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Anorectal anomalies: anorectal manometric function and anal endosonography in relation to functional outcome

Abstract To assess the relation between continence and the manometric and endosonographic state of the anorectal segment after surgery for anorectal anomalies (ARA), 33 adolescents operated upon for ARA and 14 controls were examined. Seventeen patients had low and 16 intermediate or high ARA. Fecal continence was recorded, and anal canal manometry was performed by microtransducer. The sphincter muscle complex and its relation to the anal opening was visualized by anal endosonography (ES). Ten patients had perfect continence, 10 had staining, and 13 had soiling. The anal canal resting and squeeze pressures were significantly different in all three groups, and continence function was significantly correlated to anal canal pressures. By anal ES, the internal (IAS) and the external anal sphincters (EAS) were identified with various amounts of scar tissue in all patients. In patients with high or intermediate anomalies the IAS was missing in the lower part of the anal canal, and abundant scar tissue was identified in the EAS in all patients. In patients with good continence function, the EAS was better preserved than in patients with major incontinence. The position of the anus in the EAS muscle complex was assessed, and varying degrees of eccentrically placed anal canals were identified. Continence function after surgery for ARA is thus correlated to anal canal pressures and ES images. ES, which is painless and suitable for use in children, is a valuable tool for assessing perianal structures, and the findings may serve as a helpful guide for corrective surgery.

Key words Anorectal malformations · Anal endosonography · Anal manometry

Introduction

Much attention has been paid to the operative approaches for anorectal malformations (ARM) and their functional outcome [10, 19, 20, 23, 24]. Even though anal canal manometry has been used in some series [11, 16], there is still a substantial lack of objective criteria and international standardization for assessing the functional outcome after surgery for ARM.

Recently, anal endosonography (ES) has been introduced for examination of the structures surrounding the anal canal [13]. The method has proven useful for mapping of sphincter defects in patients with anal fistulas and abscesses [14, 15, 17] as well as for evaluation of the sphincters in neurologic disease [6], idiopathic fecal incontinence [7], and, most recently, in patients with low ARM [8]. The aim of the present study was to assess the function and morphology of the anal sphincters by manometry and anal ES in patients operated upon for high and low ARM and normal controls.

Materials and methods

Forty-seven adolescents with median age 16 years (range 10–20), 17 with low (8 boys/9 girls), 16 (8 boys/8 girls) with intermediate/high ARM, and 14 controls (7 boys/7 girls) were examined. The diagnostic groups were well matched with respect to age (intermediate/high: mean = 15.8 [range 14.6–17.1] years; low: 14.9 [13.7–16.2] years; normals 15.9 [14.6–17.3] years; P = 0.58) and sex. The patients had undergone sacroperineal, sacroabdomino-perineal, abdo-mino-perineal, or perineal procedures according to the actual malformation. Fecal continence was graded 1–4: 1: continent for liquids, solids, and gas; 2: occasionally incontinent for loose stools;
3: incontinent for loose and sometimes for solid stools; and 4: incontinent for loose and solid stools. Manometry was performed with a 2-mm-diameter microtransducer (Camtec, Norway) measuring maximal anal canal resting pressure and maximal squeezing increments.

Anal canal ES was performed with a 7.5-MHz rotating transducer of 2–5 cm focal length (Bruel & Kjaer, Norway). The transducer was covered with a hard, sonolucent plastic cone (diameter 16 mm) and filled with degassed water. The probe was inserted with the subject in the left lateral position, and serial images were taken from the level of the puborectal muscle 3 to 4 cm from the anal verge and throughout the anal canal. According to Law and Bartram [13], the internal anal sphincter (IAS) was defined as the hypoechoic zone adjacent to the hyperechogenic mucosal zone (Fig. 1). The external anal sphincter (EAS) was defined as the hyperechogenic zone immediately outside the IAS and encircled by the less echogenic fatty tissue with a more scattered pattern in the ischiorectal fossa (Fig. 1) [1, 18]. The EAS muscle complex and its relation to the anal opening was assessed.

All continuous variables were found to be normally distributed except for squeeze pressure, which had to be square-root transformed. If not otherwise stated, data were given as means with 95% confidence interval. Although continence was a discrete variable, it was used as a continuous dependent variable in multiple regression analysis since the residuals were normally distributed. Dependency between sets of variables involving ordinal data was expressed through the non-parametric Spearman correlation coefficient. Two-way ANOVA with interaction was used to examine the dependence of continence and resting and squeeze pressures on the factors diagnosis (intermediate/high, low, normal) and sex. Stepwise regression analysis was used to identify the variables contributing significantly to the variance of continence, starting with age at examination, sex, and resting and squeeze pressures as independent variables. Subgroup differences were located by means of the Student-Newman-Keul post hoc test. Two-tailed P values less than 0.05 were considered significant.

**Results**

**Continence**

Ten patients (9 with low ARM, one with high) had perfect continence, 10 had staining (grade 2), and 13 had soiling (grade 3-4). Among patients with low anomalies, the males had a mean continence grade of 1.3 versus 1.9 in the females, whereas in the other groups the continence function was the same for both sexes (Table 1). Two-way ANOVA, however, showed no significant dependence on the factor sex (F1,41 = 1.1; P = 0.3), while there was significant dependence on diagnosis (F2,41 = 32.7; P < 0.0001), all three groups being significantly different (Table 1). The adolescents with low anomalies had significantly better continence than those with high or intermediate ARM, and both groups were significantly worse than the controls. There was no significant factor (sex·diagnosis) interaction.

**Anal canal pressures**

The resting pressure showed no sex dependence (F1,41 = 0.8; P = 0.4), while there was significant diagnosis dependence (F2,41 = 69.0; P < 0.0001). Thus, the resting pressures were significantly different in all three groups, being highest in the controls, intermediate in patients with low, and lowest in patients with high/intermediate ARM. The squeeze pressure was significantly higher in boys than in girls (F1,41 = 15.7; P < 0.0005) and was significantly different in all diagnostic groups (F2,41 = 22.1; P < 0.0001) (Table 1).

**Variable correlation**

Correlation coefficients between the different variables are shown in Table 2. There was a significant correlation between continence and anal canal resting pressure (r = -0.82, P < 0.0001) and between continence and squeeze pressure (r = -0.80, P < 0.0001). Furthermore, there

**Table 1** Sex, number of patients, continence, resting pressure, and squeeze pressure in each subgroup (mean values and 95% confidence intervals)

<table>
<thead>
<tr>
<th>Category of malformation</th>
<th>Sex (no. of patients)</th>
<th>Continence</th>
<th>Resting pressure (cm H₂O)</th>
<th>Squeeze pressure (cm H₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High/intermediate</td>
<td>Girls(8)</td>
<td>3.0(2.5-3.5)</td>
<td>34(24-45)</td>
<td>29(10-67)</td>
</tr>
<tr>
<td></td>
<td>Boys(8)</td>
<td>3.0(2.5-3.5)</td>
<td>29(19-40)</td>
<td>60(21-98)</td>
</tr>
<tr>
<td>Low</td>
<td>Girls(9)</td>
<td>1.9(1.4-2.4)</td>
<td>56(46-66)</td>
<td>61(25-98)</td>
</tr>
<tr>
<td></td>
<td>Boys(8)</td>
<td>1.3(0.7-1.8)</td>
<td>76(66-87)</td>
<td>143(104-181)</td>
</tr>
<tr>
<td>Controls</td>
<td>Girls(7)</td>
<td>1.0</td>
<td>96(85-107)</td>
<td>138(97-179)</td>
</tr>
<tr>
<td></td>
<td>Boys(7)</td>
<td>1.0</td>
<td>92(81-103)</td>
<td>214(173-256)</td>
</tr>
</tbody>
</table>

Fig. 1 Normal anal canal with inner, uniformly hypoechoic internal sphincter (IAS) (arrow) adjacent to hyperechoic mucosal zone. External sphincter (arrow) is hyperechoic zone immediately outside IAS and encircled by less echogenic fatty tissue with more scattered pattern in ischiorectal fossa (arrow)