Observer variation in the radiological measurement of the anorectal angle

F. Penninckx, C. Debruyne, B. Lestar, and R. Kerremans

Department of Abdominal Surgery, University Clinic Gasthuisberg, Catholic University of Leuven, Belgium

Accepted: 26 February 1990

Abstract. Determination of the anorectal angle (ARA) and the position of the pelvic floor is, theoretically, very important in understanding the mechanisms of anorectal continence and defaecation. The variability in the measurement of the ARA was analyzed. Nine experts drew the rectal axis either as a line along the posterior wall of the distal rectum or as the central axis of the rectal lumen on the outlines of 18 representative proctographic images. The standard deviations and ranges of the mean values of each ARA were comparable but large in both methods. On average, the S.D. was 8° and the range value about 23°. Inter-observer variation was not related to the magnitude of the ARA, but rather to the anorectal configuration. Drawing a line along the posterior distal rectal wall is difficult when it is irregular or when the puborectalis impression is indistinct. The central rectal axis is difficult to draw when the junction between the upper and lower rectum is ill defined or when the outlines of the distal rectum are asymmetric e.g by the presence of a rectocele. Thus, the variability of both methods was not strongly interrelated (r = 0.68 for the median values). It is concluded that, in general, radiologic assessment of the ARA is not reliable enough for comparative investigation of the dynamics of the anorectum.

Introduction

At the end of the sixties a radiological technique, called defaecography, was designed to depict the function of the anorectum during evacuation of simulated stool [1-5]. These techniques were later modified [6-7]. In order to simplify and fasten the procedure balloon proctography has been introduced [8-9]. To reduce radiation, a scintigraphic alternative has recently been described [10]. Proctography and defaecography are the only objective methods allowing quantitative measurement of the anorectal angulation (ARA) and of the pelvic floor level at rest, during squeezing and straining. The level of the pelvic floor is defined as the distance between the anorectal junction and a line drawn in relation to bony landmarks [11, 12]. Thus, determination of the anal and the rectal axis takes a key position in the quantitative analysis of radiological images. Two methods for drawing the rectal axis are used: a line along the posterior wall of the distal rectum or the central rectal axis.

In order to analyze the variability in the measurement of the ARA and its eventual reasons, we asked the 10 expert participants of a recent symposium on proctography [13] to draw the rectal axis according to both methods.

Material and methods

The outlines of the anorectum on 18 proctographic pictures were copied (Fig. 1). The axis of the anal canal was drawn on all figures. They were sent to the 10 experts who were asked to draw the rectal axis on each picture either as a line along the posterior wall of the distal rectum or as the central axis of the rectal lumen. An illustrating figure was enclosed. The proctograms were obtained in 6 control subjects (pictures 1-9 in Fig. 1), 3 patients with rectal prolapse (pictures 10, 11 and 13 in Fig. 1) and in 4 other prolapse patients after rectopexy (pictures 12, 14-18 in Fig. 1). These radiographs were made at rest (pictures 1-3, 10-12), during squeezing (pictures 4-6, 13-15) or straining (pictures 7-9, 16-18). The origin of the radiographs was unknown to the experts. All images were made with a filled rectum.

Statistical analysis

As it is not the mere presence of observer variation but its magnitude and its effect in practical terms which are the critical features to be illustrated and measured, we have chosen to set out the results fully and also to report median values and range of estimations whenever appropriate. Student's t-test for paired and unpaired samples, Wilcoxon ranked sum test, Mann-Whitney U-statistics and analysis of variance have been used where appropriate.

Results

One expert preferred not to fill in the lines as he never utilized the concept of measuring anorectal angles be-
cause of its great variability. Thus, the calculations of the ARA presented in Table 1 and in Fig. 2 are based on the data provided by 9 experts. The ARA was about 23° smaller when the rectal axis was drawn along the posterior wall of the distal rectum than when the central rectal axis was used. During straining the difference tended to be smaller. In some pictures the angles measured according to both methods were almost comparable, e.g. pictures 2, 8 and 16. Therefore, the correlation between both methods of measurement is not perfect (correlation coefficient $r = 0.75$ for the mean values and 0.68 for the median values).

The considerable variation in the estimation of the ARA is apparent from the scatter, as illustrated in Fig. 2. In individual pictures the difference between the most discrepant estimates ranged from 2 to 48° when the rectal axis was drawn along its posterior distal wall and from 9 to 38° when the central rectal axis was considered. On an average, the standard deviations ($\pm 8°$) and the range between the most extreme estimates ($23°$) were comparable in both methods. They did not increase with the magnitude of the ARA. In contrast, they were smallest in figures taken during straining (Table 1).

In some pictures the variation was smallest when the rectal axis was drawn along its distal posterior wall (pictures 1, 10, 16) while in others the method based on the central rectal axis was more reliable (pictures 2, 9, 13, 17 and 18). In about half of the pictures (pictures 3–8, 11, 12, 14, 15) the variability of the ARA estimation was comparable for both methods. A comparable degree of variation, however, did not necessarily implicate a low level of variability, e.g. picture 14. Consequently, there was no relation between both methods of ARA measurement as far as variability, i.e. standard deviation ($r = 0.15$) and range between most extreme values ($r = 0.02$), is concerned.

An attempt was made to determine what characteristics of the anorectal outlines were responsible for the variation in each method. Difficulties in determining the central rectal axis were related to: a sigmoid loop-like

---

**Table 1.** Estimates of the anorectal angle by 9 experts in 18 proctographic figures

<table>
<thead>
<tr>
<th></th>
<th>ARA values based on posterior rectal wall estimations</th>
<th>ARA values based on central rectal axis estimations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Rest (pict. 1–3, 10–12)</td>
<td>96.3</td>
<td>8.6</td>
</tr>
<tr>
<td>Squeeze (pict. 4–6, 13–15)</td>
<td>80.3</td>
<td>9.1</td>
</tr>
<tr>
<td>Strain (pict. 7–9, 16–18)</td>
<td>104.3</td>
<td>7.0</td>
</tr>
<tr>
<td>Global</td>
<td>93.7</td>
<td>8.2</td>
</tr>
</tbody>
</table>

* Range: difference between the most discrepant estimates. The mean of the differences for each series of radiographic images is presented

$* p<0.01$ and $** p<0.05$ as compared with ARA values measured by the alternative method