IDENTIFICATION OF THE PROSTATE SHAPE AND THE EXTERNAL URETHRAL SPHINCTER USING MAGNETIC RESONANCE IMAGING IN NECROPSY

Takanori Suzuki1), Yasuo Nakazawa2), Kohei Kurokawa3), Keigo Okamura3), Isao Kurosawa4), Hidetoshi Yamanaka3)

1) Department of Urology, Gunma Cancer Center
2) Nakazawa Clinic
3) Department of Urology, Gunma University School of Medicine
4) Department of Urology, Kurosawa Hospital

Abstract: The urinary incontinence in radical prostatectomy partly arises from the damage to the external urethral sphincter during the operation. The present study demonstrated that, as a means of preventing the damage to the sphincter, the prostate shape and the external urethral sphincter could be preoperatively identified using magnetic resonance (MR) imaging. Five necropsy specimens were examined. MR images were obtained in the sagittal plane, and the specimens were then cut and macroscopically examined. Two prostate shapes, croissant and doughnut, were easily identified by both methods. In the four croissant-shaped prostates, the external urethral sphincter was very well developed at the anterior surface of the prostate gland, and the membranous urethra was long. On the other hand, in the doughnut-shaped prostate it developed anteriorly and posteriorly, and the membranous urethra was short. Knowledge as to the prostate shape and the urethral sphincter acquired by MR imaging can help the surgeon to preserve the external urethral sphincter during prostatectomy.

Key words: Prostate, External urethral sphincter, MRI

INTRODUCTION

In radical prostatectomy performed for localized prostate cancer, postoperative complications, including severe to total urinary incontinence, occur at incidence of 5% and markedly reduce the quality of the patient's life1). Improvements in surgical technique have been reported by many investigators2,3). The urinary incontinence originates from damage to the external urethral sphincter or neurovascular bundle during the operation. The configuration of the external striated urethral sphincter is variable and is related to the shape of the apical prostate4). Pre-operative identification of the shape of the prostatic apex and the external urethral sphincter is of paramount importance with respect to urinary continence. The present study in necropsy specimens demonstrated that the prostate shape and the external urethral sphincter can be clearly identified using magnetic resonance (MR) imaging.

MATERIALS AND METHODS

Five whole specimens, each including the urinary bladder, prostate, penis, a part of the rectum and the pubic bone including the abdominal wall, were obtained at necropsy from the cadavers of men 64 to 83 years old (average age, 75 years). Each specimen was fixed in formalin solution. First, T1-(SE TR380/TE15) and T2-(TR1850/TE100) MR images of the specimens were obtained in the sagittal plane at 5 mm thickness. MR device (Phillips, Gyroscan ACS-NT) was used in the present study. The specimens were then cut in the mid-sagittal plane, and the prostate and the external urethral sphincter were macroscopically identified and photographed. The lengths of the
proximal urethra from the bladder neck to the urogenital diaphragm and of the membranous urethra from the prostatic apex to the urogenital diaphragm were measured. The prostate gland and the membranous urethra, including a part of the rectum and urogenital diaphragm, were dissected out, and embedded in paraffin, and the sections were stained with hematoxylin and eosin for macroscopic identification of the striated urethral muscle.

**RESULTS**

Macroscopic findings of the prostate and the external urethral sphincter in a sagittal plane

The prostate was croissant-shaped in four of the five cadavers and doughnut-shaped in one (Table). In the former (Figs. 1 and 2), the prostate gland was mainly situated at the posterior side of the urethra, and the prostatic tissue was not identified in the anterior commissure in two of four cadavers. The prostatic tissue volume in the anterior commissure was small, and the prostate was located at the distal side of the bladder neck. The external striated urethral sphincter, which was identified by hematoxylin and eosin staining, was clearly visible from the anterior area of the prostate to the urogenital diaphragm. The striated muscle was well developed anterior to the urethra, while it was thin posterior to it. In the doughnut-shaped prostate (Figs. 3 and 4), the prostate gland was well developed anteriorly and posteriorly at the urethra. Benign prostatic hyperplasia was apparent in this case. The external striated urethral sphincter was very thin at the anterior surface of the prostate gland. The length of the membranous urethra was short compared

Table. 1 The length of the proximal urethra in necropsy specimens

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Prostate shape</th>
<th>Length of the urethra (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Proximal urethra</td>
</tr>
<tr>
<td>1</td>
<td>81</td>
<td>croissant</td>
<td>5.0</td>
</tr>
<tr>
<td>2</td>
<td>64</td>
<td>croissant</td>
<td>4.0</td>
</tr>
<tr>
<td>3</td>
<td>72</td>
<td>croissant</td>
<td>4.4</td>
</tr>
<tr>
<td>4</td>
<td>76</td>
<td>croissant</td>
<td>4.8</td>
</tr>
<tr>
<td>5</td>
<td>83</td>
<td>doughnut</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Fig. 1. Macroscopic view of a croissant-shaped prostate and the external urethral sphincter in the sagittal plane. The prostate gland (arrow) is developed posteriorly, the external striated urethral sphincter (arrow head) is thick at the anterior surface of the prostate, and the membranous urethra is long. A Nelaton's catheter has been inserted into the urethral cavity. B; urinary bladder.

Fig. 2. Schema corresponding to Figure 1. B, urinary bladder; P, prostate gland; US, external striated urethral sphincter.
with that in the croissant-shaped prostates (Table).

**MR images of the prostate and the external urethral sphincter**

These shapes of the prostates, as in the macroscopic observation, were easily recognized on the sagittal T1- and T2-weighted MR images. In the croissant-shaped prostates (Fig. 5), the prostate gland was identified at the posterior aspect of the urethra in the sagittal plane. The external urethral sphincter was readily identified, and it presented a three-layer configuration. The outer-most layer, which was composed of striated muscle, showed low signal intensity on the T2-weighted images. The middle layer of the urethral wall and the cavity of the urethra showed high signal intensity, and the inner layer of the wall low intensity. The outer striated sphincter originated from the anterior commissure and terminated at the urogenital diaphragm. The enlarged doughnut-shaped prostate (Fig. 6) was readily detected extending anteriorly and posteriorly in the pelvic cavity on MR images, but the stri-
ated muscle at the anterior surface of the prostate could not be identified. The external urethral sphincter, which showed low signal intensity, could not be satisfactorily identified on the MR images, being visible only near the urogenital diaphragm.

**DISCUSSION**

The prostates with croissant and doughnut shapes have been reported to be distinguished by the presence or absence of an anterior apical notch\(^4\). The present study demonstrated that the two shapes could be easily distinguished by gross examination and on MR images obtained in the sagittal plane. The croissant-shaped prostate is developed mainly posteriorly, while the doughnut-shaped prostate shows anterior and posterior development. As observed on MR images, the anterior apical notch, which is observed in the former type, is derived from the external striated muscle originated at the anterior surface of the prostate gland.

The urethra shows a three-layer configuration on T2-weighted MR images\(^5,6\). The reports indicate that the outer muscle layer mainly composed of striated muscle shows low signal intensity, the submucosal layer between the outer and inner layers shows high intensity, and the inner layer shows low intensity. We also noted the three-layer structure of the urethra on MR images. In the croissant-shaped prostates, the external striated muscle was distinct on the T2-weighted images, and the membranous urethra was longer than that in the doughnut-shaped prostate. The prevention of urinary incontinence after radical prostatectomy is important to preserve adequate external striated urethral sphincter\(^7\). Transection of the urethra at the apex of the doughnut-shaped prostate is relatively easy, while it is much more difficult in the croissant-shaped prostate\(^7\). In radical prostatectomy, the determination of the prostate shape and the external urethral sphincter on MR images can help the surgeon to achieve optimal urethral transection with maximal preservation of continence.

**REFERENCES**