North Clin Istanb 2023;10(1):33–39
doi: 10.14744/nci.2022.21347

Original Article PEDIATRICS

Method of prevention of post-operative peritoneal adhesions

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ABSTRACT

OBJECTIVE: The purpose of the research was to assess the performance of the method of prevention of post-operative peritoneal adhesions (PAs) (author's method) in patients of different age groups.

METHODS: Two hundred eighty-five patients were in total enrolled in the study. The patients of two age groups were divided into two groups: Group 1 (treatment group), where the author's method was used on 143 patients, and Group 2 (control group) 142 patients, where was used the standard approach of prevention of intra-abdominal adhesions. All patients were operated in an urgent order on adhesive intestinal obstruction (AIO). The patients previously had surgery on AIO one to 3 times. Within each group, sick children and adults were identified. The gender distribution was comparable in both groups.

RESULTS: The recurrence of AIO was significantly less in Group 1 than in Group 2 (1.4% and 6.3%, respectively, $p<0.05$). A separate study of the results of treatment in the age aspect in groups showed some features. Among children the AIO relapse rate in study Groups 1 and 2: Early AIO-in 1 (0.86%) and 2 (1.8%) patients, respectively; late AIO-in 1 (0.86%) and 4 (3.5%), patients, respectively. Among adults who didn't have relapse AIO during the follow-up period in Group 1. The AIO relapse rate in Group 2: Early AIO – in 1 (3.5%) and late AIO-2 (6.9%) patients, respectively.

CONCLUSION: The proposed author's method for preventing AIO recurrence has shown its effectiveness among patients with adhesive AIO. Besides, using this method in children to reduce the AIO relapse rate by more than thrice; in adult patients, to prevent the development of clinically significant signs of PA and normalize the patient's quality of life.

Keywords: Adhesion; author's method; innovation; peritoneal adhesions.

Cite this article as: *Gudiev C, Minaev S, Vasiliev V. Method of prevention of post-operative peritoneal adhesions. North Clin Istanb 2023;10(1):33–39.*

By the activity level of N-acetyltransferase (constitutive enzyme), people are divided into two groups: rapid acetylator phenotype and slow acetylator phenotype. Among the study subjects, people with rapid acetylation phenotype (over 65.4%) and predisposition to adhesion prevailed [1]. The human peritoneal mesothelial cells are capable of causing intense biological responses by inducing the formation of fibrinous adhesions that localize the area of inflammation [2]. A more profound understanding of cellular and molecular events has led to the identification of many biologically active molecules with potential angiogenesis regulation and tissue remodeling being of importance for healing the peritoneal wound and adhesion [3].

Retrospective study of 414 children after laparotomy during the neonatal period at the John Radcliffe Hospital, Oxford, UK. Twenty-three patients (6%) were subjected to laparotomy on adhesive small bowel obstruction (ASMO). Single adhesions have caused bowel obstruction in eight patients (35%), multiple

Received: May 25, 2022 *Revised:* July 04, 2022 *Accepted:* September 03, 2022 *Online:* February 13, 2023

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adhesions in six (26%), and dense adhesions in nine patients (39%) [4]. Children operating on twisted intestines showed the highest risk (9.2%) of rehospitalization due to adhesions during the next 5 years [5].

The women with cesarean delivery showed an increased risk of adhesions and adhesive intestinal obstruction (AIO). The repeated cesarean section increased the risk of adhesions [6]. Despite using sound surgical techniques and irrespective of the surgical access by laparotomy or laparoscopy, post-operative adhesions appear in the overwhelming majority of women who underwent abdominopelvic surgery [7].

Acute AIO (AAIO) is a common surgical pathology that can make up to 3.5% of all patients admitted to the surgical department. According to the leading surgical institutions, the operative mortality varies from 5.2% to 28.4% and shows no significant trend toward decrease [8]. Peritoneal adhesion (PA) remains one of the complex and open problems of abdominal surgery. The relapse rate sometimes reaches 60–70%, and AAIO takes the first place among the other forms of intestinal obstruction irrespective of great progress in minimally invasive technologies [9]. Eleven patients were operated on AAIO using laparoscopy. All patients were admitted after prior surgical treatment. Single band adhesions and indolent adhesion in the abdomen were observed in all cases [10]. Small bowel obstruction is a frequent and essential manifestation. Approximately 30% of patients require surgical treatment during admission [11].

A large number of papers [12–14] demonstrated the success of the scientific search for study of biochemical adhesion process, PA development, means and methods of their prevention based on the early activation of a patient, new surgical techniques and medicinal products, and minimally invasive surgical technique. However, the approaches offered by the authors [15–17] and means of PA prevention do not provide sufficient efficacy and depend on many factors unmanageable by a doctor.

Considering the above, for the assessment of the performance of the author's method for mechanical prevention of sentinel loops adhesion in the background of the normally occurring biochemical adhesion process in patients of different age groups, we have conducted the study that included the patients: Children who had undergone the surgical treatment of AIO in an urgent order and adults who had undergone the routine surgical treatment of PA.

Highlight key points

- The presented author's method made it possible reliably (more than threefold) to reduce the number of AIO relapses in children and prevent the development of post-operative PA in adult patients.
- The routine surgical treatment for adhesiolysis followed by the author's method is the preferred tactic for managing patients suffering from PA and having a high risk of AIO.
- The area of the anterior abdominal wall provides manipulation for using the author's method in full, without affecting the operative wounds and adjacent dressed tissues.

MATERIALS AND METHODS

Two hundred eighty-five patients were in total enrolled in the study. The patients of two age groups were divided into two groups: Group 1 (treatment group), where the author's method was used on 143 patients and Group 2 (control group) – 142 patients, where was used the standard approach of prevention of intra-abdominal adhesions. All patients were operated in an urgent order on AIO. The patients had surgery on AIO from 1 to 3 times. Within each group, sick children and adults were identified. The study groups were comparable by gender, age, and nature of the pathology.

The study consisted of two parts: A retrospective study (formation of Group 2 [control group]) based on the analysis of results of a common approach for intra-abdominal adhesions prevention) and prospective study (formation of Group 1 [treatment group]) where the author's method for postoperative adhesion prevention was used).

Children

The study included 229 children who underwent emergency surgical treatment for AIO and who had previously (primarily) been operated on: acute appendicitis -137 (59.8%), introsusception -36 (15.7%), blunt abdominal trauma -34 (14.8%), necrotizing enterocolitis -15 (6.5%), liver echinococcosis -5 (2.2%), and Payer's disease -2 (0.9%). Boys to girls ratio made 1.3:1. The average age of the patients was 9.8±1.7 years old. Group 1 included 116 children, Group 2–113. The study was conducted in the clinical facilities of Stavropol Regional Children's Clinical Hospital, Grozny Children's Clinical Hospital No 2, and Makhachkkala Republican Children's Clinical Hospital.

On children with the signs of AIO, treatment was started with conservative measures in the form of nasogastric intubation, infusion therapy, cleansing, and saline enema. No effect of the conducted treatment was the indication for surgery. The surgical treatment consisted of the elimination of cause of the mechanical intestinal obstruction (dissection of adhesions, untwisting, and laying the sentinel loops in the physiological position, and so on). Children who underwent colostomy were not included in this study.

The author's method was used for all Group 1 children within the first 4 days of the post-operative period. Then, for up to 5–6 days (11 patients) of the post-operative period, the procedure was continued for the patients that were somewhat difficult to activate due to their young age, degree of severity of the post-operative condition, patient, pronounced predisposition to adhesions.

In the post-operative period, the abdominal brain exposure to the variable magnetic field was used for Group 2 to arrest the intestinal distention. The device "Magniter" was applied to the anterior abdominal wall for 20 min daily during the first 4 days of the post-operative period. From 5 to 15 post-operative days, the control group of patients received electrophoresis with hyaluronidase 64 IU.

During the treatment efficacy assessment, the following criteria were considered: Subjective data (intensity of pain and asthenic syndrome and quality of life); objective data, including the dynamics of symptoms (pain, edema, and hyperemia) and period of the patients staying at the hospital.

The adhesive process in the abdomen was determined using the Androsov, Blonov, and Knokh position specimens. These specimens are based on the creation of the thrust vector during mechanical tractions causing the adhesion tensioning between points of its attachment to various sites of the abdomen. Pain appearance or intensification is clinically determined.

The ultrasound examination of the abdomen was performed on GE Pro series LOGIQ 500 and SonoAce PICO using the curvilinear transabdominal multifrequency transducers within the range from 3.5 to 7.5 MHz. The echostructure of the abdomen, mobility of parietal and visceral peritoneum, "return" symptoms and small bowel dyskinesia in the area of its fixation by adhesives were examined.

Adults

The study included 56 patients aged from 26 to 57 years old who had undergone abdominal surgery on AIO from 1 to 3 times. Group 1 included 27 patients and Group 2-had 29. The gender distribution was comparable in both groups. The study was conducted in the clinical facilities of Grozny Children's Clinical Hospital No 9, and hospital City Clinical Hospital No 64 of the Department of Health Moscow.

All patients with pronounced clinical picture (constant spastic abdominal pains intensified after meals, distension, constipation, often offensive breath, low body mass index) of PA, after clinical, laboratory examination and imaging, PA diagnosing, and pre-operative preparation being standard in the surgery were routinely operated.

The scope of surgical treatment was limited by dissection of adhesions that could cause clinically significant signs of PA and threatened by AIO. The surgical treatment was performed using the endoscopic method; if it was impossible to ensure access or sufficient adhesiolysis, the abdominal cavity organs were accessed by open laparotomy (two patients). The author's method was used for all patients of Group 2 in the post-operative period.

Using the author's method for the adult patients started 8 h after surgical treatment with single peridural anesthesia for each procedure at a daily interval for 3 days. The short-term use of the author's method was explained by the preliminary readiness of patients by the attending physician regarding the importance of their early activation in the post-operative period in the form of motion activity (physical exercises involving the pelvic girdle: Turns, bends, and walking) with the respiratory maneuvers in deep thoracic and abdominal types of breathing. The anesthesiologist performed the catheterization of the peridural space in terms of the patient's preparation for surgery to ensure efficient postoperative anesthetic support using the author's method.

The objective signs of the author's method efficacy were the absence of symptoms based on viscerosensory reflexes in case of the adhesion tensioning: Carnot symptom – pain intensification in the epigastric region when extending the trunk; Knokh symptom – scar pain when putting the roll under the lumbus; Blinov symptom – scar pain when bending forward; and Khunafin symptom – pain occurring when inflating the abdomen artificially.

Figure 1. Authors' method technique.

All patients who operated on PA were followed up for 3 years.

The author's method is a manual and/or instrumental (concussor) exposure procedure for the abdominal organs that includes seven exercises used in three stages [18]. Stage 1 is the 1st day after surgery during which from 1 to 3 procedures are conducted; Stage 2 is the 2nd day after surgery during which from 1 to 2 procedures are conducted; Stage 3 starts from the 3rd day after surgery once a day, for up to 2–3 days. The procedure can consist of 3 and more exercises.

The author's method is used with peridural anesthesia, through the abdominal wall, to move the sentinel loops relative to each other and their standard topographic location, within the wide range, in the early post-operative period, daily, for a period till full activation of a patient.

The procedure includes the following exercises (Fig. 1).

1. The first exercise consists in placing the patient on his back, with both hands putting around the anterior abdominal wall by capturing the largest possible volume of sentinel loops, lifting up and down. The exercise was performed two or more times;
2. The second exercise – the patient was placed on the left side, and the abdominal wall and internal organs hanging to the left were "tossed" up to the right iliac region by a quick, jerky movement of the palm of the right hand so that the organs would fall to their previous position under their weight. The exercise was performed two or more times;
3. The third exercise – the patient was placed on the right side, and the abdominal wall and internal organs hanging to the right were "tossed" up to the right iliac region by a quick, jerky movement of the palm of the left hand so that the organs would fall to their previous position under their weight. The exercise was performed two or more times;
4. The fourth exercise – the patient was placed on his back with the raised pelvis and lower abdomen, placing a roller, the fingers of both hands pressed on the abdomen going from the upper edge of the pubic bone upward to the costal arches so that the sentinel loops would move as much as possible to the side of the diaphragm. The exercise was performed two or more times;
5. The fifth exercise – the patient was placed on his back, the palms of both hands put around from the side of the lumbar, and the anterior abdominal wall, first the left and then the right half of the abdomen, and intensively squeezing, the sentinel loops were moved relative to each other. The exercise was performed two or more times;
6. The sixth exercise – the patient was placed on his back and the abdominal organs were kneaded in the longitudinal and transverse directions; then, one hand clenched into a fist was immersed in the abdominal wall, with its back surface pushing, rolling the abdominal organs and soft tissues of the abdominal wall onto the palm of the other hand by kneading. The exercise was performed two or more times; (the sixth exercise was not used in the study);
7. The seventh exercise – the patient lay on his stomach so that the entire anterior abdominal wall hung down without support; pushing, vibrating, and pressing bottom-up movements were made on the abdominal cavity. The exercise was performed two or more times. (the seventh exercise was not used in the study).

Statistical Analysis

The analysis of the significance of differences in groups was performed using the variation statistics methods in the licensed software "Statistica 10.0" (StatSoft, USA). The data analysis included standard methods of descriptive and analytical statistics. To compare the medians, the t-test and non-parametric tests for two samples (χ^2, F-test) were used.

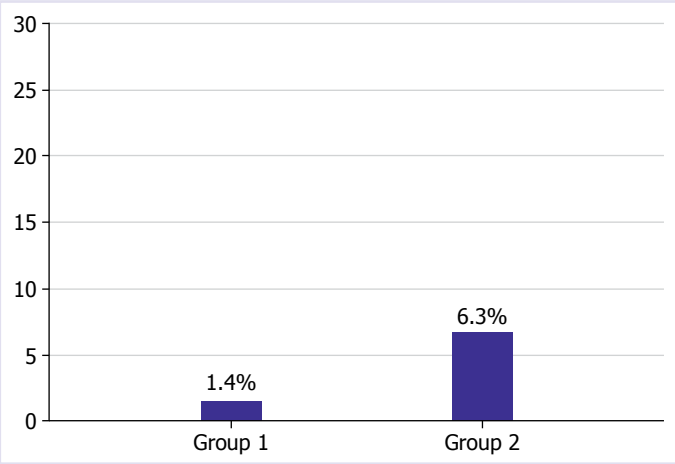

FIGURE 2. The comparison of the AIO relapse rate after the treatment.

Approval was obtained from the Stavropol State Medical University Clinical Research Ethics Committee (No. 29 of 29 of May 15, 2013). The research was conducted in accordance of the Declaration of Helsinki.

RESULTS

The development of recurrence of AIO was significantly less in Group 1 than in Group 2 (1.4% and 6.3%, respectively, $p<0.05$) (Fig. 2). A separate study of the results of treatment in the age aspect in groups showed a number of features. Among children the AIO relapse rate in study Groups 1 and 2: Early AIO – in 1 (0.86%) and 2 (1.8%) patients, respectively; late AIO-in 1 (0.86%) and 4 (3.5%), patients, respectively. Among adults who did not have relapse AIO during the follow-up period in Group 1. The AIO relapse rate in Group 2: Early AIO-in 1 (3.5%) and late AIO-2 (6.9%) patients, respectively.

The features of the course of the adhesive process within the groups showed features among children and adults.

Children

The most distinct signs of the author's method efficacy were the absence of pains in the post-operative period characteristic of PA and AIO, significantly lower severity of post-operative paresis and earlier restoration of intestinal motility (function). In Group 1, enteral nutrition became possible starting from day 3, and in Group 2 – on day 4–5. The appearance of bowel movements in Group 1 was observed significantly earlier ($p<0.05$) on days 2.8 + 0.5 after surgery than in Group 2-days 4.5 + 0.6.

The comparison of the AIO relapse rate after the treatment revealed its decrease by more than 3 times in Group 1 in contrast to Group 2: Early peritoneal adhesive intestinal obstruction – in 1 (0.86%) patient and 2 (1.8%) patients, respectively; late AIO-in 1 (0.86%) and 4 (3.5%), respectively.

Adults

The post-operative period in patients of Group 1 was without complications. The intestinal motility was observed in all patients on the 1st day after surgery. Using the author's method on a routine basis in adult patients made it possible to prevent the development of clinically significant manifestations of post-operative PA, such as abdominal pains associated with food intake and physical activity, and to normalize the quality of life of patients.

DISCUSSION

The post-operative adhesion occurring in more than 90% of cases of open abdominal surgeries is their expected outcome. The adhesions are the reason for more than 75% of cases of AIO [19]. Based on the analysis of 446,331 cases of abdominal surgeries, the total ASMO incidence made 4.6%. No significant difference in the AIO development after laparoscopy or open appendectomy was revealed (1.4% vs. 1.3%, respectively) [20]. The problem of post-operative ASMO after the restorative proctocolectomy is not changed with the laparoscopy. Most cases occur in the early post-operative period [21].

Two hundred and eighty-eight patients with ASMO were enrolled in the study. Among them, 37 (12.9%) patients showed strangulated intestinal obstruction, and 251 (87.1%) patients showed simple intestinal obstruction. Eighty-four (29.2%) patients suffered from obstruction relapse during 24 months of follow-up on average. The relapse rate decreased in patients who had undergone the surgical treatment in contrast to the patients who had received the conservative treatment, 21.3% (26/122) versus 34.9% (58/166) [22].

Based on the analysis of more than 1640 scientific works of the world's experience in studying and fighting against PA, it can be concluded that PA is a complex disease occurring from surgical treatment of the abdominal organs. The abundance and variety of treatment and preventive methods evidence their unreliability to a certain extent. All this necessitates a search for new approaches to PA prevention, the development of more reliable and safe preventive methods for this disease [23].

Particular fucoidans injected abdominally during a week after abdominal surgeries reduce the adhesion level to 90% [12]. Post-operative hyperbaric oxygenation in rats subjected to laparotomy did not change the rate but reduced the density of abdominal adhesions and promoted vessel proliferation [13]. The formation of adhesions can be reduced using minimally invasive surgical methods and adhesion barriers (Bologna Guidelines for Diagnosis and Management of ASBO: revised in 2017, Guidelines of the ASBO Working group of the World Society of Emergency Surgery) [14]. The ASBO relapse risk is significantly lower for operative treatment of the primary episode of ASBO. The guidelines that recommend managing ASBO using non-operative methods are most likely based on the fact that the surgical treatment increases the risk of new adhesions. However, the long-term ASBO relapse risk should be considered in treating ASBO patients [16]. Using berberine is a reasonable solution to prevent primary and recurrent adhesions [15]. Adding dexamethasone to the saline as an irrigation fluid during laparotomy can reduce the development of adhesions. Proving the dose-dependent better result was failed [17]. The various forms of adhesion barriers were developed (gels, solutions, films) using several biomaterials to prevent post-operative adhesions. However, there are no products that could fully prevent post-operative adhesions [24]. Despite a wide range of therapy based on traditional and modern drugs, there is no consensus on the efficacy of these methods and means for preventing or managing post-operative adhesions [25].

High (over 65.4%) genetically determined adhesions [1–3], high post-operative PA incidence and various forms of intestinal obstruction [19–21], and insufficient efficacy of the existing methods and means of combating it [12–16] have predetermined the long-term, if not permanent, the relevance of the remaining problem of post-operative PA.

The predisposition to adhesions and remaining post-operative PA incidence corresponds to the modern scientific concept of the adhesion process as a universal protective and adaptive response of the organism to abdominal irritation (injury) [26]. It follows that adhesion is an inevitable process after each surgical treatment. Consequently, a threat of excessive (pathological) formation of connective tissue will constantly accompany the surgical practice threatening the development of PA and its complications, despite minimizing the incidence in the past 20–30 years. However, sometimes, even one adhesion (35% of cases) [4] in the abdominal cavity is enough to cause PA and AIO.

As it follows from the above works, a trend to search for drugs that effectively suppress the biochemical adhesion process has been formed in science. However, it should be noted that effective drug suppression of the biochemical adhesion process may contradict the statement that adhesion is a universal protective and adaptive response of the organism [26]. Therefore, the drugs that effectively inhibit the biochemical adhesion process raise doubts about their safe administration because they will not only have a selective effect on the excessive and pathological intra-abdominal adhesive process. These drugs will be equally effective for inhibiting the healing of the operative wound, anastomoses, sutured vessels, etc., the consequences of which are known to surgeons.

Based on the above, it seems preferable to search for a method for mechanical obstruction (prevention) to adhesion of sentinel loops. The pharmacologic stimulation of the intestines, activation of a patient in the early post-operative period, implementation of minimally invasive surgery, and impact minimization surgical techniques that have recently given a pronounced anti-adhesion effect are essentially mechanical methods for prevention of adhesions with the persistent biochemical adhesion process. This was extended by using the author's method.

The author's method is aimed at the forced, mechanical movement of the abdominal organs (sentinel loops) from their usual locations and relative to each other in a wider range than with medication-enhanced intestinal motility and activation of patients, making it possible significantly to minimize pathological adhesions of the intestine with subsequent development of PA.

The value of the author's method also consists in that the prevention of the sentinel loops adhesions occurs in the background of intensive anti-inflammatory therapy and persistent usually occurring biochemical adhesion processes due to the healing of the operative wound, sutured vessels, etc. occurs. At this, the bandage is not removed from the operative wound during laparoscopic or open laparotomic access, and the wound remains intact. The area of the anterior abdominal wall manipulates the author's method in full without affecting the operative wounds and adjacent dressed tissues. It should also be noted that the author's method technique is not aimed at influencing the anterior abdominal wall, like traditional tissue massage, but involves the coverage of the sentinel loops by widely spaced arms through the abdominal wall and their movement within the widest and safest range.

The author's method technique, duration of stages, number of procedures, and exercises were changed and supplemented at the attending physician's discretion, depending on the nature of the disease and patient's condition. The early start of the author's method, with the daily interval to complete the patient's activation, remained unchanged.

Conclusions

1. The proposed author's method made it possible reliably (more than threefold) to reduce the number of AIO relapses in children and prevent the development of post-operative PA in adult patients till having no clinically significant manifestations and normalizing the quality of life.
2. Based on the analysis of the above scientific works and this study, it should be concluded that routine surgical treatment for adhesiolysis followed by the author's method is the preferred tactic for managing patients suffering from PA and having a high risk of AIO.
3. Considering the method's efficacy, high reproducibility (not requiring long-term doctor training due to the simplicity of the exercises), safety for the patient, and low material costs, the author's method can be recommended for use in surgical practice after surgical treatments of the abdominal organs.

Ethics Committee Approval: The Stavropol State Medical University Clinical Research Ethics Committee granted approval for this study (date: 15.05.2013, number: 29/29).

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

Authorship Contributions: Concept – CG, SM, VV; Design – CG, SM, VV; Supervision – CG, SM, VV; Fundings – CG; Materials – CG, SM; Data collection and/or processing – CG; Analysis and/or interpretation – CG; Literature review – CG; Writing – CG; Critical review – CG, SM, VV.

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