RARE ABDOMINAL COMPLICATIONS AFTER UNDERGOING POSTERIOR SPINAL FUSION FOR PROGRESSIOND IDIOPATHIC SCOLIOSIS – CASE SERIES AND A LITERATURE REVIEW

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ABSTRACT

Spine surgery is associated with perioperative risk of complications in children and adolescents. Spinal manipulation for the correction of scoliotic deformity can lead to abdominal complications especially to superior mesenteric artery syndrome. It is a relatively rare disease that the etiology is closely related to the anatomy and the topography of the duodenum, aorta, and superior mesenteric artery syndrome. The authors present and analyze the case series of patients who were diagnosed and treated for SMAS after scoliosis surgery.

Superior mesenteric artery syndrome can occur frequently in patients after surgical correction of the spine deformities. At the curvatures of the order of 80 degrees or more, there is a significant change in the topography of the anatomical structures and their adaptation to a new position after surgery. Special attention must be paid to young, lean patients, with BMI below 19, and the postoperative effect of an elongated axis of the spine. Even if superior mesenteric artery syndrome occurs, in most cases it can and should be treated conservatively. But it is very important that delayed treatment of SMAS may result in death.

Keywords: complication, scoliosis, surgery, pediatric, spinal, deformity, AIS, SMAS, superior mesenteric artery syndrome
INTRODUCTION

Spine surgery is associated with perioperative risk of complications in children and adolescents. An understanding of relevant risk factors is important in minimizing morbidity and mortality. Although abdominal complications are uncommon in spine surgery, they have been reported to occur in patients with anterior spinal fusion. Furthermore, spinal manipulation for the correction of scoliotic deformity can lead to abdominal complications especially to superior mesenteric artery syndrome (SMAS).

SMAS is a relatively rare disease that was first described by Rokitansky in the nineteenth century, and further analyzed by Wilkie.\(^1\)\(^-\)\(^2\) The etiology is closely related to the anatomy and the topography of the duodenum, aorta, and superior mesenteric artery. SMAS is caused by the compression of the mesenteric vessels in the third part of the duodenum. This is caused by the activation of extrinsic factors.\(^1\)\(^,\)\(^3\)\(^-\)\(^4\) The main predisposing factors are weight loss and loss of the fat protection due to anorexia, severe trauma, and tumors, anatomical variants (the ligament of Treitz and superior mesenteric artery), and surgeries performed in the abdominal cavity.\(^5\)\(^-\)\(^6\) The authors present a series of patients with a history of rapidly progressed idiopathic scoliosis who experienced an abdominal complication following a posterior spinal fusion.

CASE REPORT

Case 1

A 15-year-old girl was admitted to our department for the surgical treatment of juvenile idiopathic scoliosis, which had rapidly progressed (above 15°/year). Before treating the patient X-ray, MRI, and CT examinations of the spine were carried out to rule out other pathologies. A clinical examination found idiopathic thoracolumbar scoliosis, with a Cobb angle of 90° in the main curvature. The Risser test was 3. Her height, body weight, and BMI before the surgery were 153 cm, 44.5 kg, and 19, respectively. Preoperative radiograph of the spine is shown in Figures 1. The surgical procedure was performed under intraoperative neuromonitoring of the spinal cord. We performed a one-stage procedure of correction and posterior stabilization with multi-level SPO osteotomy. Postoperatively, we obtained the expected correction without any neurological deficits. The upper curvature was reduced to 30°. Postoperative radiograph is shown in Figure 2. The height of the patient after correction was 162 cm, BMI-16, and a postoperative weight of 42 kg. Paradoxically, after the treatment, BMI changed from 19 to 16, which assigned the patient to the underweight, starvation and emaciation group. On the fifth postoperative day, the patient's condition deteriorated. She suffered from abdominal pain, nausea and vomiting (8 times/day). We performed an abdominal CT with contrast, which confirmed SMAS (the CT result along with marked structures and measurements are shown in Figure 3). The angle of the SMA ramification from the aorta was 17.3° (normal range: 38–56°), and the distance between the SMA and the aorta at the level of the duodenum was from 4.3 mm to 6.5 mm (normal range 10–20 mm).
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Figure 1. A preoperative X-ray image (AP view) of the spine (case 1).
Figure 2. A postoperative X-ray (AP view) image of the spine (case 1).
Figure 3. An image of abdominal CT scan with contrast, the angle of the SMA ramification from the aorta is approximately 17 degrees, the level of the duodenum is 4.3–6.5 mm between the SMA and the aorta; SMA - superior mesenteric artery; LRV - left renal vein.

Case 2

A 14-year-old girl was admitted to our department for the surgical treatment of adolescent idiopathic scoliosis, which also had rapidly progressed (above 20°/year). X-ray, MRI, and CT examinations of the spine were carried out to rule out other pathologies. A clinical examination showed idiopathic double curve thoracolumbar scoliosis, with a Cobb angle of 122°/100°. The Risser test was 3/4. Her height, body weight, and BMI before the surgery were 155 cm, 46 kg, and 19, respectively. Preoperative radiograph of the spine is shown in Figures 4. The surgical procedure was performed under intraoperative neuromonitoring of the spinal cord, a one-stage procedure of correction and posterior stabilization with multi-level SPO osteotomy. Postoperatively,
we obtained the expected correction without any neurological deficits. The upper curvature was reduced to 60°. Postoperative radiograph is shown in Figures 5. The height of the patient after correction was 164 cm, BMI-16, and a postoperative weight of 42 kg. Paradoxically, similar to first case, after the treatment, BMI changed from 19 to 16, which assigned the patient to the underweight, starvation and emaciation group. On the fourth postoperative day, the patient's condition deteriorated. She suffered from abdominal pain, nausea and vomiting (10 times/day).

We performed an abdominal CT with contrast, which confirmed SMAS. The angle of the SMA ramification from the aorta was 21° (normal range: 38°–56°), and the distance between the SMA and the aorta at the level of the duodenum was from 3.5 mm to 5.5 mm (normal range 10–20 mm).

Figure 4. A preoperative X-ray image (AP view) of the spine (case 2).
Figure 5. A postoperative X-ray (AP view) image of the spine (case 2).
Treatment

In these both cases we used conservative treatment and parenteral nutrition for five days. On the tenth postoperative day, the patients’ condition improves enough that she was able to take fluids and oral food. Initially, the patients received an easily digestible diet, controlled by a dietician. She returned to a normal nutrition on the fourteenth (case 1) and eleventh (case 2) postoperative day. The patients were discharged from the hospital on the fourteenth (case 2) and eighteenth (case 1) postoperative day in a good general condition after the complete resolution of SMAS symptoms.

DISCUSSION

SMAS is an uncommon condition caused by mechanical obstruction of the distal third of the duodenum between the superior mesenteric artery and the abdominal aorta. SMAS is associated with both operative and non-operative corrections of scoliosis, as well as anorexia nervosa, severe weight loss, tumors, burns, and other traumas. SMAS is a rare disease, with an incidence of less than 0.4%. However, after surgical correction of the spine the incidence increases and is estimated to be 1-4.7%. It is a disease that often affects women more than men, in a ratio of 3 to 2, and some authors pay attention to a rather high number of deaths (33%), as described in the literature. These figures may not necessarily reflect the actual number of cases due to the difficulties in correct diagnosis.

It most often occurs in young, slim, tall patients, with an asthenic body type. BMI may also be a characteristic factor, which was seen in our patient. However, under adverse conditions, it can occur in any age group, in both the sexes. In most cases described in the literature, the presence of SMAS was associated with the anatomy and topography of the duodenum, aorta and superior mesenteric artery. The location of the duodenum resembles a horseshoe where the raised bank faces the right side and the concave part embraces the head of the pancreas. The uppermost section of the duodenum is slightly expanded and is called the bulb (the first part of the duodenum). It is adjacent to the liver and the gallbladder. Then, the duodenum gradually narrows and is directed downwards (the descending part or the second part), embraces the head of the pancreas and then horizontally (the inferior part or the third part) crisscrosses the spine toward the mesenteric vessels. Thus, it forms an upper and lower folding. On the other hand, the duodeno-jejunum bend is directed slightly upward and moves into the jejunum (the ascending part or the fourth part). The third section of the duodenum extends in the vicinity of the abdominal aorta and the SMA, and lies exactly in front of the L1-L2 vertebrae. When branching off the aorta, SMA moves forward and down at an angle of approx. 45° (normal range 38–56°), with a normal structure and anatomical relations. The third part of the duodenum runs from the right to the left in the space between the SMA and the aorta. Thus, when extrinsic factors act, the third part of the duodenum between the aorta, superior mesenteric artery and the spine is compressed. This causes partial or complete obstruction of the duodenum. The pathomechanism of the syndrome is therefore related to the narrow distance between the SMA and the aorta, and the narrow vascular angle of the SMA ramification from the aorta, different anatomical variants of the ligament of Treitz, or an excessive loss of...
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weight (due to secondary causes that leads to loss of fat protection like burns, the lack of appetite, cancers and other serious injuries of the body, such as trauma to the head).

The spatial relationships of the deformed spine changes during the three-dimensional correction of deformation, and thus it elongates in varying degrees in the sagittal plane. In our case, the axis of the spine after correction increased by almost 10 cm. During derotation of the deformation, the blood vessels (aorta, superior mesenteric artery) tighten and stretch. A degree of the narrowing of the angle between the SMA and the aorta can cause acute or chronic clinical symptoms. The anatomical relations after the operation are shown on the CT scan (Figure 3).

SMAS is difficult to diagnose since it has no specific symptoms. It usually manifests itself through symptoms such as bloating, pain in the upper abdomen after a meal, nausea, vomiting, decreased appetite and weight loss. Paradoxically, it may create the vicious circle mechanism and an aggravation of these symptoms. Postoperative obstruction reveals a similar clinical picture as the SMA syndrome, so differentiating the latter from other diseases and making a correct diagnosis is difficult. However, our center prefers an abdominal CT scan with contrast, as the most accurate diagnostic tool. SMAS is diagnosed on CT on the basis of the following: angle of SMA ramification from the aorta below 25° (normal range: 38–56°), when measured in the sagittal plane; the distance between the SMA and the aorta at the level of the duodenum less than 8 mm (normal range 10–20 mm). We can consider the fact and argue with the other authors on whether in the case of our patient’s scoliosis of 90–120° if we have used the SMAS diagnostic criteria (the value of the angle of ramification, the distance from the duodenum) which are adapted to healthy patients, with normal anatomy. As a result of the deformation, there is a significant change in the topography of the anatomical structures and their adaptation to the new situation. Thus, we should know the value of the angle of the SMA ramification in the adapted position to make a proper correct diagnosis of SMAS. It would be useful to perform a CT scan in patients at risk before and after surgery in order to know the location and to evaluate the organs and vessels of the abdominal cavity. Alternatively, if any clinical signs occur, we ought to do another CT scan of the abdomen to assess the displacement of the structures after surgical correction of the spine as compared to the preoperative image. In our case, this angle was 17.3° with an undisturbed anatomy, which met the diagnostic criteria. By knowing the value of the angle of curvature in scoliosis, height and BMI before and after surgery, "the extension of the backbone" by almost 10 cm resulting in the tightening of the blood vessels, and common clinical symptoms, we could diagnose SMAS, even though we did not take measurements before the surgery.

The conservative treatment of SMAS usually starts by removing causative factors such as a corset, if it was used. The treatment includes: intensive fluid therapy, replenishment of electrolyte deficiencies, anti-emetics, and if necessary the limitation of oral feeding and feeding through a nasogastric tube or even total parenteral nutrition. The parameters should be continuously monitored, and a nutritionist ought to conduct surveillance to prevent malnutrition that can interfere with weight gain, result in the loss of muscle mass and impair healing of surgical wounds. In most cases, the complete recovery period is 7-14 days, but the literature also report chronic conditions as well as those diagnosed six or more weeks after surgery. The most important thing is to diagnose SMAS so as soon as possible in order to implement treatment at the appropriate time.
Surgical intervention is rarely necessary. It is used when the conservative treatment gives no effects in 4–6 weeks or when other pathology coexists, such as peptic ulcer, pancreatitis, etc. The surgery is reserved for patients with a chronic SMA disease process. The most common treatments used in SMAS surgery include: anastomosis bypass and duodenal derotation. The surgery is not required in complications after spinal surgery.

CONCLUSION

SMAS is a rare condition that is caused by the rotation of anatomic structures following scoliosis surgery and the consequent contraction of the aorto-mesenteric angle and extension of the SMA trunk. SMAS can occur frequently in patients after surgical correction of the spine, but because of the atypical symptoms and drugs administered in the perioperative period, which can mask the potential symptoms, it may be undiagnosed. First, special attention must be paid to young, lean patients, with BMI below 19, and the postoperative effect of an elongated axis of the spine, which increases the patient height. The diagnosis can be made by contrast-enhanced abdominal tomography. In most cases, symptoms are improved with conservative treatment. Otherwise, release of the ligament of Treitz (if possible with a laparoscopic approach) and duodenojejunostomy are ideal surgical treatment options for patients who do not respond to conservative treatment. The problem of diagnosis in large deformations remains unsolved. At the curvatures of the order of 90–120° or more, there is a significant change in the topography of the anatomical structures and their adaptation to a new position after surgery. Several questions could be raised, such as should a CT scan be performed in patients at risk before surgery in order to know the location, evaluate organs and vessels of the abdominal cavity or if it should be done after the surgery as well, and is it advisable to wait until the symptoms appear. But it is very important that delayed treatment of SMAS may result in death.

CONSENT

The authors obtained written, informed consent from the patients for the publication of this article.

COMPETING INTERESTS

The authors declare for no conflict of interest.

ABBREVIATION LIST

- Adolescent idiopathic scoliosis (AIS)
- Computed tomography (CT)
- Left renal vein (LRV)
- Superior mesenteric artery (SMA)
- Superior mesenteric artery syndrome (SMAS)
- Posterior approach (PSF)
AUTHOR’S CONTRIBUTIONS

Pawel Grabala – 70 % - idea, building of structure, discussion, references
Michal Latalski – 30 % - discussion, references

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