Clinical Features of Gastrointestinal Tract Atresia of Surgically Treated Patients at the Pediatric Surgery Clinic, University Clinical Centre of Sarajevo in Time Period 2009-2018

Karavdić K\(^1\) *, Kafedžić A\(^2\), Maksić H\(^3\) and Pilav I\(^4\)

\(^1\)Department of Pediatric Surgery, University Clinical Center of Sarajevo, Bosnia and Herzegovina, Europe
\(^2\)Faculty of Medicine, University of Sarajevo, Bosnia and Herzegovina, Europe
\(^3\)Department of Neonatology, University Clinical Center of Sarajevo, Bosnia and Herzegovina, Europe
\(^4\)Department of Thoracic Surgery, University Clinical Center of Sarajevo, Bosnia and Herzegovina, Europe

Abstract

Introduction: Gastrointestinal tract atresia is one of the most common causes of neonatal intestinal obstruction [1]. Atresia represents discontinuity of a tubular organ, by definition. It represents one of the most common congenital anomalies of this organ system. Atresia can occur on any portion of the gastrointestinal tract. However, the most common locations are in the esophageal, jejunoileal and duodenal area. Symptomatology develops immediately after birth or during the following hours/days. Non-isolated appearance of gastrointestinal tract atresia indicates the complexity of these patients.

Objective: Evaluate the clinical features of gastrointestinal tract atresia on esophageal, duodenal, jejunoileal, colonic and anorectal level of surgically treated patients at the Pediatric surgery clinic of the University Clinical Centre of Sarajevo, in time period 2009-2018.

Methodology: A retrospective clinical study was carried out, covering 79 patients with confirmed diagnosis of gastrointestinal tract atresia. Demographic and clinical features were analysed, as well as the characteristics of the anomalies.

Results: 79 patients included in the study, 60.8% were male, 38% female, and 1.2% hermaphrodite. Esophageal atresia was diagnosed in 39.2%, duodenal in 11.4%, jejunoileal in 20.3%, colonic in 1.2% and anorectal in 27.9% cases. Prenatal diagnosis and polyhydramnios were noted in 19%. Associated anomalies were present in 58.2% of patients. In 69.6% cases, patients had the length of hospital stay shorter than 20 days. Postoperative complications occurred in 64.6% patients, while postoperative sepsis was noted in 29.1%. The overall mortality rate is 13.9%.

Conclusion: Preoperative/antenatal clinical features do not determine the characteristics of the gastrointestinal tract atresia. There is a significant impact of preoperative/antenatal factors on the treatment outcome of neonatal patients with gastrointestinal tract atresia. Furthermore, there is also a significant impact of clinical characteristics of neonatal patients with gastrointestinal tract atresia on the treatment outcome.

Keywords: Gastrointestinal tract atresia; Esophageal; Duodenal; Jejunoileal; Colonic; Anorectal; Clinical features

Introduction

Gastrointestinal tract atresia is one of the most common causes of neonatal intestinal obstruction [1]. Atresia represents discontinuity of a tubular organ [2]. It represents one of the most common congenital anomalies of this organ system [3]. Atresia can occur on any portion of the gastrointestinal tract. However, the most common locations are in the esophageal, jejunoileal and duodenal area [4]. Symptomatology develops immediately after birth or during the following hours/days [5]. Non-isolated appearance of gastrointestinal tract atresia indicates the complexity of these patients.

The embryonic development of GIT, due to its complexity, creates the opportunity for the development of various congenital anomalies of this organ system. Because developmental errors occur early in pregnancy, a woman may be exposed to a variety of risk factors [6-10].

A prenatal recording of an anomaly is also possible. Also, the presence of polyhydramnion may indirectly indicate this diagnosis [11,12].

The occurrence of GIT atresia with other co-morbidities has been reported, [13] and it is necessary to perform an adequate diagnostic
evaluation of these children and provide them with optimal care and treatment [14].

Numerous classifications of GIT atresia are based on the clinical characteristics of patients [15,16]. Examining their association with antenatal/preoperative and postoperative patient factors may lead to useful conclusions in the form of prognostic factors [17,18]. Accordingly, the impact of antenatal/preoperative factors on the outcome of these patients also needs to be examined.

Objective of the Research
The aim of the study is to evaluate the clinical features of gastrointestinal tract atresia on esophageal, duodenal, jejunoileal, colonic and anorectal level of surgically treated patients at the pediatric surgery clinic of the University Clinical Centre of Sarajevo, in time period 2009-2018.

Methodology
A retrospective-descriptive clinical study was conducted, using data from case histories of surgically treated patients at the KCUS Pediatric Surgery Clinic. Disease histories include discharge letters from the Pediatric Surgery Clinic and Neonatal Intensive Care Pediatric Clinics, surgery sheets, lab tests, histopathological findings, and temperature lists. The study included 79 surgically treated patients at the KCUS Pediatric Surgery Clinic, between January 2009 and December 2018, diagnosed with GIT atresia. Of the total number of patients, 31 had esophageal, 9 duodenal, 16 jejunoileal, 1 colon and 22 anorectal atresia.

The inclusion criteria for this research are
1. Patients who have been surgically treated for atresia at any level of GIT in a given period at the KCUS Pediatric Surgery Clinic.
2. Neonatal patients.

Exclusion criteria
1. Patients with incomplete medical records.
2. Patients with combined GIT atresia.
3. Non-surgically treated patients at the KCUS Pediatric Surgery Clinic.

Research methods
Patients were divided into 5 groups according to the level of atresia: group of patients with esophageal, group of patients with duodenal, group of patients with jejunoileal, group of patients with colonic and group of patients with anorectal atresia.

The following parameters were analyzed, divided into three groups:
1. Antenatal / preoperative characteristics
   • Demographic information (gender);
   • Pregnancy data (presence of polyhydramnion, antenatal diagnosis of atresia, presence of risk factors in pregnancy);
   • Birth data (APGAR score, birth weight, gestational age, mode of birth);
   • Associated congenital anomalies
2. Characteristics of the anomaly
3. Postoperative characteristics
   • The time of establishment of complete oral food intake;
   • Length of hospitalization;
   • Postoperative complications;
   • Mortality

Results of Research
A retrospective-descriptive study was conducted involving 79 surgically treated patients at the KCUS Pediatric Surgery Clinic, between January 2009 and December 2018, diagnosed with GIT atresia. Three patients were excluded from the study because of the presence of combined GIT atresia.

Of the total number of patients, 39.2% had esophageal, 11.4% duodenal, 20.3% jejunoileal, 1.2% colon and 27.9% anorectal atresia.

Of the 79 patients tested, 48 were male (60.8%), 30 were female (38%), and 1 was hermaphrodite (1.2%). (Figure 1) shows the gender distribution by GIT atresia level.

Figure 1: Gender distribution of anomalies.

Examining the distribution of gender anomalies in groups where the number of patients is greater than 1, we observed a significant difference in the test sample with the chi-square test values: $\chi^2 = 7.948$, $p=0.047 (<0.05)$. Details and possible complications during pregnancy were also examined.

Among mothers of children with esophageal atresia we found: cases of treated sterility (3.2%), endocrine disorders such as gestational diabetes mellitus and hypothyroidism (6.5%), umbilical artery syndrome (3.2%), and preeclampsia (3.2%). Progesterone therapy during pregnancy was reported in 9.7% of cases. Pregnancy smoking was reported in 11.1% of mothers of children with duodenal atresia. Hypothyroidism and smoking were present in mothers with jejunoileal atresia in 6.25% of cases. Progesterone use in pregnancy was reported in the same percentage. One of the mothers of children born with anorectal atresia had an abnormal karyotype, while treated sterility was reported in 4.5% of cases. Progesterone therapy during pregnancy was reported in 9.1% of cases.

The finding of polyhydramnion in patients with GIT atresia is 19%, as shown in (Figure 2). In the group of patients with esophageal atresia, polyhydramnion was present in 29% of cases. Patients with duodenal atresia experienced polyhydramnion in pregnancy in 22.2% of cases, whereas jejunoileal atresia occurred in 25% of cases.

Figure 3 shows the gestational age of the test sample. In the group
of patients with esophageal atresia, the proportion of prematures is 32.3%, in duodenal atresia this percentage is 55.6%, jejunoileal 37.5%, and anorectal 22.7%. The distribution of prematures and term babies according to the level of gastrointestinal atresia showed no statistical significance (p>0.05).

It is significant to note that chromosomal disorders occurred in patients with duodenal atresia in 22.2% of cases. In 100% of cases it was Down Syndrome. Chromosomal disorders also occurred in patients with esophageal, jejunoileal and anorectal atresia, but in a much smaller percentage.

Figure 6 present data on the length of hospitalization of patients according to the amount of gastrointestinal atresia.

Figure 7 show the time of establishment of complete oral food intake in the studied patients according to the level of gastrointestinal atresia.

Table 1 and Figure 4 present data on the birth weight of patients according to the level of gastrointestinal atresia. The percentage of patients with low birth weight per group for esophageal, duodenal, jejunoileal and anorectal atresia is chronologically: 32.3%, 66.7%, 31.3%, and 36.4%.

Table 1: Descriptive statistics of birth weight of the whole sample and individual anomalies.

<table>
<thead>
<tr>
<th>Birth weight (grams)</th>
<th>Median</th>
<th>Standard deviation</th>
<th>Median</th>
<th>Interquartile range</th>
</tr>
</thead>
<tbody>
<tr>
<td>The whole sample</td>
<td>2836.582</td>
<td>701.7325</td>
<td>2800</td>
<td>2312.5-3350</td>
</tr>
<tr>
<td>Esophageal atresia</td>
<td>2777.903</td>
<td>640.4084</td>
<td>2670</td>
<td>2337.5-3320</td>
</tr>
<tr>
<td>Duodenal atresia</td>
<td>2307.778</td>
<td>420.0231</td>
<td>2150</td>
<td>2000-2650</td>
</tr>
<tr>
<td>Jejunoileal atresia</td>
<td>3020.313</td>
<td>725.3883</td>
<td>2855</td>
<td>2425-2610</td>
</tr>
<tr>
<td>Anorectal atresia</td>
<td>3012.727</td>
<td>783.7467</td>
<td>3000</td>
<td>2400-3462.5</td>
</tr>
</tbody>
</table>

Of the total number of patients, 46(58.2%) had an associated anomaly of the gastrointestinal or other organ system. The percentage of associated anomalies relative to different organ systems can be seen in Figure 5. The percentage of patients with esophageal atresia and at least one associated anomaly is 61.3%. In the group of patients with duodenal atresia, this percentage is 44.4%. Jejunoileal atresia was followed by associated anomalies in 62.5% and anorectal in 59.1% [Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Text Box Tools tab to change the formatting of the pull quote text box].

In relation to the total number of patients with esophageal atresia, 71% of patients had some form of postoperative complications. In the case of anorectal atresia, postoperative complications occurred in 68.2% of cases, while at jejunoileal level, they occurred in 62.5% of patients.
Sepsis occurred in 29% of patients with esophageal atresia. At anorectal level atresia, this percentage was 27.3%, while in patients with jejunoileal atresia sepsis was observed in 37.5% of cases. The most common cause of sepsis was Acinetobacter baumanii, and the frequency and other causes can be seen in Figure 8.

Based on Figure 9, it is concluded that the highest number of patients with fatal outcome [11] is the percentage of children with esophageal atresia (7.6%). In the group of children with this anomaly, the mortality rate is 19.4%. In the groups of patients with jejunoileal and anorectal anomalies, mortality was 12.5% and 13.6%, chronologically. None of the 9 patients with duodenal atresia had a lethal outcome. Although we observed the highest mortality in patients with esophageal atresia, the incidence of fatal outcome in relation to gastrointestinal atresia did not show statistical significance (p>0.05).

In determining the eventual association between the anomaly classification results found and the antenatal/preoperative characteristics, the following results were observed.

From Table 2, it can be concluded that the classification of esophageal atresia according to Waterston was significantly associated with the presence of associated neonatal anomalies (p<0.001). The percentage of patients with associated anomalies is the highest in the Type C Waterston classification, resulting from its definition.

**Table 2: Summary of statistical significance of the association between esophageal atresia classifications and antenatal / preoperative clinical features ('Fisher’s exact test, **Freeman-Halton test, shaded fields show statistically significant data).**

<table>
<thead>
<tr>
<th>Antenatal / preoperative clinical features of esophageal atresia</th>
<th>Gross and Vogt classification</th>
<th>Waterston classification</th>
<th>Spitz classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>p=0.516</td>
<td>p=0.132</td>
<td>p=0.516</td>
</tr>
<tr>
<td></td>
<td>χ²=0.423</td>
<td>χ²=4.05</td>
<td>χ²=0.423</td>
</tr>
<tr>
<td>Gestational age</td>
<td>p=0.739</td>
<td>p=0.092**</td>
<td>p=0.739</td>
</tr>
<tr>
<td></td>
<td>χ²=1.11</td>
<td>χ²=0.111</td>
<td></td>
</tr>
<tr>
<td>Mode of birth</td>
<td>p=0.108*</td>
<td>p=0.194</td>
<td>p=0.835</td>
</tr>
<tr>
<td></td>
<td>χ²=3.276</td>
<td>χ²=0.043</td>
<td></td>
</tr>
<tr>
<td>Prenatal diagnosis of atresia</td>
<td>p=1*</td>
<td>p=1**</td>
<td>p=1*</td>
</tr>
<tr>
<td>The presence of polyhydramnion</td>
<td>p=0.322</td>
<td>p=0.445</td>
<td>p=0.322</td>
</tr>
<tr>
<td></td>
<td>χ²=0.98</td>
<td>χ²=1.619</td>
<td>χ²=0.98</td>
</tr>
<tr>
<td>Childbirth</td>
<td>p=0.739</td>
<td>p=0.107**</td>
<td>p=0.05</td>
</tr>
<tr>
<td></td>
<td>χ²=0.111</td>
<td>χ²=3.84</td>
<td></td>
</tr>
<tr>
<td>APGAR score</td>
<td>p=0.759</td>
<td>p=0.711</td>
<td>p=0.561*</td>
</tr>
<tr>
<td></td>
<td>χ²=0.094</td>
<td>χ²=0.683</td>
<td></td>
</tr>
<tr>
<td>Associated anomalies</td>
<td>p=0.619</td>
<td>p=0.001**</td>
<td>p=0.139*</td>
</tr>
<tr>
<td></td>
<td>χ²=0.247</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other antenatal / preoperative parameters showed no significant association with the type of esophageal atresia classification. However, the following trends have been observed.

Waterston’s classification of esophageal atresia showed a higher prevalence of male gender in Type A - 87.5%. According to the same classification, Type A has 100% preterm infants, as well as infants weighing between 2500 g and 4500 g.

According to the APGAR score, the lowest values were recorded in the Type B Waterston classification, where 25% of children had values lower than 7-7, and in the Type I Spitz classification, where this percentage was 22.2%.

However, it has been observed that Type I of this classification has 100% female patients. Also, in Type I, most children had a low birth weight (<2500 g), while in the Type III patient group, 100% of children had a birth weight in the range of 2500 g to 4500 g. Patients with Type III of this classification were born naturally in 83.3% of cases, compared to 66.7% of patients with Type I. The APGAR score in 100% of patients with duodenal atresia was above 7-7.

The association between the classification of jejunoileal atresia and antenatal/preoperative characteristics has not been observed to
be significant. However, some differences were noted. Type IIIA is characterized by 100% male patients and 80% neonatal birth weight between 2500g and 4500g. Type IIIB has 80% of term babies born. With duodenal atresia, 100% of patients with jejunoileal atresia had an APGAR score above 7-7. Associated anomalies were observed more frequently in Type IIIA and Type IIIB (80%) compared to Type IV (33.3%).

An examination of the classification of anorectal atresia and antenatal/preoperative characteristics showed no significant association. However, although not statistically significant, a large number of male children with high anorectal atresia were observed. Also, it was observed that 83.3% of children with high atresia were born at term.

The APGAR score in the group of patients with high anorectal anomaly was lower than 7-7 in 33.3% of cases. The existence of associated anomalies was observed in 75% of cases of high anorectal atresia, versus 40% of low ones.

The classification of esophageal atresia according to Gross and Vogt, the classification according to Waterston, and the classification according to Spitz did not show statistically significant influence on the postoperative clinical characteristics of the examined sample. However, the following trends have been observed.

It was observed that the length of hospitalization for Type A Waterston Classification was below 20 days in 71.4% of cases.

The time of establishment of complete oral food intake with the Type II Gross and Vogt classification, and with the Type A and C classification according to Waterston was within 100% of cases within the first 20 postoperative days.

The occurrence of postoperative complications was observed in 100% of the Type C cases according to Waterston.

The incidence of sepsis in Type I classification according to Gross and Vogt is 33.3%.

Mortality in the Type II Gross and Vogt classification, in the Type C Waterston classification and in the Type II Spitz classification is 25% each (Table 3).

Mortality in the Type II Gross and Vogt classification, in the Type C Waterston classification and in the Type II Spitz classification is 25% each. Esophagus atresia by Gross and Vogt, Waterston classification, and Spitz classification did not show statistically significant influence on the postoperative clinical characteristics of the examined sample. However, the following trends have been observed.

No statistical significance was observed in determining the influence of Gray and Skandalakis classification of duodenal atresia or jejunoileal atresia on the postoperative characteristics of patients (Table 4-7). However, the following trends are explained.

Table 4: Presentation of statistical analysis of influence of antenatal/preoperative characteristics of patients with esophageal atresia on their postoperative clinical characteristics-length of hospitalization and time of establishment of complete oral food intake (*Fisher’s exact test, shaded fields show statistically significant data).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Length of hospitalization</th>
<th>Time of establishing complete oral food intake</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p=0.022</td>
<td>p=0.418</td>
</tr>
<tr>
<td></td>
<td>χ²=5.231</td>
<td>χ²=0.655</td>
</tr>
<tr>
<td>Gestational age</td>
<td>p=0.709</td>
<td>p=0.005*</td>
</tr>
<tr>
<td></td>
<td>χ²=7.14</td>
<td></td>
</tr>
<tr>
<td>Mode of birth</td>
<td>p=0.815</td>
<td>p=0.502</td>
</tr>
<tr>
<td></td>
<td>χ²=0.055</td>
<td>χ²=0.451</td>
</tr>
<tr>
<td>Prenatal diagnosis of atresia</td>
<td>p=0.452*</td>
<td>p=0.179*</td>
</tr>
<tr>
<td>The presence of polyhydramnion</td>
<td>p=0.959</td>
<td>p=0.678</td>
</tr>
<tr>
<td></td>
<td>χ²=0.003</td>
<td>χ²=0.172</td>
</tr>
<tr>
<td>Childbirth</td>
<td>p=0.252</td>
<td>p=0.932</td>
</tr>
<tr>
<td></td>
<td>χ²=1.312</td>
<td>χ²=0.007</td>
</tr>
<tr>
<td>APGAR score</td>
<td>p=0.239</td>
<td>p=1*</td>
</tr>
<tr>
<td></td>
<td>χ²=1.389</td>
<td></td>
</tr>
<tr>
<td>Associated anomalies</td>
<td>p=0.293</td>
<td>p=0.418</td>
</tr>
<tr>
<td></td>
<td>χ²=1.106</td>
<td>χ²=0.655</td>
</tr>
</tbody>
</table>

Table 5: Presentation of statistical analysis of influence of antenatal/preoperative characteristics of patients with esophageal atresia on their postoperative clinical characteristics - postoperative complications, sepsis occurrence and mortality (*Fisher’s exact test, shaded fields show statistically significant data).

<table>
<thead>
<tr>
<th>Postoperative complications</th>
<th>Povaja postoperative complications</th>
<th>Sepsis</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>p=0.472</td>
<td>p=0.324</td>
<td>p=0.902</td>
</tr>
<tr>
<td></td>
<td>χ²=0.518</td>
<td>χ²=0.974</td>
<td>χ²=0.015</td>
</tr>
<tr>
<td>Gestational age</td>
<td>p=0.445</td>
<td>p=0.935</td>
<td>p=0.301</td>
</tr>
<tr>
<td></td>
<td>χ²=0.585</td>
<td>χ²=0.007</td>
<td>χ²=1.072</td>
</tr>
<tr>
<td>Mode of birth</td>
<td>p=0.959</td>
<td>p=0.008</td>
<td>p=0.517</td>
</tr>
<tr>
<td></td>
<td>χ²=0.003</td>
<td>χ²=7.039</td>
<td>χ²=0.42</td>
</tr>
<tr>
<td>Prenatal diagnosis of atresia</td>
<td>p=1*</td>
<td>p=0.29*</td>
<td>p=1*</td>
</tr>
<tr>
<td>The presence of polyhydramnion</td>
<td>p=0.736</td>
<td>p=0.736</td>
<td>p=0.457</td>
</tr>
<tr>
<td></td>
<td>χ²=0.114</td>
<td>χ²=0.114</td>
<td>χ²=0.552</td>
</tr>
<tr>
<td>Childbirth</td>
<td>p=0.445</td>
<td>p=0.353</td>
<td>p=0.045</td>
</tr>
<tr>
<td></td>
<td>χ²=0.585</td>
<td>χ²=0.862</td>
<td>χ²=4.031</td>
</tr>
<tr>
<td>APGAR score</td>
<td>p=0.145*</td>
<td>p=0.024</td>
<td>p=0.853</td>
</tr>
<tr>
<td></td>
<td>χ²=5.115</td>
<td>χ²=5.115</td>
<td>χ²=0.304</td>
</tr>
<tr>
<td>Associated anomalies</td>
<td>p=0.66</td>
<td>p=0.472</td>
<td>p=0.527</td>
</tr>
<tr>
<td></td>
<td>χ²=0.194</td>
<td>χ²=5.518</td>
<td>χ²=0.54</td>
</tr>
</tbody>
</table>

The length of hospitalization in Type III of this classification was 100% shorter than 20 days. Postoperative complications occurred in 66.7% of patients with Type I. Sepsis was observed in 66.7% of
patients with Type I, while no cases in Type III were noted. There were no lethal outcomes in this patient group.

The classification of jejunoileal atresia and postoperative complications showed no significant association. It was observed that the length of hospitalization for Type IIIA was less than 20 days in 80% of cases. The presence of postoperative complications was observed in 100% of patients with type III. Type IV was followed with the highest percentages of sepsis, in as many as 66.7% of cases, while no type IIIB was reported. No death was reported in any type IIIB patient. Mortality was highest in type IIIA, where it was 20%. Type IV mortality is 16.7%.

When analyzing the influence of the classification of anorectal atresia on the postoperative clinical characteristics of the test sample, a significant influence of the characteristics of anorectal atresia was observed at the time of complete oral food intake (p=0.025, $\chi^2=5.051$). Patients with low anorectal atresia achieved complete oral food intake in 72.7% of cases within 10 days of surgery. In contrast, only 22.2% of patients with high anorectal atresia established oral intake during this period. Postoperative complications occurred in 83.3% of patients with high anorectal atresia, compared with 50% of cases of low anorectal atresia.

Sepsis occurred in 41.7% of patients with high anorectal atresia as opposed to 10% of patients with low. Also, it was observed that 25% of patients with high anorectal atresia had a fatal outcome, while there were no lethal outcomes in the group of patients with low anorectal atresia.

The following results were observed when analyzing the influence of antenatal/preoperative parameters on the postoperative clinical characteristics of the test specimen.

There was a significant effect of gender on the length of hospitalization of these patients (p=0.022, $\chi^2=5.231$). It was observed that 70% of male patients were hospitalized for less than 20 days as opposed to 27.3% of female patients.

There was a significant effect of gestational age on the time of establishment of complete oral food intake in patients with esophageal atresia (p=0.005). It was observed that 100% of patients born at term had a healthy oral food intake within 20 days of surgery.

Although statistically insignificant, the following percentages were observed. In 86.7% of cases of naturally occurring esophageal atresia, the time required to establish complete oral food intake was less than 20 days. Patients with APGAR score less than 7-7 had a hospitalization length of more than 20 days in 66.7% of cases.

There was a significant influence of the mode of birth of children with esophageal atresia on the incidence of postoperative sepsis (p=0.008, $\chi^2=7.039$). It was observed that 35.7% of children born by caesarean section had postoperative sepsis, compared to 23.5% of children born naturally.

There was a significant effect of birth weight on the mortality of children with esophageal atresia (p=0.045, $\chi^2=4.031$). Children with low birth weight in this group had a lethal outcome in 40% of cases, compared with 9.5% of children with childbirth in the range of 2500 g to 4500 g.

There was a significant effect of APGAR score on the postoperative onset of sepsis (p=0.024, $\chi^2=5.115$). As many as 66.7% of patients with values lower than 7-7 had sepsis, compared to 20% of patients with higher values. Although statistically insignificant, the following results are also presented.

The occurrence of postoperative complications in female patients was observed in 81.8% of cases, as opposed to their occurrence in male patients in 70% of cases.

Postoperative complications in preterm children with esophageal atresia were reported in 80% of cases. The death rate of children in this group is 30%.

The incidence of postoperative complications was reported in 71.4% of cases of patients with esophageal atresia born by caesarean section.

The presence of polyhydramnion during pregnancy in children with esophageal atresia was followed by a mortality rate of 11.1%, as opposed to patients without the presence of polyhydramnion in which the It was observed that 100% of male patients were hospitalized for less than 20 days, and that the time taken to establish complete oral food intake was less than 10 days.

It was observed that 100% of children with a birth weight between 2500 and 4500 g had a hospitalization of less than 20 days.

Children born in the normal term with duodenal atresia had
hospitalizations shorter than 20 days in 100% of cases, compared with 80% of preterm children.

No statistical significance of the influence of antenatal/preoperative parameters of patients with duodenal atresia on outcome was demonstrated (Table 2).

Postoperative complications in patients with duodenal atresia did not occur in male patients, whereas in female patients they occurred in 42.9% of cases.

The occurrence of postoperative complications in preterm children occurred in 20% of cases, while in term children it occurred in 50% of cases.

Postoperative sepsis was not observed in patients diagnosed with polyhydramnion during pregnancy, compared to 28.6% of children without recorded polyhydramnion.

Male patients with jejunoileal atresia were hospitalized for less than 20 days in 80% of cases, compared with 50% of female patients.

Urgent patients had a hospitalization length of less than 20 days in 80% of cases, whereas in preterm patients this length of hospitalization was present in 50% of cases.

Patients with a birth weight between 2500 g and 4500 g had a hospitalization of less than 20 days in 81.8% of cases, compared with 40% of children of low birth weight.

The length of hospitalization in patients with jejunoileal atresia without associated anomalies was shorter than 20 days in 83.3% of cases, as opposed to the group with associated anomalies where this percentage was 60%.

A significant effect of prenatal diagnosis of jejunoileal atresia on the incidence of postoperative complications was observed (p=0.039, $\chi^2=4.267$). Children with prenatal diagnosis of atresia had postoperative complications in 37.5% of cases, as opposed to children without prenatal diagnosis where complications occurred in 87.5% of cases.

Also, there was a significant effect of birth weight on the incidence of postoperative complications in patients with jejunoileal atresia (p=0.018, $\chi^2=5.605$). Postoperative complications occurred in 81.8% of patients of birth weight between 2500 g and 4500 g, while in children with a birth weight of less than 2500 g they occurred in 20% of cases.

Although statistically insignificant, the following results are also presented. Occurrence of postoperative sepsis was observed in 40% of male patients, while in female patients it occurred in 33.3% of cases. Postoperative complications occurred in 80% of term children as opposed to 33.3% of premature infants. Sepsis occurred in 50% of preterm infants, while in 30% of cases it occurred in term neonates.

The incidence of postoperative sepsis in patients with low birth weight was reported in 60% of cases of jejunoileal atresia, compared with 27.3% in children of birth weight between 2500 g and 4500 g.

The mortality rate of children with jejunoileal atresia whose mothers had registered polyhydramnion during pregnancy is 25%, compared to those who are not, whose mortality is 8.3%.

The lethal outcome of patients in this group with associated anomalies was reported in 20% of cases, whereas no such outcome was observed in patients without comorbidity.

The patient with colon atresia was hospitalized for less than 20 days, and complete oral food intake was established within the first 20 postoperative days. Peritonitis has been reported postoperatively. It had no lethal outcome. There was a significant effect of the birth rate of these patients on the length of hospitalization (p=0.046). Patients born naturally were hospitalized in less than 20 days in 93.8% of cases, while caesarean section patients had this length of hospitalization in 50% of cases.

There was a significant influence of the mode of birth of patients with anorectal atresia on the time of complete oral food intake (p=0.003). Natural-born patients in 76.9% of cases had complete oral food intake within the first 10 postoperative days, whereas no such case was noted in patients born by cesarean section.

There was a significant effect of the existence of associated anomalies on the time of establishment of complete oral food intake in patients with anorectal atresia (p=0.025, $\chi^2=5.051$). Patients with associated anomalies in 27.3% of cases established complete oral nutrition within the first 10 postoperative days, as opposed to 77.8% of patients without associated anomalies. Although statistically insignificant, the following observations are presented.

The length of hospitalization of female patients with anorectal atresia was shorter than 20 days in 100% of cases, and the time to establish complete oral nutrition in 80% of cases was within the first 10 postoperative days.

The time of establishment of regular oral food intake in term patients was shorter than 10 days in 57.1% of cases.

In the group of patients with anorectal atresia, 85.7% of patients of birth weight between 2500 g and 4500 g had a hospitalization of less than 20 days.

No patients with an APGAR score below 7-7 failed to complete oral food intake within the first 10 postoperative days, compared to 58.8% of patients with higher values for this score.

Discussion

GIT atresia is a relatively common congenital anomaly, whose symptomatology is presented in the first days after birth. Consequently, if there is no prenatal diagnosis of atresia, the postnatal diagnosis should be timely. The definitive treatment is surgical. However, like any surgery, it is accompanied by a high risk of postoperative complications, which affect the length of hospitalization of patients.

The mortality of patients with GIT atresia depends not only on the timing and consequences of surgery, but also on the associated congenital anomalies. Also, the timing of the start of oral food intake, as well as the time of establishment of a complete oral diet, effect on length of hospitalization and the final outcome.

Accordingly, examining the influence of antenatal/preoperative factors on the prognosis of patients, as well as examining the association between anomaly characteristics and the above parameters, can provide insight into predictive factors.

Our study included 79 patients with a proven diagnosis of GIT atresia. Data on 31 patients with esophageal, 9 with duodenal, 16 with jejunoileal, 1 with colon and 22 with anorectal atresia were collected. No patients with pyloric atresia were noted. Of the total number of patients with gastrointestinal atresia, 39.2% belong to esophageal atresia.
An analysis of our sample of patients with esophageal atresia revealed a higher percentage of boys. Also, according to a study by Xiao-Wen Li et al. [19] at Chongqing Medical University Children’s Hospital, based on a sample of 198 patients with esophageal atresia, 60.6% of the patients were male. This percentage is similar to ours, where 20 of 31 patients are male (64.5%).

The Sfeir et al. [20] study, based on 307 patients diagnosed with esophageal atresia in 38 medical centres, shows a male-to-female ratio of 1.3. This ratio for our sample is 1.6.

The effect of gender on length of hospitalization was found to be significant in our study (p<0.05). The hospitalization time for girls was significantly longer than the hospitalization time for boys. A study by Exelius J et al. [21] states that hospitalization times were significantly longer in boys.

Our study also demonstrates an association between APGAR score and postoperative sepsis (p<0.05). According to the Sugito K et al. [22] retrospective study, based on data from a 28-year period, APGAR scores significantly influence the mortality of children with esophageal atresia. Similar results are shown by a study conducted by Vukadin M et al. [23].

The presence of polyhydramnion in pregnancy was observed in 29% of patients with esophageal atresia. A Pretorius D et al. [24] study on prenatal diagnosis of esophageal atresia and TEF reported that polyhydramnion was present in 62% of cases.

The significantly low percentage of prenatal diagnosis of polyhydramnion in our sample may be due to inadequately controlled pregnancies or inadequately kept medical records.

In our sample, 32.3% of patients with esophageal atresia were premature. The Li XW et al. [19] study mentioned earlier states that this percentage is 16.7%. The Sulkowski JP et al. [25] study, conducted on 3479 patients, states that 37% of children were born prematurely.

A De Jong et al. [26] study reports significantly higher mortality in preterm infants with this anomaly. The effect of gestational age on the postoperative clinical parameters of this group of patients in our study is significant only when the time of complete oral food intake is established (p<0.05).

Sulkowski JP et al. [25] also stated that 83.5% of the children tested had at least one associated anomaly of the gastrointestinal or any other organ system. Our study shows that 61.3% of patients had esophageal atresia associated with other anomalies. Although the Sulkowski study was conducted on a much larger sample than ours, the percentage of associated anomalies is much higher. However, a study by Tandon et al. [27] although 127 patients were reported, reported that associated anomalies occurred in a much smaller percentage, 41%.

Li XW et al. [19] stated that 24.7% of patients with esophageal atresia had low birth weight (<2500 g). In our study, this percentage is 32.3%. This information can be explained by the fact that the Li XW study had two times lower percentage of preterm babies than ours.

Our study proved that there was a significant effect of birth weight of these patients on mortality (p<0.05). A study conducted by Choudhury on 240 patients did not prove a statistically significant association between the two factors [28].

According to the Li XW et al. [19] Study, the incidence of postoperative sepsis in this group of patients is 6.1%. Our study showed that there was a significant effect of the mode of birth of patients with esophageal atresia on the incidence of postoperative sepsis (p<0.05).

Sfeir et al. [20] cites 5% patient mortality from his study. Lal DR et al. [29] reported a mortality rate of 7.5%, which was significantly associated with the presence of associated anomalies. A slightly higher mortality was recorded by the Chang EY et al. [30] study where this percentage is 15.3%. 19.4% of patients with esophageal atresia had a lethal outcome in our study. This percentage, although closer to the last study cited, is still significantly higher than the others. This may be due to inadequate preoperative treatment of patients before their arrival at the KCUS Pediatric Surgery Clinic or the presence of severe associated anomalies, which affected the final outcome.

Considering the classification of esophageal atresia, the Lal DR et al. [29] study states that according to the Gross and Vogt classification, Type I was observed in 85% of cases, while Type II was present in 7% of cases.

Bakal U et al. [31] cites the same results in his study. In our Type I study, 87.1% of patients had this classification. Type II was represented in 12.9% of cases. Our study did not record other types of this classification.

A study conducted in France on patients with esophageal atresia Type I Gross and Vogt classifications showed the presence of prenatal diagnosis of atresia in 85.2% of cases [32]. However, the prognosis of these patients is not significantly conditioned by prenatal diagnosis [32]. Our study also failed to demonstrate a significant effect of prenatal diagnosis on the final outcome of patients.

Waterston’s classification was used in a Canadian study by Konkin when examining its association with the prognosis of patients with esophageal atresia [33]. There was 20% mortality in Type C of this classification, while no other deaths were reported in the other two types [33]. In our study, the mortality in the Type C Waterston classification is 25%. The high mortality of this type of this classification is justified by its criteria (birth weight below 1800 g or the presence of severe pneumonia or several associated anomalies).

In the same study, the Spitz classification was used, with a mortality of 1% for Type I, 16% for Type II and 57% for Type III [33]. Within this classification, in our study, the percentage of the highest mortality was in Type II, where it was 25%. Such a high mortality is explained by the fact that this group includes children with a birth weight below 1500 g or with a large heart defect. None of the patients included in our study belonged to Type III of this classification.

Postoperative complications occurred in 62% of patients in the Lal DR et al. [29] study. In the patients with esophageal atresia of our study, postoperative complications occurred in a higher percentage, in 71% of cases.

Our study demonstrated a significant association of esophageal atresia characteristics with the presence of associated anomalies (p<0.05). However, this significance arises from the very definition of types of esophageal atresia by classification and is not considered relevant.

Duodenal atresia is represented in 11.4% of all gastrointestinal atresia observed. A study by Choudhry et al. [34] on a sample of 61 patients with duodenal atresia showed that 57.4% were male and 42.6% female. The Grosfeld et al. [35] study was performed on 103
patients and described 57.3% of female patients and 42.7% of male patients. In our sample of 9 patients, 2 were male (22.2%) and 7 were female (77.8%). Different studies show a different representation of this anomaly by gender, depending on the sample observed.

Choudhry et al. [34] research showed that 57% of patients had a congenital anomaly. A study by Grosfeld et al. [35] found that associated anomalies occurred in 52.4% of cases. Also, as many as 30.1% of patients have Down syndrome [35]. The Burjonrappa et al. [36] study reports that associated anomalies occur in 76% of duodenal atresia cases. Our study reported the presence of associated anomalies in 44.4% of cases. The diagnosis of Down syndrome was confirmed in 22.2% of children. Percentage disproportions may be due to sample size.

In Grosfeld’s study, 44.7% of preterm births were reported [35]. In our study, this percentage is 55.6%.

A Dalla Vecchia et al. [37] study performed on 277 patients with intestinal atresia suggests that mortality within the group of patients with duodenal atresia is 4%. Within our sample, no lethal outcome was reported, despite the high proportion of patients with associated anomalies. Jejunoileal atresia accounts for 20.3% of the gastrointestinal atresia examined.

Of the 16 patients with jejunoileal atresia, 10 were male (62.5%). A Calisti et al. [38] study on 43 patients with jejunoileal atresia reported that the percentage of boys was 58.1% and that of girls was 41.9%. A study conducted by Ekwnufie et al. [39], based on 9 patients with the same anomaly, states that the percentage of boys is 77.8%. On the basis of the above, it can be assumed that jejunoileal atresia occurs somewhat more frequently in male patients.

In a study by Calisti et al. [38], the median birth weight of newborn is 2644 g. Our study records the median birth weight of patients with atresia at a jejunoileal level slightly higher 2855 g. A study done by Ekwnufie et al. [39] in Nigeria reports a birth weight range of 1700 g to 3000 g. Our study demonstrates a significant effect of the birth weight of children with jejunoileal atresia on the onset of postoperative complications (p<0.05). Calisti et al. [38] states that prenatal diagnosis only existed in 34% of cases, and that it has no significant effect on the outcome. In our study, no significant effect of prenatal diagnosis of jejunoileal atresia on the mortality of these patients was demonstrated.

However, there was a significant effect of prenatal diagnosis on the incidence of postoperative complications (p<0.05).

The Burjonrappa S et al. [36] study reported that postoperative complications occurred in 52% of patients. The Ekwnufie et al. [39] study states that this percentage is 55, 6% in their sample. Our study cites this percentage at 62.5%.

Based on the classification of jejunoileal atresia, a Subbarayan et al. [40] study states that the most common type was Type II. On the other hand, Ekwnufie et al. [39] states that the most common type was Type I. The most common type of jejunoileal atresia according to this classification in our study is Type IV (37.4%). Our study has Type IIIA and Type IIIB equally represented. Their percentage in the total number of patients with jejunoileal atresia is 31.3% each. Type I and Type II are not registered.

Mortality is 0.8% according to the Dalla Vecchia et al. [37] study. Mortality was significantly higher in the Sweeney and Ekwnufie et al. [39,41] studies, in which it was, chronologically, 16% and 33.3%, respectively. Patients with Type IIIB and IV had the highest mortality [39]. Mortality in the group of patients in our sample with jejunoileal atresia was 12.5%. The same mortality rate was reported in a study of 24 patients with jejunoileal atresia [42]. In our study, the mortality was highest in Type IIIA (20%). Type IV mortality is 16.7%.

Our study has only one patient with colon atresia, representing 1.2% of the total number of gastrointestinal atresia’s included in the study. According to the Etensel et al. [43] study, 3.7% of the total number of gastrointestinal atresia’s were colonial. A slightly higher percentage was observed in the El-Asmar et al. [44] study at Ain Shams University, performed on 12 patients, where it was 4.9%.

Based on the internationally used classification of colonial atresia, in the Etensel et al. [43] study 66.7% of patients belonged to Type III, 22.2% to Type II, and 11.1% to Type IV. The El-Asmar et al. [44] study states that out of 12 patients with colon atresia, 1 patient had Type II, 4 Type II, 6 Type IIIA and 1 Type IV patient. Our patient belongs to Type IV of this classification.

According to the Burjonrappa et al. [36] study, 38% of colonial atresia cases were accompanied by associated anomalies. A similar result was found in the Etensel et al. [43] study, where this percentage is 33%. In the El-Asmar et al. [44] study, it is as high as 58.3%. However, our patient did not have any associated anomalies.

According to the Dalla Vecchia et al. [37] study, mortality in patients with colon atresia is 0%. Since our patient did not have a lethal outcome, mortality has the same value in our group.

Due to the low incidence of colon atresia, there is a risk of late diagnosis and treatment initiation [43]. The timely detection of this anomaly allows for early correction and is associated with a good outcome [43].

Of the total number of patients with gastrointestinal atresia, anorectal atresia was present in 27.9% of cases.

Within the group of patients with anorectal atresia [25], 16 were boys (72.7%), 5 girls (22.7%) and 1 hermaphrodite (4.6%). The Mittal et al. [45] study cites the percentage of males in 57.1% of cases and of females in 42.9%.

Our study demonstrates a significant effect of the mode of birth of children with anorectal atresia on the length of hospitalization (p<0.05). Also, significant influence of birth method on the time of establishment of complete oral food intake of these children (p<0.05) was demonstrated.

According to Ameh’s et al. [46] study, the most common cause of neonatal intestinal obstruction was anorectal atresia, which occurred in 68.9% of cases. Of these, 86.5% were high and 13.5% were low anorectal atresia.

Our study proved that there was a significant effect of classification of anorectal atresia on the time of complete oral food intake (p<0.05).

The presence of associated anomalies in patients with anorectal atresia was observed in our study in 59.1% of cases. According to Harris et al. [47], based on a study of 12 patients, that percentage is 92%. The Mittal et al. [45] study reports this data at the levels of high and low anorectal atresia, which occurred with associated anomalies in 78.08% and 37.31% of cases, respectively. According to our study, no significant association was observed between the characteristics
of anorectal atresia, in the form of division into high and low, and the existence of associated anomalies. However, there was a significant effect of the associated anomalies in these patients with the time to complete oral food intake (p<0.05).

The Harris et al. [47] study reported the mortality of these patients in 41.7% of cases. Our study shows a significantly lower mortality rate of 13.6%.

Prenatal diagnosis of GIT atresia and the presence of polyhydramnion during pregnancy were present in 19% of our study. The finding of polyhydramnion, although nonspecific, may cast doubt on this type of anomaly. Better pregnancy management and prenatal diagnosis also reveal associated anomalies, which, according to our study, were present in 58.2% of children. In this way, the readiness of the gynaecologist, neonatologist, pediatric surgeon, and anesthesiologist for post-natal treatment of the infant can be optimized and antenatal counselling of the parents can be discussed.

Conclusion
Preoperative/antenatal factors do not affect the clinical features of gastrointestinal atresia. Preoperative/antenatal factors have implications for the final outcome of treatment of infants with gastrointestinal atresia, and future research should be based on a more thorough examination of this effect.

The clinical characteristics of infants with gastrointestinal atresia affect the endpoint of treatment. The use of internationally recognized classifications, including the care and treatment of neonatus, should be widespread in clinical practice.

Knowledge of risk factors and prevention of their effects on the fetus may reduce the incidence of gastrointestinal tract atresia’s as well as other congenital anomalies.

Adequate pregnancy management and prenatal diagnosis can diagnose gastrointestinal atresia as well as associated anomalies, thus optimizing the readiness of the gynaecologist, neonatologist, pediatric surgeon, and anesthesiologist for postnatal treatment of the infant, and providing antenatal counselling for parents.

Despite numerous scientific studies based on this topic and the development of neonatal surgery, mortality accompanying gastrointestinal atresia is still significant, and adequate treatment requires the existence of special centers dealing with this pathology, as well as specially trained teams consisting of gynaecologists, neonatologist, neonatal surgeon and anesthesiologist.

References


