Perioperative Complications in Posterior Spinal Fusion Surgery for Neuromuscular Scoliosis

Mitsuyoshi Matsumoto, Masayuki Miyagi, Wataru Saito, Takayuki Imura, Gen Inoue, Toshiyuki Nakazawa, Eiki Shirasawa, Kentaro Uchida, Tsutomu Akazawa, Naonobu Takahira and Masashi Takaso

1) Department of Orthopaedic Surgery, School of Medicine, Kitasato University, Sagamihara, Japan
2) Department of Orthopaedic Surgery, St. Marianna University School of Medicine, Kawasaki, Japan

Abstract:

Introduction: Patients with neuromuscular disorders sometimes show progressive spinal scoliosis. The surgery for neuromuscular scoliosis (NMS) has high rates of complications. In this study, we elucidated the perioperative complications in patients with NMS.

Methods: We included 83 patients with NMS (58 boys and 25 girls; 61 with muscular dystrophy, 18 with spinal muscular atrophy, and 4 others) who had undergone posterior fusion surgery for scoliosis. We evaluated the perioperative complications (within 3 months), age at time of surgery, operative time, blood loss, preoperative %VC and FEV₁₀ (%) for pulmonary function, and preoperative ejection fraction (EF) for cardiac function.

Results: There were 5 (6%) major complications, including pneumonia and a cardiovascular complication requiring intensive care unit (ICU) care, and 15 (18%) minor complications including viral enteritis and a urinary tract infection. Overall, there were 20 (24%) complications. Three of the 5 major complications were pulmonary. The mean age at the time of surgery was 13.7 y, operative time was 304 min, and blood loss was 1530 ml. The mean preoperative %VC was 41%, FEV₁₀ was 91%, and EF was 60%. When we separated the patients into a group with major complications (n = 5) and a group without major complications (n = 78), the preoperative %VC in the group with major complications (23%) was significantly lower than that in the group without (42%) (p < 0.05). However, operative time, blood loss, preoperative FEV₁₀ (%) and EF between the two groups were not significantly different (p > 0.05).

Conclusions: Compared with the previous findings of the perioperative complication rate (45%-74%) for NMS, the complication rate was remarkably low in this case series. Because of advances in medical skills, including anesthesia and surgical instruments, surgery for NMS appears to be safe. However, patients with NMS with complications demonstrated severe restrictive ventilatory impairment preoperatively. Therefore, we should be vigilant for perioperative pulmonary complications especially in patients with NMS and preoperative severe restrictive ventilatory impairment.

Keywords:

Neuromuscular scoliosis, perioperative complications, posterior spinal fusion surgery

Introduction

Patients with muscular dystrophy including Duchenne muscular dystrophy and spinal muscular atrophy develop systemic and progressive muscle weakness, and often exhibit scoliosis. Posterior corrective spinal fusion surgery on patients with neuromuscular scoliosis (NMS) is widely performed to improve the quality of life (QOL) of the patients, and surgery is expected to inhibit the progression of scoliosis and improve sitting balance. Furthermore, in patients with NMS, the large Cobb angle is correlated with low pulmonary function including %VC and FEV₁₀ (%). Therefore, spinal fusion surgery for NMS is recommended. However, in many cases, patients with NMS exhibit decreased cardiac and respiratory functions before surgery, and there is concern about the high occurrence of perioperative complications. The aim of this study was to elucidate the incidence of perioperative complications in patients with NMS.
who have undergone posterior spinal fusion surgery.

Materials and Methods

Ethical approval from our Institutional Review Board (IRB) was obtained for this study, which was conducted in accordance with the ethical principles specified in the 1964 Declaration of Helsinki and its later amendments.

Patient population

We considered 100 patients who had undergone posterior spinal corrective fusion surgery for NMS from 2006 to 2016. We excluded 17 patients who were able to walk. The remaining 83 patients were included in the present study. There were 58 boys and 25 girls, including 62 with muscular dystrophies (Duchenne muscular dystrophy, 46; Fukuyama type congenital muscular dystrophy, 11; other type of muscular dystrophy, 3), 18 with spinal muscular atrophies, and 3 with other myopathies. Most of the patients could communicate with others without trouble, but some had mental retardation, especially those with the Fukuyama type congenital muscular dystrophy. However, all the patients underwent pulmonary function evaluation via spirometry and cardiac function evaluation via echocardiography preoperatively. All the patients had sitting difficulty and back pain associated with scoliosis. No patients were excluded because of their preoperative physical status.

The usual perioperative treatment of NMS consisted of the following: NMS patients were admitted 1 week prior to the operation, and their motor and respiratory functions were evaluated by a physical therapist. An anesthesiologist and pediatrician reviewed also carefully all of the patients’ data including the physical findings and preoperative pulmonary and cardiac function, and prepared the perioperative management system for use in the operation room and in the pediatric intensive care unit. We attempted extubation as soon as possible after the operation when the patients could ventilate their lungs spontaneously to prevent respirator dependency. Furthermore, we tried also to execute the management system, including early detection and early treatment, according to the perioperative communication among the orthopedic surgeon, anesthesiologist, and pediatrician.

Clinical Endpoint

We evaluated the perioperative complications, age at operation, the operative time, blood loss, the preoperative pulmonary function, the preoperative cardiac function, and the preoperative Cobb angle. Perioperative complications of grade III or higher using the Clavien-Dindo classification were defined as major complications. Clavien-Dindo classification grade III or above indicates a complication requiring some kind of surgical intervention and life-threatening complications requiring intensive care management. For the pulmonary function, %VC and FEV₁₀⁻ (%) were evaluated, and then for the cardiac function, ejection fraction (EF) was evaluated.

Statistical analysis

We divided the patients into two groups: those with a major complication (+) and those without (−). The operative time, blood loss, the preoperative pulmonary function, the preoperative cardiac function, and the preoperative Cobb angle between those with (+) and without (−) a major complication were compared using a Mann-Whitney U test. A p < 0.05 was considered significant.

Results

Patient characteristics are described in Table 1. Their mean age at time of surgery was 13.7 y, operative time was

| Table 1. Patient Characteristics. |
|----------------------------------|
| Average | Range |
|--------|-------|
| Age    | 13.7  |
| Operative time | 304 min |
| Blood loss | 1530 ml |
| Pre-ope %VC | 40.7% |
| Pre-ope FEV1.0 | 90.6% |
| Pre-ope EF | 60.2% |
| Pre-ope Cobb angle | 81.7° |
| Post-ope Cobb angle | 39.3° |
304 min, blood loss was 1,530 ml, preoperative %VC was 41%, FEV1.0 was 91%, EF was 60%, preoperative Cobb angle was 82°, and postoperative Cobb angle was 39° (Table 1).

Perioperative complications were observed in 20 patients (24%), of which five (6%) were major complications including CO2 narcosis, pneumonia, and heart failure; there were 15 patients (18%) with minor complications including infections and delayed wound healing (Table 2). Three of the five major complications (4%) were respiratory complications including pneumonia, CO2 narcosis, and respiratory failure. The patient with respiratory failure required re-intubation and management with an artificial ventilator. The patients with pneumonia or CO2 narcosis required additional ICU treatment. However, all the patients recovered fully after the additional treatment. The other two of the five major complications (2%) were cardiac complications including acute heart failure and hemodynamical instability, both of which required additional ICU care. However, all the patients recovered fully after the additional treatment. A majority of the minor complications were infections including urinary tract infections and wound surface infections, which were found in seven cases (8%). Although most of the patients required antibiotics and wound treatments, the infections did not develop into major complications.

The mean preoperative %VC, FEV1.0, and EF in patients with major complications were 23%, 92%, and 56%, respectively. All the five patients with major complications showed severe preoperative restrictive ventilator impairment (%VC < 30%). In addition, 30 out of 83 patients in this series showed severe preoperative restrictive ventilator impairment (%VC < 30%) and 5 out of 30 patients with severe preoperative restrictive ventilator impairment showed major complications perioperatively.

When we classified the patients into a group with major complications (+) and a group without major complications (−), the preoperative %VC in the (+) group (23%) was significantly lower than that in the (−) group (42%) (p < 0.05) (Fig. 1a). The preoperative Cobb angle tended to be higher in the (+) group than in the (−) group without major complications, but the difference was not significant (p > 0.05) (Fig. 1d). Furthermore, there were no significant differences in the preoperative FEV1.0 (%), the preoperative EF, the operative time, or blood loss between the two groups (Fig. 1b, c, e, f).
Patients with NMS often exhibit decreased respiratory and cardiac functions before surgery and there is concern regarding the perioperative complications in these patients. In the present study, the perioperative complication rate was 24% including major complications 6% and minor complications 18%, although the preoperative respiratory and cardiac functions were decreased in most cases. According to the previous reports, the overall complication rates are between 22.5% and 68%, and the major complication rates are between 6% and 49% (Table 3). Although the criteria for major complications between the studies were different, the perioperative complication rate in the present study was remarkably low. Not only the improvements in surgical instruments and techniques, and the advancement of anesthetic techniques in recent years, but also our perioperative supporting system of anesthesiologist and pediatrician might have contributed to the reduced rates of complications. We reported previously that extubation on the operative day was possible after the operation to prevent respirator dependency. Patients could ventilate their lungs spontaneously as soon as they awake in the present study. Therefore, spinal fusion surgery for NMS improves pulmonary or cardiac function in all cases. Thus, whether spinal fusion surgery for NMS improves pulmonary or cardiac function remains unclear. Fourth, we did not evaluate the postoperative clinical findings including SRS-22.

In conclusion, the rate of complications was remarkably low in the present case series. However, patients with NMS and major complications demonstrated severely restrictive ventilatory impairment preoperatively. Therefore, we should be vigilant for perioperative pulmonary complications when we perform surgery especially in patients with NMS and preoperative severely restrictive ventilatory impairment.

We believe that the most important step for preventing perioperative complications is attempting extubation once the patients could ventilate their lungs spontaneously as soon as possible after the operation to prevent respirator dependency. We reported previously that extubation on the operative day for NMS surgery showed good outcomes without any respiratory complications. However, optimal extubation timing remains controversial. Bach et al. recommended extubation for NMS surgery by the third postoperative day. However, a future prospective study is needed to confirm our findings.

Table 3. Previous Reports of Perioperative Complication Rate for NMS.

| Diagnosis          | Major complication rate | Overall complication rate | 
|--------------------|--------------------------|----------------------------|
|                    | N/A                      | 48%                        |
|                    | N/A                      | 62%                        |
|                    | 27%                      | 43%                        |
|                    | 6%                       | 28%                        |
|                    | 21.6%                    | 22.5%                      |
|                    | N/A                      | 33.1%                      |
|                    | 24%                      | 68%                        |
|                    | N/A                      | 40.1%                      |
|                    | 49%                      | N/A                        |
|                    | 6%                       | 24%                        |

N/A: not available
CP: cerebral palsy
DMD: Duchenne muscular dystrophy
SMA: Spinal muscular atrophy

Discussion

Patients with NMS often exhibit decreased respiratory and cardiac functions before surgery and there is concern regarding the perioperative complications in these patients. In the present study, the perioperative complication rate was 24% including major complications 6% and minor complications 18%, although the preoperative respiratory and cardiac functions were decreased in most cases. According to the previous reports, the overall complication rates are between 22.5% and 68%, and the major complication rates are between 6% and 49% (Table 3). Although the criteria for major complications between the studies were different, the perioperative complication rate in the present study was remarkably low. Not only the improvements in surgical instruments and techniques, and the advancement of anesthetic techniques in recent years, but also our perioperative supporting system of anesthesiologist and pediatrician might have contributed to the reduced rates of complications. We reported previously that spinal fusion surgery for scoliosis in a case of Duchenne muscular dystrophy successfully improved the patient’s sitting difficulty and back pain. In addition, Velasco et al. reported spinal fusion surgery for NMS decreased the rate of respiratory decline. Galasko et al. reported spinal fusion surgery improved survival of patients with NMS. Therefore, spinal fusion surgery for NMS is strongly recommended.

Three of the five major complications after NMS surgery in the present study were respiratory. Preoperative restrictive ventilatory impairment might lead to the development of perioperative complications. The previous reports showed also that most of the major complications were respiratory. In the present study, the Cobb angle tended to be higher in the group with major complications than the group without major complications, although this tendency was not statistically significant. Kang et al. reported patients with low pulmonary function and a high Cobb angle were more likely to develop a postoperative pulmonary complication. An increasing Cobb angle might lead to pulmonary dysfunction. These possibilities indicate that we should be vigilant for perioperative pulmonary complications when we perform surgery especially in patients with NMS and preoperative severely restrictive ventilatory impairment.

In conclusion, the rate of complications was remarkably low in the present case series. However, patients with NMS and major complications demonstrated severely restrictive ventilatory impairment preoperatively. Therefore, we should be vigilant for perioperative pulmonary complications in patients with NMS and preoperative severely restrictive ventilatory impairment.

Conflicts of Interest: The authors declare that there are no relevant conflicts of interest.
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