The prevalence of fecal incontinence (FI) in the general population increases with age in male and female. The internal anal sphincter (IAS) plays a key role in maintaining continence, providing a large part of the maximum resting pressure (MRP). Increasing age is associated with a weakening of the MRP. The IAS thickness was measured using an ultrasound scanner with a 10 MHz rotating endoprobe in 774 subjects (382 female and 392 male). There was a positive correlation between the thickness of IAS and age in both sexes. In female, the thickness of IAS did not change from 20's (1.89 ± 0.41) to 40's (2.06 ± 0.52), but increased after 50's (2.32 ± 0.54) with age. In male, after 50's (2.14 ± 0.54) was significantly thicker than to 40's (1.86 ± 0.54). The thickness of IAS was thicker in female than in male (2.30 ± 0.60 and 2.05 ± 0.53, \( p < 0.001 \)). It is known that the MRP decreases with age, therefore an increase of IAS thickness in the elderly may be an attempt at compensation, which ultimately fails because of a loss of tone.

Fecal incontinence (FI) is a common disorder with a high impact on quality of life. The prevalence of FI in the general population increases with age in male and female\(^1\). Although the cause of FI is often multifactorial, FI is frequently caused by anal sphincter insufficiency\(^2\). The anal sphincter muscles consist of the circular internal and external anal sphincters together with the sling-shaped associated puborectalis muscle. The internal anal sphincter (IAS) is composed of smooth muscle arranged in oblique bundles. The IAS plays a key role in maintaining continence, providing 75 percent of the maximum resting pressure (MRP)\(^3\). Increasing age is associated with a weakening of the MRP\(^4\). Anal sphincter imaging with high spatial resolution first became possible with the introduction of anal endosonography, a rapid and minimally invasive\(^5\). Findings of several studies in small sample size suggest that IAS thickens with age\(^6-10\). The aim of this study was to evaluate thickness of IAS in a large group by using a high-frequency transducer to define age and sex-related differences in IAS thickness.

**Abstract**

The prevalence of fecal incontinence (FI) in the general population increases with age in male and female. The internal anal sphincter (IAS) plays a key role in maintaining continence, providing a large part of the maximum resting pressure (MRP). Increasing age is associated with a weakening of the MRP. The IAS thickness was measured using an ultrasound scanner with a 10 MHz rotating endoprobe in 774 subjects (382 female and 392 male). There was a positive correlation between the thickness of IAS and age in both sexes. In female, the thickness of IAS did not change from 20's (1.89 ± 0.41) to 40's (2.06 ± 0.52), but increased after 50's (2.32 ± 0.54) with age. In male, after 50's (2.14 ± 0.54) was significantly thicker than to 40's (1.86 ± 0.54). The thickness of IAS was thicker in female than in male (2.30 ± 0.60 and 2.05 ± 0.53, \( p < 0.001 \)). It is known that the MRP decreases with age, therefore an increase of IAS thickness in the elderly may be an attempt at compensation, which ultimately fails because of a loss of tone.

**KEY WORDS:** Aging; Internal anal sphincter; Fecal incontinence; Maximum resting pressure; Anal endosonography

**Introduction**

Fecal incontinence (FI) is a common disorder with a high impact on quality of life. The prevalence of FI in the general population increases with age in male and female\(^1\). Although the cause of FI is often multifactorial, FI is frequently caused by anal sphincter insufficiency\(^2\). The anal sphincter muscles consist of the circular internal and external anal sphincters together with the sling-shaped associated puborectalis muscle. The internal anal sphincter (IAS) is composed of smooth muscle arranged in oblique bundles. The IAS plays a key role in maintaining continence, providing 75 percent of the maximum resting pressure (MRP)\(^3\). Increasing age is associated with a weakening of the MRP\(^4\). Anal sphincter imaging with high spatial resolution first became possible with the introduction of anal endosonography, a rapid and minimally invasive\(^5\). Findings of several studies in small sample size suggest that IAS thickens with age\(^6-10\). The aim of this study was to evaluate thickness of IAS in a large group by using a high-frequency transducer to define age and sex-related differences in IAS thickness.

**Subjects and Methods**

**-Subjects**

Between January 2005 and December 2006, 774 consecutive subjects, 382 female and 392 male aged 20-89 years old with no history of rectal prolapse, anorectal surgery and fecal incontinence entered the study. All gave informed consent. Twenty female were aged 20 to 29 years, 52 were aged 30 to 39 years, 49 were aged 40 to 49 years, 81 were aged 50 to 59 years, 106 were aged 60 to 69 years, 74 were aged 70 to 79 years. Thirteen male were aged 20 to 29 years, 53 were aged 30 to 39 years, 51 were aged 40 to 49 years, 111 were aged 50 to 59 years, 106 were aged 60 to 69 years, 74 were aged 70 to 79 years. Thirteen male were aged 20 to 29 years, 53 were aged 30 to 39 years, 51 were aged 40 to 49 years, 111 were aged 50 to 59 years, 80 were aged 60 to 69 years, 84 were aged 70 to 79 years. There was not significant difference for distribution of the study population between female and male.

**-The technique of anal endosonography**

All patients were examined in the left lateral position by one examiner (YS) using a TOSHIBA SSA-550A (Tokyo, Japan) ultrasound scanner with a 10 MHz rotating endoprobe (TOSHIBA PVL-715RT) maximum diameter 2 cm. The intra-anal probe was inserted into the rectum and then withdrawn slowly, and images of the IAS were measured at its thickest portion in the anal canal. The IAS was defined as a homogenous, hypoechoic circular band, following the mucosa and submucosa (Fig. 1). The thickness of IAS was measured in transverse images at the 3 and 9 o’clock to exclude the influence of childbirth and the mean values were calculated for each individual.
Results

There was a positive correlation between the thickness of IAS and age in both sexes (Fig. 2). The mean thickness of IAS measured for age-groups in female and male were shown in Fig. 3 and 4, respectively. In female, the thickness of IAS did not change from 20’s (1.89±0.41) to 40’s (2.06±0.52), but increased after 50’s (2.32±0.47) with age. In male, after 50’s (2.14±0.54) was significantly thicker than to 40’s (1.86±0.54). The mean thickness data as well as statistical evaluation of gender are shown in Table 1. The thickness of IAS was thicker in female than in male (2.30±0.60 and 2.05±0.53, p < 0.001).

-Statistical analysis

All data are given as mean±standard deviation (mm). Correlations between IAS thickness and age were calculated with linear regression analysis (Pearson’s correlation coefficient). Measures were also analyzed for subgroup effects (age, gender). Group comparisons were performed with Kruskal Wallis H-test and Mann-Whitney U-test for unpaired non-parametric data. Results were defined as statistically significant when the respective test statistic had a P value less or equal to 5 percent.

![Fig. 1](image1) Representative examples of internal anal sphincter (arrow heads ) aged 30’s (a), 60’s (b) and 90’s (c). Moreover, the echogenicity of the internal sphincter changed with age as the sphincter muscle became more echogenic.

![Fig. 2](image2) Internal anal sphincter thickness showed a significant positive correlation with age in both sexes.

![Fig. 3](image3) Mean thickness of internal anal sphincter in female for age-groups.

![Fig. 4](image4) Mean thickness of internal anal sphincter in male for age-groups.

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Female (n=382)</th>
<th>Male (n=392)</th>
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<tbody>
<tr>
<td>20 - 29</td>
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<tr>
<td>30 - 39</td>
<td>2.06±0.52</td>
<td>1.86±0.54</td>
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<td>60 - 69</td>
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<td>70 - 79</td>
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*Significant gender difference: p<0.001

**Table 1** Comparison of internal anal sphincter thickness of female and male.

<table>
<thead>
<tr>
<th></th>
<th>Female (n=382)</th>
<th>Male (n=392)</th>
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<tbody>
<tr>
<td>Mean thickness</td>
<td>2.30±0.60*</td>
<td>2.05±0.53</td>
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</table>

*Significant gender difference: p<0.001
**Discussion**

FI is defined as either the involuntary passage or the inability to control the discharge of fecal matter through the anal canal\[^{11}\]. Clinically, there are three subtypes: (a) passive incontinence – the involuntary discharge of rectal contents without awareness; (b) urge incontinence – the discharge of stool in spite of active attempts to retain bowel contents; and (c) combined incontinence – both passive and urge fecal incontinence\[^{21}\]. Majority of FI patients have passive incontinence (PI). PI is generally associated with dysfunction of smooth muscle tissue of the IAS\[^{11}\].

The IAS locates at the most distal part of gastrointestinal tract, and is formed by thickened circular smooth muscle coat. At rest, the IAS smooth muscles are totally contracted state, and this tonic contraction is responsible for a part of the closure of the anal canal. The IAS plays in maintaining continence, providing a continence line, so that a gender difference should be found for the IAS thickness. This study corroborates in a larger series of previous studies\[^{6-8,12}\], there was no significant difference for the thickness of IAS between male and female. Moreover we have revealed for the first time a significant gender difference in IAS thickness. Aging affects MRP in both sexes but to a greater degree in female\[^{13}\], so that a gender difference should be found for the IAS thickness. In previous studies\[^{6-8,12,14,15}\], there was no significant difference for the thickness of IAS between male and female. However, the statistical power is low due to the small number of patients included. Even in the largest published series, Favetta et al.\[^{9}\] treated 100 patients could not demonstrate any significant difference in accordance with sex.

It might be reasonable to assume that there is a correlation between the muscle bulk of a sphincter and the pressure it exerts. In trying to explain why a thicker IAS is weaker, we could find several studies\[^{16-18}\] about pathologic condition of IAS that occur with age. Microscopic study of the IAS have shown a reduction in the number of smooth muscle cells and a marked increase in the proportion of fiber tissue in patients with FI\[^{16}\]. Klosterhalfen et al.\[^{17}\] revealed that the amount of connective tissue in the IAS increased with age in continent subjects. Speakman et al.\[^{19}\] have also shown there was a relative increase in collagen or decrease in smooth muscle with age. In a study of biopsies of bladders from patients with normal autonomic innervation and no evidence of overflow obstruction, there was a significant linear decrease in the amount of acetylcholinesterase-containing nerves with age\[^{19}\]. The inverse correlation between age and anal pressures is similar to that reported previously for the lower esophageal sphincter\[^{20}\], suggesting that aging may affect the sphincters and/or sphincter innervation\[^{21}\]. Although there are no similar studies on IAS, it is possible that changes in the proportion of connective tissue may be related to changes in autonomic innervation\[^{18}\].

It is known that the MRP decreases with age, therefore, alterations in thickness of IAS are crucial physiologic implications of age as well\[^{10}\]. It remains speculative whether an increase in IAS thickness in the elderly is an attempt at compensation, which ultimately fails because of a loss of tone. Thus, any structural or pathologic change may be expected to exacerbate this loss in tonic closure and increase the risk of FI.

**Conclusion**

In the present report the thickness of IAS was found to increase with age in both sexes but was more pronounced in female. We would therefore recommend female after around 50 years old in particular doing pelvic-floor muscle training like Kegel exercises to prevent from FI.

**References**