A mechanical digestive tract obstruction is a condition characterized by complete or partial impairment of bowel passage due to an obstacle within the small or large bowel. First reports of digestive tract obstruction cases come from the 3rd–4th century BC. Despite a long time and advancements which have been made in diagnosing and treatment, it is still a serious problem commonly encountered in the clinical practice. In Poland, mechanical bowel obstruction is a reason of more than 20% of emergency surgical interventions in the abdominal cavity. It should be emphasized that definitely more often the causative disease factor is in the small bowel (1). Among reasons causing that condition, peritoneal adhesions
are an increasingly growing factor of so called adhesive small bowel obstruction (ASBO). Adhesions may result from a previous surgery within the peritoneal cavity or a previous inflammatory process of the gall-bladder, genital organs, appendix, pancreas or large bowel diverticula.

This study aims to analyse the reasons and incidence of adhesive small bowel obstruction during two periods of time (1990-1995 and 2005-2010).

During recent decades, a clear shift in the causative factors of small bowel obstruction has been observed. In 1960s and 1970s, the most frequent reason of mechanical bowel obstruction was stuck hernia. In the USA and West Europe, effective selective surgical treatment of hernias led to a significant decrease in the number of stuck hernia cases and, consequently, cases of small bowel obstruction. As a result, an increase in adhesive small bowel obstruction (ASBO) incidence occurred: from 43% in the years 1960–69 to 58% in the years 1980–89 (2). At the same time, the rate of stuck hernia as a reason of mechanical bowel obstruction decreased from 41% to 24% (2). Currently, in developed countries, intestinal adhesions are the cause of 50% to 74% of mechanical small bowel obstructions (3, 4).

On the other hand, an increasing number of surgeries, specially large bowel resections and gynaecological procedures, caused an increase in ASBO cases. Approximately 120,237 large bowel resections were performed in the USA in 2000 (5). In the following years, the number of procedures increased, reaching approximately 132,788 in 2004 (5). It makes a 10% increase during 4 years. Those numbers reflect a significant increase in the problem associated with adhesive small bowel obstruction.

The most recent data show that ASBO is the cause of 60–70% of small bowel obstruction cases and 40% of all cases of digestive tract obstruction (6). In Poland, still the most frequent reason of small bowel obstruction is stuck hernia with peritoneal adhesions taking the second position (1, 7). However, the tendency observed in highly developed countries may also be seen in our country. It can be expected that peritoneal adhesions will become the most frequent cause of small bowel obstruction in Poland in the coming years.

Adhesive small bowel obstruction is not only a diagnostic and therapeutic problem but also an economic one. In the USA, more than 300,000 patients with small bowel obstruction is hospitalized each year, which results in about one billion dollar treatment costs (8). In Sweden, annual direct treatment costs in relation to peritoneal adhesions are estimated at about 13 million dollars (9).

A method of choice in treatment of adhesive small bowel obstruction is surgery, especially when clinical symptoms and imaging results indicate that the intestine wall may be perforated or twisted. However, in specified situations, waiving the subsequent surgery, patient rehydration and gastrointestinal contents suctioning may be an effective method of treatment even in the case of up to 30–60% of patients (10).

**MATERIAL AND METHOD**

We performed a retrospective analysis of medical records of patients with adhesive small bowel obstruction hospitalized at the 1st Department of General Surgery and Surgical Oncology of the Provincial Polyclinic Hospital in Płock in the periods of 1990–1995 and 2005–2010. Data showed a significant increase in the number of ASBO cases. In 1990–1995, 58 ASBO patients were treated at the 1st Department of General Surgery and Surgical Oncology while in the period of 2005–2010, this number increased to 215 (fig. 1).

![Fig. 1. Number of patients and average age of patients with adhesive small bowel obstruction treated during the period between 1990-1995 and 2005-2010 at the 1 Department of General and Oncological Surgery](image)
The mean age of patients hospitalized between 1990 and 1995 was 56.53 years and it was higher than 52.54 years in the period of 2005–2010. During both periods, we noted a slightly higher incidence in women – 32 (55%) and 114 (53%), respectively.

In both periods, the most frequent causes of the disease were previous surgeries involving the large bowel (30.5% and 24.8%) and gynaecological procedures (20.2% and 18.8%). Quite often, peritoneal adhesions causing small bowel obstruction resulted from appendectomy (15.2% and 12.8%) and cholecystectomy (11.8% and 12.2%). In tab. 1, we summarized primary surgeries causing ASBO.

Conservative treatment consisted in nasogastric tube placement, intravenous hydration, administration of analgesics and antispasmodic agents, monitoring of diuresis. Since 1997, additional treatments with water soluble contrast agents administered orally or through a nasal-stomach probe has been implemented.

RESULTS

All operated patients had a laparotomy. There were no laparoscopic procedures performed. The vast majority of cases of bowel obstruction were caused by single adhesions which were released by cutting with scissors or electrocoagulation. In the first group, laparotomy with lysis of peritoneal adhesions was performed in 22 (38%) patients. In five patients, small bowel plication was performed. In the period of 2005–2010, 28 (13%) patients were operated on. In two cases, because of recurring symptoms of ASBO and the need for surgery, small bowel plication was decided on. Data are shown in tab. 2.

Thirty percent of patients from both analysed periods suffered from concomitant diseases. The most frequent were hypertension, coronary heart disease and type 2 diabetes mellitus. Forty percent had more than one comorbidity. Detailed data are presented in tab. 3.

Mean hospitalization time in the period of 1990–1995 was 11.3 days with patients who had a surgery being hospitalized longer (17.8 days) than patients who received conservative treatment (8.08 days). In the period of 2005–2010, mean hospitalization time was shortened to 6.95 days. Surgical treatment was associated with 15.6 days of hospital stay and conservative treatment – with 5.7 day hospitalization.

Small bowel necrosis and the need of intestine resection occurred in 5 (8.4%) patients in the period of 1990–1995 and in 3 (1.4%) patients in the period of 2005–2010. In each case, a resection of intestine segment was

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<th>Table 1. Surgical procedures performed on patients hospitalized at the 1st Department of General Surgery and Surgical Oncology resulting in ASBO</th>
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<tr>
<td>Large bowel and rectum resections</td>
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<td>Small bowel procedures</td>
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<td>Hysterectomy</td>
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<td>Abdominal aortic aneurysm repair</td>
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<td>Other</td>
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<td>Other procedures: hernia repairs, urologic surgical procedures, one hemihepatectomy, one antireflux surgery</td>
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<th>Table 2. Number of patients with adhesive small bowel obstruction and therapeutic methods during the period between 1990-1995 and 2005-2010</th>
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<tr>
<td>Number of patients</td>
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<td>Conservative treatment</td>
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<td>Surgical treatment</td>
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<td>Small bowel plication</td>
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<th>Table 3. Coexisting diseases and number of patients with adhesive small bowel obstruction treated at the Department of General and Oncological Surgery during the period between 1990-1995 and 2005-2010</th>
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<td>Arterial hypertension</td>
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<td>History of cerebral stroke</td>
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<td>Atrial fibrillation</td>
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<td>Rheumatoid arthritis</td>
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<td>Others</td>
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connected with a significant prolongation of hospital stay. In both periods of time, there were 5 deaths, which accounts for 8.4% and 2.2% for the first and the second period, respectively.

Between 2005 and 2010, water soluble contrast agents were used in the treatment of ASBO. It should be emphasized that implementation of that method brought a 15% reduction in the need for surgery. Another important thing resulting from water soluble contrast agents implementation is accelerating decisions to perform surgery. This translated into a decrease in hospital stay in both surgical and conservative treatment groups.

**DISCUSSION**

The most frequent cause of peritoneal adhesions is a previous surgery. Post-mortem examinations showed the presence of postoperative peritoneal adhesions in 67% of cases (11). However, clinical evidence indicates that the rate of postoperative adhesions development is significantly higher, reaching up to 95% (12). The vast majority of peritoneal adhesions cause no symptoms. However, about 15–18% of patients will require a reoperation (13). Taking into account the number of abdominal surgeries being performed, it makes a large group of potential patients who will need to be hospitalized and have surgical procedure performed. Incidence of digestive tract obstruction following laparotomy varies in available literature reports. In one cohort of 446,331 patients it was 4.6% (14). An analysis by Angelet et al. showed a 0.4% to 13.9% rate of small bowel obstruction after surgery (15). Disease rate depends on the type of performed surgery (14).

It should be noted that negative history of surgical treatment does not exclude the possibility of peritoneal adhesions existence. Approximately 75% of patients who have never had an abdominal surgery has symptoms caused by peritoneal adhesions (16). Peritoneal adhesions may develop on the grounds of inflammatory processes within the abdominal cavity, for example bowel, appendix, gall-bladder, or – in women – genital organ inflammatory diseases. In lack of previous surgeries, that conditions are responsible for about 20% of ASBO cases (16). The risk of peritoneal adhesions development depends on the type of surgery, postoperative course and the type of surgical incision (13). Adhesive small bowel obstruction is more frequent after operations on the lower abdomen (17). Laparoscopy seems to reduce the number of postoperative peritoneal adhesions and, in consequence, the risk of ASBO (18, 19, 20). In the study of 567 patients, incidence of ASBO following traditional appendectomy or cholecystectomy was estimated at 10.7% and 6.4%, respectively (21).

This publication, as well as others, indicates that lower abdomen surgeries are related with a higher risk of small bowel obstruction. Our data also showed that ASBO was considerably more frequent following operations on the lower abdomen which accounted for approx. 70% in the period of 1990–1995 and about 66% in the period of 2005–2010. The risk of small bowel obstruction after cholecystectomy and appendectomy as assessed by Beck et al. was 1% up to 10% (22).

However, it appears that appendectomy is not as frequent cause of adhesive small bowel obstruction as it was believed. Ten-year follow up of 3,000 patients who underwent that kind of procedure showed a need for hospital readmittance in only 3% of cases (17).

Adhesive small bowel obstruction is significantly more frequent following surgical interventions on the bowels. Nieuwenhuijzen et al. estimated the risk of that kind of procedures as 10% to 25% (23). Procedures specially associated with the risk of ASBO are large bowel and rectum resections, open gynaecological surgeries and appendectomy (24).

The same relationships were observed in patients treated at the 1st Department of General Surgery and Surgical Oncology of the Provincial Polyclinic Hospital in Płock in both periods of time. During the course of a 2-year follow up, 15.3% of patients who underwent a rectal or sigmoid surgery had symptoms of digestive tract obstruction, of whom 5.1% required reoperation and lysis of peritoneal adhesions (22). Retrospective analysis of medical records of 234 patient with the history of large bowel resection showed an even higher, 24% rate of small bowel obstruction, 18% of which was caused by intestinal adhesions (23). A one year risk of ASBO was 11% and increased to
30% within 10 years (23). The pelvis was the most frequent location of adhesions (23). Another American analysis performed in a large group of patients (4,555) who underwent large bowel resection showed that within 3 years, 10% of patients were hospitalized with symptoms of small bowel obstruction (25). In that group, in about 58% of patients symptoms occurred within the first year and 22% of patients required surgery, the most often being lysis of peritoneal adhesions (25). Parker et al. analysed medical records of 12,584 patients who underwent operations on the lower abdomen. Among them, 8,861 were admitted to hospital again, and adhesive small bowel obstruction was the reason of 643 hospitalizations in that group (26). Four hundred and thirty (69.9%) patients needed to be reoperated with the purpose of peritoneal adhesions lysis (26). The remaining 197 (30.6%) patients received conservative treatment. The majority of intense mobility small intestine is localized within the lower abdomen and pelvis. That may be the reason why peritoneal adhesions developed in that region cause ASBO much more frequently.

Therefore, large bowel resections are believed to be associated with a significantly higher risk of ASBO. Gynaecological surgeries are also connected with a quite high risk of small bowel obstruction, but not as high as procedures on the colon. ASBO occurred in 4,297 (11.1%) out of 38,751 patients (14). Its rate depended on the type of surgery performed. The most cases of adhesive small bowel obstruction were observed after operations on the adnexa (23.9%), then after hysterectomy (15.6%) with the lowest number after caesarean section (0.1%) (14). Surgical access had also a big impact on obstruction development with no cases observed after laparoscopic procedures (14). Our data showed that ASBO was more frequent after resection of the uterus than after operations on the adnexa. There was one case of adhesive small bowel obstruction following caesarean section and no cases following laparoscopic gynaecological surgeries. In the case of appendectomy, the type of surgery also affects the rate of small bowel obstruction. Isaksen et al. performed a retrospective analysis of medical records of 2,333 patients who underwent open surgery and 2,372 patients who underwent laparoscopic procedure (27). ASBO rates were low in both groups, reaching 1% and 0.4%, respectively (27). The difference was statistically significant in favour of the less invasive method (27).

Development of laparoscopy resulted in a significant increase in procedures performed using that technique. While reduction in postoperative pain, faster return to normal activities, shorter time of hospitalization are well known advantages of that technique, its effect on peritoneal adhesions development is not fully understood. Intraoperative endothelial injury is the cause of adhesions development. In the process of healing, new endothelium is produced which covers injured surfaces within 5–8 days (28). That involves a migration of macrophages to the injured site and inflammatory response (29, 30). A process of adhesion development ends up with production and stabilization of fibrin fibres.

It seems that lower degree of perioperative injury translates into smaller adhesions development. During an open surgery, organs are manipulated. It always poses an injury, thus making a possibility for adhesions to develop during the healing process. Such situations can be avoided during laparoscopic procedures where patient position causes dislocation of organs into a specified part of the abdominal cavity, which allows for a significant reduction in organ manipulation. Another issue translating into the endothelial injury limitation and in the same way into the process of healing is avoiding of surgical gloves tissue contact. Significantly smaller extent of peritoneal injury and a foreign body such as stitches left inside a human body is another important element which can impact peritoneal adhesions development. A retrospective analysis of medical records of 108,141 patients showed that the risk of small bowel obstruction after abdominal surgery was 0.4% to 13.9% (15). What is important, the risk of ASBO was 4-fold higher when the surgery was performed with the open technique compared to laparoscopic procedures (15).

Polymeneas et al. assessed the amount of peritoneal adhesions developed after cholecystectomy performed with the traditional and laparoscopic techniques. All patients who underwent the traditional surgery had peritoneal adhesions of varying intensity (18). Among patients who had laparoscopy, 55.5% had no peritoneal adhesions and in the remaining part of that group, adhesions were
limited or easy to dissect (18). In another study Dowson et al. found significantly less peritoneal adhesions after large bowel resections performed by laparoscopy compared to open surgery (19). It concerned both the operated site and sites of abdominal wall incisions (19). Similar findings were made in women after gynaecological surgeries. 59% of women who had midline incision in the lower abdomen during a previous surgery had peritoneal adhesions, and in the case of transverse supra-pubic incision, that percentage was 28% (20).

No adhesions were found in patients who underwent previous laparoscopic procedure (20). Among clinical trials, the one comparing four groups of patients including 469 patients who had never had any surgery, 125 patients after a laparoscopic procedure, 131 patients who underwent laparotomy with transversal incision and 89 patients who had laparotomy with midline incision should be mentioned. The rate of peritoneal adhesions in each group was 0.68%, 1.6%, 19.8% and 51.7%, respectively (31). All the above mentioned studies confirm that the laparoscopic technique significantly reduces peritoneal adhesions development. A risk of small bowel obstruction with that technique is also lower. It is consistent with evidence from clinical literature. Dupree et al. found that of 211 patients who underwent laparoscopic large bowel resection, 4 (1.9%) were admitted with symptoms of small bowel obstruction but were cured by conservative means (32). Another 4 patients (1.9%) required surgery and lysis of abdominal adhesions (33). In contrast, in a group of 505 patients who underwent open surgery those rates were 5.5% and 2.1% (32). Another analysis found the same risk of ASBO but observation time was much longer in the laparoscopy group (33). Additional, it should be outlined that the need for reoperation was 4 times higher in the open surgery group (33).

Patients with small bowel obstruction get to the hospital after at least a dozen of hours from the disease onset. Because of that, significant fluid loss and dehydration of various extents are often observed. It should be noted that malignancies most often occur in the elderly. That group is more exposed to dehydration. Very important part of treatment is correction of volume and electrolytes depletion and intravenous administration of analgesics and antispasmodic agents. During the first hours of treatment, insertion of the urinary catheter with hourly determination of urine output is often necessary. Digestive tract decompression with the nasogastric tube quite quickly results in the reduction in or almost complete alleviation of nausea, vomits and pain (34). Some authors propose placement of the long nasointestinal probe, which in their opinion offers an opportunity for suctioning gastrointestinal contents accumulating above the barrier in the small bowel and better bowel decompression resulting in much better conditions in the case of surgery (35). However, results of a prospective randomized trial showed the same efficacy of conservative treatment with placement of the nasogastric tube or nasointestinal tube (35).

It should be emphasized that digestive tract decompression is very important for the safety of anaesthesia in the case of surgery given that residual stomach contents increase the risk of aspiration. The following conservative treatment is used at the 1st Department of General Surgery and Surgical Oncology of the Provincial Polyclinic Hospital in Plock – fluid and electrolytes resuscitation, administration of analgesics and antispasmodic agents, monitoring of fluid balance, decompression of the digestive tract using the nasogastric tube and use of water soluble contrast agents. That kind of treatment was effective in approx. 87% of cases. The remaining patients had surgery. Early surgery in cases of small bowel obstruction raises a lot of doubts. Unfortunately, currently there are not objective imaging methods or biochemical tests that would allow for diagnosis, for example strangulation causing a risk for intestine viability. A decision on performing a surgery should be based on assessment of patient’s clinical condition, imaging results (X-ray, CT scans) and biochemical tests results (C-reactive protein, leucocytosis, gas analysis with lactate measurement). Nevertheless, it appears that quite a large group of patients may be treated conservatively.

Retrospective analysis of 123 patients showed that 85 could be cured without the need of surgery and in 88% of them, the symptoms relieved within 48 hours (36). Similar results of conservative treatment were obtained ac-
According to another analysis where 73% of patients were effectively treated with conservative measures without observation of significantly increased mortality or strangulation (37). Prolonged treatment time exceeding 5 days was associated with ineffectiveness of conservative treatment (37). In such case, a surgery becomes a must. One of its methods is traditional laparotomy. Lysis of a single or multiple peritoneal adhesions eliminates the cause of the disease. In some cases, bowel resection with primary anastomosis is necessary. Surgeons experienced in laparoscopic procedures can use that technique. There are reports proving efficacy of that kind of treatment. Of 23 laparoscopic procedures for the small bowel obstruction, 20 were successful (38). Only in 3 cases, conversion to open surgery was needed (38).

Adhesive small bowel obstruction is a problem often encountered at surgical emergency all over the world. Its increasing incidence is the result of a large number of abdominal surgeries which are the main cause of development of peritoneal adhesions. For that reason, efforts are made to seek methods aiming at preventing peritoneal adhesions development. Deeper knowledge of adhesions development mechanisms directs actions toward a few areas – operative technique, methods to mitigate injured surfaces adherence, and pharmacological measures. Operative technique modifications are aimed at reduction in the perioperative trauma by minimal organ manipulations, avoiding tissue contact with foreign material, using lower voltage electrocoagulation. Important measure is utilization of nontalc gloves. Talc coming out of gloves is a foreign body with very strong power to develop peritoneal adhesions (39). Surgeon’s skills and experience are also of big importance. Animal leporine studies showed that longer duration of a surgery and bigger intraoperative bleeding were associated with a higher amount of peritoneal adhesions (40).

It seems that using the laparoscopic technique is another important element which can have an impact on a reduction in peritoneal adhesions development. Reduced perioperative trauma, smaller peritoneal incision, lower amount of foreign material inserted into the peritoneal cavity, smaller intraoperative bleeding, faster return of bowel motility, reduced organ manipulation unquestionably are important advantages which can help reduce the amount of peritoneal adhesions.

Nevertheless, the technique has some limitation. Improper surgical tool use can itself be the cause of organ injury. Laparoscopic technique by itself does not completely eliminate adhesions development (41). Another important factor is the impact of carbon dioxide insufflation. The amount of cold and dry gas pumped into the peritoneal cavity and duration of laparoscopic procedure increase the risk of peritoneal adhesions development (42). However, heating and watering of carbon dioxide allow eliminating the negative effect of insufflations (43). Another important factor in the prevention of peritoneal adhesions development is usage of biodegradable barriers separating injured organ surfaces. It is important that they stayed active for 5-7 days, which is the time needed for the new endothelium to develop. Administration of crystalloids was proved to be ineffective because of insufficient time of action. Dextran 70 solution caused a lot of undesirable effects (44, 45).

Currently studies are ongoing on other substances which can be left in the peritoneal cavity long enough, for example icodextrin and hyaluronic acid. Primary data showed that using 4% icodexan solution reduced the number of peritoneal adhesions developed after a surgery (46). The initial experiences were confirmed by the results of a multicentre ARIEL study (47). Reduced amount of adhesions was observed after both open and laparoscopic surgeries (47). What is significant, usage of that medicine is simple, acceptable and well tolerated by patients (47). Other reports also indicate that it is possible to obtain a reduction in peritoneal adhesions (48) but further studies on that issue are needed. Barriers such plates, gel or membranes separating injured organ surface are also available. One of the most often used materials of confirmed efficacy is Seprafilm (49) but its usage may increase the risk of leakiness of inter-intestinal anastomosis (50). Research has been conducted on the possibility to obtain a reduction in peritoneal adhesions development by a decrease in inflammatory response or interruption of connective tissue production. In animal studies, intramuscular and intraperitoneal administration of a nonsteroidal anti-inflam-
matory drug (nimesulide) caused a reduction in the amount of postoperative adhesions (51). This indicates the possibility for targeting further clinical studies. In contrast, using steroids was not effective in rats (52) and cause problems with wound healing. Positive effects were obtained during vitamin E administration in rats (53). A significant reduction in peritoneal adhesions after laparotomy compared to the control group was observed (53). However, as in the case of nimesulide, more research is needed.

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**CONCLUSIONS**

1. Recently, we have observed a significantly increasing number of patients with mechanical bowel obstruction.
2. Adhesive small bowel obstruction, especially following primary large bowel and gynaecological surgeries, constitutes a significant problem.
3. Gastrointestinal series may help decide whether to perform a surgery or safely continue with the conservative treatment.