CHANGES IN RECTAL VOLUME AND PROSTATE LOCALIZATION WITH PLACEMENT OF A RECTUM EMPTYING TUBE

Hiroshi Fuji,* Shigeyuki Murayama,* Masashi Niwakawa,† Raizou Yamaguchi, † Ryou Yamashita, † Takashi Matsui, † Haruo Yamashita, † Eriko Urakabe,* Tetsuo Nishimura, ‡ Kenichi Tobisu†

*Proton Therapy, †Urology and ‡Radiation Oncology Division
Shizuoka Cancer Center
Advantage of proton beam is reduction of deposited dose at organs around the target by “distal-fall-off” of the energy. However, less electron density tissues and inappropriate localization or delineation compromise the advantage.
Proton Beam Therapy for Prostate Cancer

- Rectal volume is dominant factor of prostate localization.
- Gas in the rectum may cause uncertainty of deposited dose at target and organ around the target.
To investigate the effect of rectal volume reduction by means of a rectum emptying tube (RET) on prostate immobilization
Prostate Localization with Rectum Emptying Tube

- Prostate position under empty rectum
- Prostate position under rectum filled with gas
- Rectum Emptying Tube
- Prostate position with rectum emptying tube
Study design

- Prospective trial
- Low or intermediate risk of prostate cancer
- Prepared for proton beam therapy
- PS 0-1
- Accrued 21 patients between Mar. 2007 – Sept. 2007
- 17 of 21 patients were analyzed
- Two case with inappropriate placement of RET and one case rejected continuing examination were excluded
Rectum Emptying Tube

- Rectum emptying tube was curved to fit the shape of the rectum and the anal canal
- 25 cm in length, 9 mm in diameter
- 6 -8 holes on the side for draining the gas within the rectum
Whether RET can reduce the rectal volume (RV) and decrease the variation of it?
Whether RET can reduce the motion of the prostate?
CT images with / without RET

No-RET

Prostate

Gas

1st CT

2nd CT

RET

1st CT

2nd CT
Changes in rectal volume

**Averaged rectal volume**

- **No-RET**
- **RET**

**Difference in rectum volume on 1st and 2nd CT**

- **No-RET**
- **RET**
Changes in rectal volume by RET

<table>
<thead>
<tr>
<th></th>
<th>No-RET</th>
<th>RET</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectal volume (cc)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st CT</td>
<td>61.2</td>
<td>39.7</td>
<td>.003</td>
</tr>
<tr>
<td>2nd CT</td>
<td>48.9</td>
<td>40.0</td>
<td>.231</td>
</tr>
<tr>
<td>Mean</td>
<td>55.0</td>
<td>39.9</td>
<td>.003</td>
</tr>
<tr>
<td>Difference in</td>
<td>24.9</td>
<td>7.8</td>
<td>.006</td>
</tr>
<tr>
<td>rectal volume (cc)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3-D motion analysis of the prostate with and without RET

**Superior-inferior**

- **No-RET**
- **RET**

**Anterior-posterior**

**Right-left**

(cm)

-1 1 2 3

(cm)

-1 1 2 3

(cm)

-1 1 2 3

(cm)

-1 1 2 3

(cm)
## Motion of the prostate with and without RET

<table>
<thead>
<tr>
<th></th>
<th>No-RET (mm)</th>
<th>RET (mm)</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (range)</td>
<td>Mean (range)</td>
<td></td>
</tr>
<tr>
<td>Anterior - posterior</td>
<td>5.3 (1.0-30.5)</td>
<td>1.6 (0.0-3.1)</td>
<td>0.005</td>
</tr>
<tr>
<td>Superior - inferior</td>
<td>2.1 (0.0-7.0)</td>
<td>1.2 (0.0-4.0)</td>
<td>0.037</td>
</tr>
<tr>
<td>Left - right</td>
<td>1.0 (0.0-2.9)</td>
<td>0.7 (0.1-1.8)</td>
<td>0.118</td>
</tr>
</tbody>
</table>
Dose-Distribution of Horizontal and Vertical Beam
Dose-Volume Histogram of Rectum

- **Horizontal Beam Only**
- **Horizontal Beam and Vertical Beam**
Conclusion

- RET placement reduced both rectal volumes and variation in rectal volume.
- The procedure reduced displacement of the prostate in the anterior–posterior and superior–inferior directions.
- RET placement thus appeared to be an effective technique for immobilization of the prostate.
- RET placement could be introduced to proton beam therapy for more precise dose deposition and less morbidity.