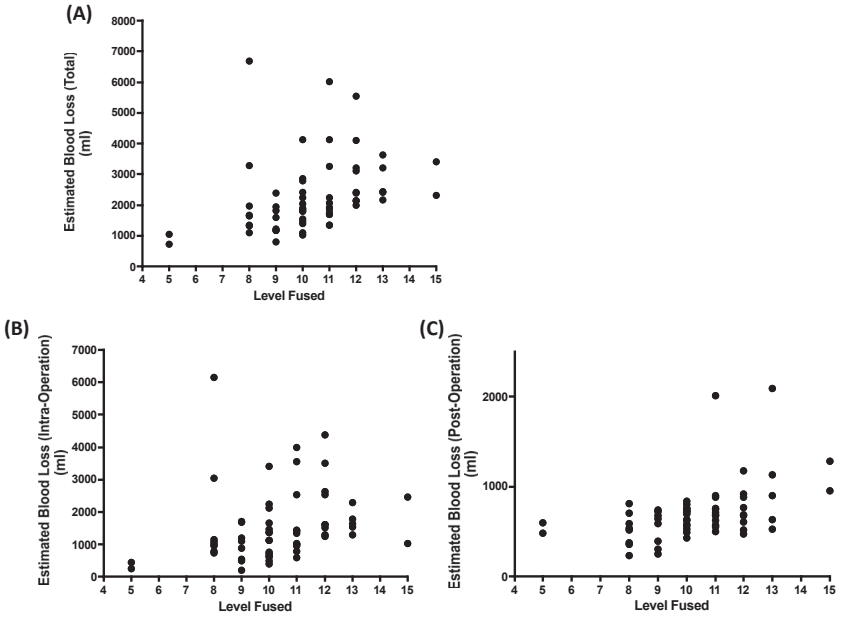

Fig. 4 The extent of fused vertebrae correlated with (A) peri-operative (r = 0.537, p < 0.0001), (B) intra-operative (r = 0.421, p = 0.0007) and (C) post-operative estimated blood loss (r = 0.481, p < 0.0001).

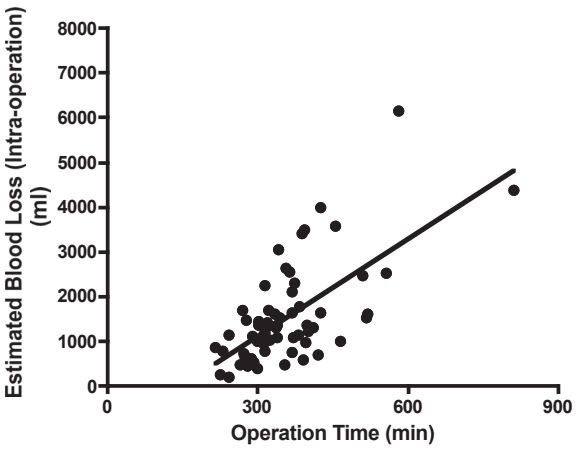

Fig. 5 The length of the operation correlated with the intra-operative blood loss ($r = 0.487$, $p < 0.0001$).

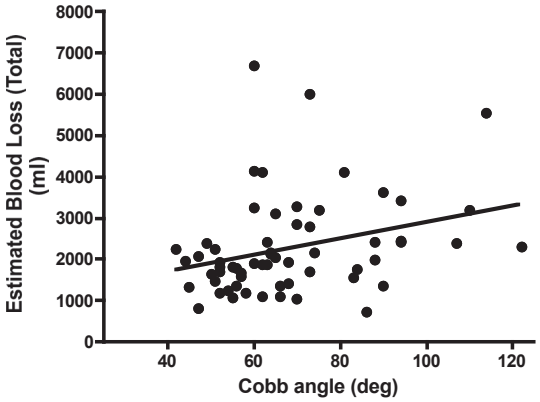

Fig. 6 The pre-operative Cobb angle correlated with the total peri-operative estimated blood loss ($r = 0.370$, $p = 0.0033$).

extent of fused vertebrae.

Many factors may influence to intra-operative and post-operative blood loss during surgery to correct scoliosis. We found that the peri-operative estimated blood loss correlated with the length of the operation, pre-operative Cobb angle, and extent of fused vertebrae. The length of the surgery may depend on skill of the surgeon, the extent of fused vertebrae and the severity of the deformity. We also found that the length of the surgery and the extent of fusion correlated each other. As would be expected, extensive surgeries are more likely to take longer, partly as a result of the time needed for setting the instrument and correction (derotation, compression and distraction) procedure.

To minimize the blood loss, it is important for the surgery to be as short as possible, however, in more extensive surgeries, the surgeon also has to be concerned about the post-operative blood loss. Even though the total blood loss is roughly estimated based on the extent of fused vertebral body and curvature severity, it is important to recognize the existence of other variables that can cause bleeding.

In our series, no allogenic transfusions were performed. Homologous transfusion and intra-operative cell salvage were considered to be effective for avoiding the need for allogenic transfusion.

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（和文抄録）

側弯症後方手術における固定椎体数と周術期出血量の関係

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（目的）思春期特発性側弯症に対する後方矯正固定術での周術期出血量を調べ，特に固定椎体数との関係について調査した．また，自己血輸血および術中回収血輸血で対処可能であったか否かを調査した．

（方法）思春期特発性側弯症に対して後方矯正固定術を施行した 61 例について，カルテ，手術記録を調査した．調査項目は，側弯 Cobb 角（術前，術後，矯正率），固定椎体数，手術時間，術前自己血貯血量，術中出血量，術後出血量，同種血輸血の要否について行った．

（結果）術前 Cobb 角は 68.2 ± 18.2 度，術後 Cobb 角は 21.8 ± 17.0 度であり，矯正率は 70.4 ± 16.4%であった．固定椎体数は 5 から 15 椎体（平均 10.3 椎体）であった．手術時間は 359 ± 98 分であり，固定椎体数と手術時間の間に相関を認めた（$r = 0.485$, $p < 0.0001$）．術中出血量は 1554 ± 1106 ml，術後出血量は 709 ± 321 ml であった．同種血輸血を要した症例は無かった．周術期の出血量は手術時間（$r = 0.570$, $p < 0.0001$），椎体固定数（$r = 0.537$, $p < 0.0001$），術前 Cobb 角（$r = 0.370$, $p = 0.0033$）とそれぞれ相関を認めた．

（結語）思春期特発性側弯症に対する後方矯正固定術において，周術期出血量は手術時間，術前 Cobb 角，固定椎体数とそれぞれ相関を認めた．同種血輸血を必要とした症例は無く，術前自己血貯血および術中回収血輸血が有効的に利用されていると考えた．