

## Surgical Outcome of Radical Maxillectomy in Advanced Maxillary Sinus Cancers

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We investigated the surgical outcome of radical maxillectomy in advanced maxillary sinus cancers invading through the posterior wall and into the infratemporal fossa.

Twenty-eight patients with maxillary sinus squamous cell carcinoma, who visited the Otorhinolaryngology Department at Severance Hospital from March, 1993 to February, 2001 and underwent the surgery, were analyzed retrospectively by reviewing clinical medical records and radiologic test results. The mean follow-up period was 78.8 months. (26~162 months) Local recurrence, sites of local recurrence, and the 2-year disease-free survival rate were analyzed.

Of the total 28 cases, 9 cases were T3, and 19 cases were T4. Total maxillectomy was performed in 12 cases (42.9%) and radical maxillectomy in 16 cases (57.1%). Regardless of staging, radical maxillectomy was performed only when cancers invaded through the posterior wall and into the infratemporal fossa. When cancers only marginally or did not invade the posterior wall, total maxillectomy was performed. The 2-year disease-free survival rate was 75% for both total and radical maxillectomy, and the local recurrence rates were 8.3% and 18.7% respectively. All recurrence occurred at the posterior resection margin of the maxillectomy.

We strongly recommend the use of radical maxillectomy in the cases of advanced maxillary sinus cancers invading the infratemporal fossa. Radical maxillectomy can provide sufficient safety margins and lower the local recurrence rate.

**Key Words:** Radical maxillectomy, total maxillectomy, infratemporal fossa

## INTRODUCTION

Three percent of all head and neck cancers are known to originate from the paranasal sinuses.<sup>1</sup> Of these, 80% originate from the maxillary sinus, and histologically, 60-90% of these cases have been shown to be squamous cell carcinoma.<sup>1,2</sup> As the cancer develops in the confined space of the maxillary sinus, it causes no early signs or symptoms, accordingly, the majority of cases can only be diagnosed at the advanced stage.<sup>3</sup>

As the maxillary sinus cancer progresses to the advanced stage, it invades the surrounding structures.<sup>4</sup> Superiorly, it may invade the orbital fossa, anteriorly, the skin, posteriorly, the pterygopalatine fossa, and if it proceeds further through the posterior wall, it may even invade the infratemporal fossa.<sup>4</sup> If the orbital fossa is invaded, orbital exenteration should be performed in addition to the maxillectomy. If the skin is invaded, reconstruction with a free flap should be considered after excision of the skin lesion, so that the tumor can be resected completely, and leave a sufficient safety margin.

Maxillectomy was first described in the early 19th century, but there is still some confusion regarding the terminology. Generally, two terms are in current use, 'total maxillectomy' and 'radical maxillectomy', but they describe different procedures, the most important difference being whether or not the excision of the pterygoid plate is performed along with the maxillectomy.<sup>5,6</sup> Total maxillectomy, the classical method of surgery for maxillary sinus cancer, is performed by resecting

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the tumor mass, by approaching between the posterior wall of the maxillary sinus and the pterygoid plate, leaving the pterygoid plate intact. In contrast, radical maxillectomy is performed by removing a larger area around the mass, including the pterygoid muscle and the pterygoid plate, in cases of moderate to severe invasion of the infratemporal fossa. On the other hand, orbital exenteration, which is performed when the cancer cells invade the orbital content, is not a criterion of either total maxillectomy or radical maxillectomy.<sup>5-7</sup>

When a maxillary sinus cancer proceeds through the posterior wall and invades the pterygopalatine fossa, total maxillectomy cannot guarantee sufficient safety resection margins, and the possibility of residual tumor in the postero-superior portion of the maxillary sinus exists. Therefore, in such cases, instead of total maxillectomy, radical maxillectomy, where resection margins can be assured to be sufficient, is more recommendable.<sup>7</sup>

If a maxillary sinus cancer invades the infratemporal fossa, the cancer stage increases from stage 3 to stage 4, and the possibility of complete resection decreases.<sup>8</sup> In such cases, if the operator does not have a full anatomical understanding of the infratemporal fossa, he might hesitate before deciding to perform a radical maxillectomy.

In this study, in order to investigate the surgical outcome of radical maxillectomy in advanced maxillary sinus cancers, we analyzed the results of radical maxillectomy in cases where the squamous cell carcinoma of the maxillary sinus invades through the posterior wall and into the infratemporal fossa. Radical maxillectomy was performed

through a lateral approach, exposing the root of the pterygoid plate and thereby, allowing the operator a direct view of the pterygoid muscle, and the ability to remove the tumor as a single mass.

## MATERIALS AND METHODS

### Study subjects

The charts and radiologic examinations of 28 patients, who after being diagnosed with squamous cell carcinoma of maxillary sinus origin, underwent total or partial maxillectomy between March, 1993 and February, 2001, were reviewed retrospectively. Of the 28 patients, 22 were male and 6 were female; their average age was 55.6 years (range: 34-75 years) (Table 1).

### Preoperative evaluation

To determine the primary site and the presence of neck metastasis, paranasal sinus computed tomography (CT) and neck CT were performed on all 28 patients. Plain chest X-ray, abdominal ultrasound, and whole body bone scan (WBBS) were also taken to determine the presence of distant metastasis. MRI was only performed in cases where invasion to the cheek skin or dura were suspected.

### Follow up

Patients who were described as achieving disease-free survival, but had not been followed

**Table 1.** Age and Sex Distribution

| Age (year) | Male      | Female   | Total     |
|------------|-----------|----------|-----------|
| 34 - 39    | 2         | 0        | 2 ( 7.1)  |
| 40 - 49    | 3         | 1        | 4 (14.3)  |
| 50 - 59    | 10        | 1        | 11 (39.3) |
| 60 - 69    | 6         | 3        | 9 (32.1)  |
| 70 - 75    | 1         | 1        | 2 ( 7.1)  |
| Total      | 22 (78.6) | 6 (21.4) | 28 (100)  |

Value: No (%).

**Table 2.** Clinical T-stage on Presentation

|       | T3       | T4a       | Total     |
|-------|----------|-----------|-----------|
| N0    | 9        | 18        | 27 (96.4) |
| N1    |          |           |           |
| N2    |          | 1         | 1 ( 3.6)  |
| N3    |          |           |           |
| Total | 9 (32.1) | 19 (67.9) | 28 (100)  |

Value: No (%).

**Table 3.** Treatment Modality by T-stage

|               | T3       | T4a       | Total     |
|---------------|----------|-----------|-----------|
| Surgery alone | 2        | 3         | 5 (17.9)  |
| Surgery+RTx   | 6        | 13        | 19 (67.8) |
| RTx+Surgery   | 1        | 3         | 4 (14.3)  |
| Total         | 9 (32.1) | 19 (67.9) | 28 (100)  |

Value: No (%).

up via the outpatient department (OPD) were told to visit the OPD for a check-up. And all cases were reviewed by a competent Head and Neck oncologist to include a thorough clinical examination, CT scan and chest X-ray. The average follow-up duration for disease-free survival was 78.8 months (range: 26 - 162 months).

### Statistical analysis

Staging was determined according to the 2002 AJCC (American Joint Committee on Cancer) Cancer Staging Classification. Statistical analysis was done using the Wilcoxon rank sum test and 2-year survival rate was calculated.

## RESULTS

### T stage of the patients

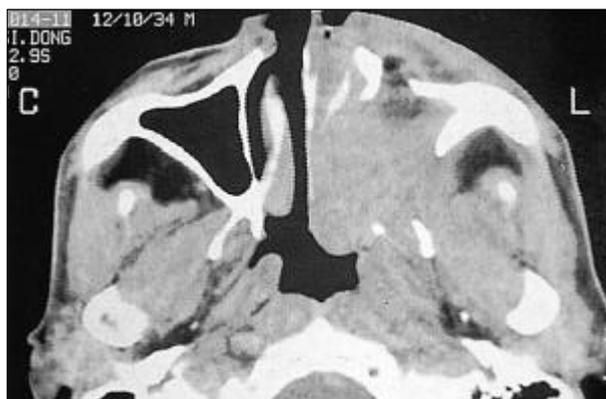
Analysis of the T stage on presentation showed that 9 cases were T3, and 19 were T4. Of the 19 cases of T4, there was one case of neck metastasis

(Table 2).

### Treatment modality

Regardless of staging, 82.1% cases were treated by combined surgery and radiotherapy. The other 17.9% were treated by surgery alone (Table 3). All the operations were performed by only one expert surgeon. Average 5550 rad of radiation was irradiated on operation field including ipsilateral neck area postoperatively only in cases that remaining cancer was suspected or severe posterior invasion was confirmed. Chemotherapy was not performed in any patient.

Of the 28 patients, total maxillectomy was performed in 12 cases (42.9%) and radical maxillectomy in 16 cases (57.1%). 77.8% of the T3 stage patients underwent total maxillectomy and the remaining 22.2%, who had either severe destruction of the posterior bony wall or had a tumor localized in the pterygopalatine fossa, underwent radical maxillectomy. 73.7% of the T4a stage patients (Fig. 1) were treated by radical maxillectomy and the other 26.3%, who did not have



**Fig. 1.** CT scan of radical maxillectomy case. Tumor destructed posterior bony wall of left maxillary sinus wall and invaded the pterygoid fossa.

posterior wall destruction but had orbital invasion, and were thus staged as T4a, underwent total maxillectomy (Table 4).

#### Local recurrence

Of the total 28 cases, local recurrence occurred in four. Recurrence did not arise in any of the T3 stage patients, but rather only in T4a stage patients who received both surgery and radiotherapy. Local recurrence occurred in one of the 12 patients who underwent total maxillectomy, and in 3 of the 16 patients who underwent radical maxillectomy. In other words, the recurrence rate

for total and radical maxillectomy were 8.3% and 18.7%, respectively (Table 5). The sites of recurrence were the infratemporal fossa (2 cases), the sphenoid sinus (1 case), and the posterior portion of the hard palate (1 case). Thus, in all four cases, the tumor recurred at the posterior resection margin of the maxillectomy (Table 6). All local recurrences occurred within 1 year of the operation.

We analyzed the recurrence rate according to the degree of histological differentiation. In cases of moderately and poorly differentiated carcinoma, the recurrence rate were 15.8% and 16.7%, respectively. Of the 4 cases of local recurrence, 3 cases were of moderate differentiation (Table 7). These findings suggest that the degree of differentiation may not be a main factor of local recurrence.

#### 2-year disease-free survival rate and cause of death

The 2-year survival rate of patients that underwent total maxillectomy or radical maxillectomy respectively, were both 75%.

Two years postoperatively, there was no case of recurrence and all patients were free from disease. The average follow-up duration was 78.8 months (26 - 162 months). Analysis of the 2-year survival rate according to T stage showed that if there was

**Table 4.** Type of Maxillectomy

|                      | T3       | T4a       | Total     |
|----------------------|----------|-----------|-----------|
| Total maxillectomy   | 7        | 5         | 12 (42.9) |
| Radical maxillectomy | 2        | 14        | 16 (57.1) |
| Total                | 9 (32.1) | 19 (68.9) | 28 (100)  |

Value: No (%).

**Table 5.** Local Recurrence Rate

|                      | T3    | T4a    | Total       |
|----------------------|-------|--------|-------------|
| Total maxillectomy   | 0 / 7 | 1 / 5  | 1/12 ( 8.3) |
| Radical maxillectomy | 0 / 2 | 3 / 14 | 3/16 (18.7) |
| Total                | 0 / 9 | 4 / 19 | 4/28 (14.3) |

Value: recurred cases/total cases (%).

**Table 6.** Sites of Local Recurrence

|                      | Site of recurrence  | No |
|----------------------|---------------------|----|
| Total maxillectomy   | infratemporal fossa | 1  |
| Radical maxillectomy | infratemporal fossa | 1  |
|                      | sphenoid sinus      | 1  |
|                      | hard palate         | 1  |
| Total                |                     | 4  |

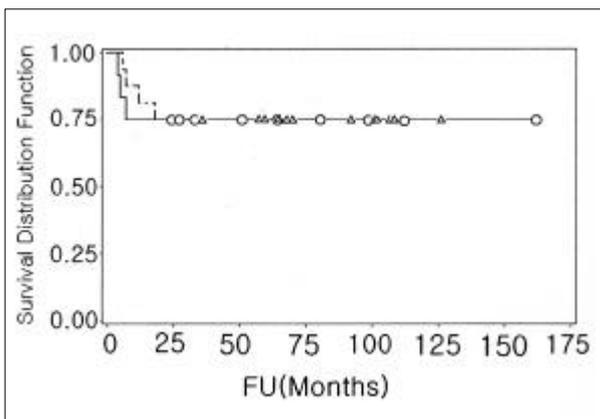
**Table 7.** Local Recurrence Rate According to the Degree of Squamous Differentiation and Type of Surgery

|                      | Well  | Moderate      | Poor       |
|----------------------|-------|---------------|------------|
| Total maxillectomy   | 0 / 2 | 1 / 8         | 0 / 2      |
| Radical maxillectomy | 0 / 1 | 2 / 11        | 1 / 4      |
| Total                | 0 / 3 | 3 / 19 (15.8) | 1/6 (16.7) |

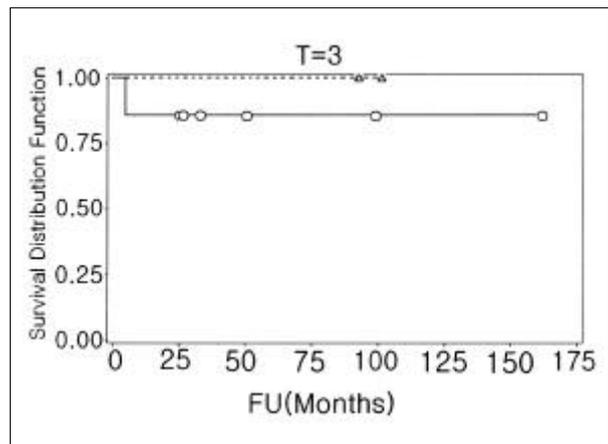
Value: recurred cases/total cases (%).

no local recurrence within 2 years of the operation, then no morbidity occurred during subsequent follow-up. This analysis also showed that the 2 year survival rate after radical maxillectomy was not much worse than after total maxillectomy (Fig. 2, 3 and 4).

All four cases of local recurrence died within 2 years of the operation due to pneumonia or sepsis caused by lung metastasis.



**Fig. 2.** Wilcoxon rank sum test- survival plot for all study patients according to the type of maxillectomy ( $\Delta$  and dotted line : radical maxillectomy,  $\circ$  and solid line : total maxillectomy).



**Fig. 3.** Wilcoxon rank sum test- survival plot for T3 patients according to the type of maxillectomy ( $\Delta$  and dotted line : radical maxillectomy,  $\circ$  and solid line : total maxillectomy).

**DISCUSSION**

Several methods, such as, surgery, radiotherapy, the intra-arterial injection of chemotherapeutic agents can be considered for the treatment of maxillary sinus cancer. However, the combined modality of surgery and postoperative radiotherapy is currently widely accepted to be the most effective.<sup>9-11</sup> From the surgeon's point of

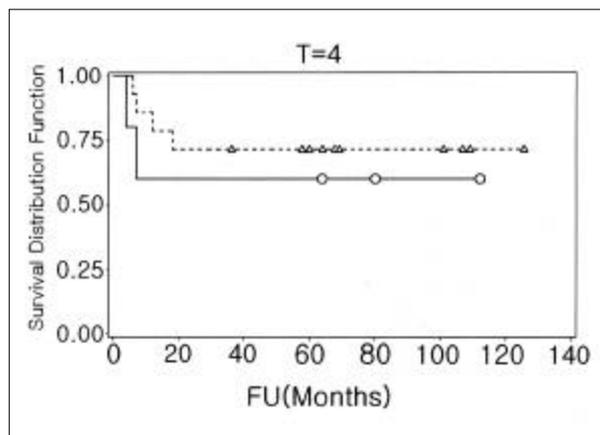


Fig. 4. Wilcoxon rank sum test-survival plot for T4a patients according to the type of maxillectomy ( $\Delta$  and dotted line : radical maxillectomy,  $\circ$  and solid line : total maxillectomy).

view, it is very important that the tumor mass should be removed, and that no residual tumor is left behind, to reduce the likelihood of local recurrence. To date, total or radical maxillectomy is performed for the treatment of maxillary sinus cancer. However, if radical maxillectomy is to be successful, a full understanding of the infratemporal fossa anatomy is required. In addition, radical maxillectomy has associated disadvantages such as long operation time, more bleeding and a postoperative trismus. Although there are a small number of reports on the use of various oral instruments to maintain mouth opening, no definite treatment method for solving trismus has been established.<sup>12,13</sup>

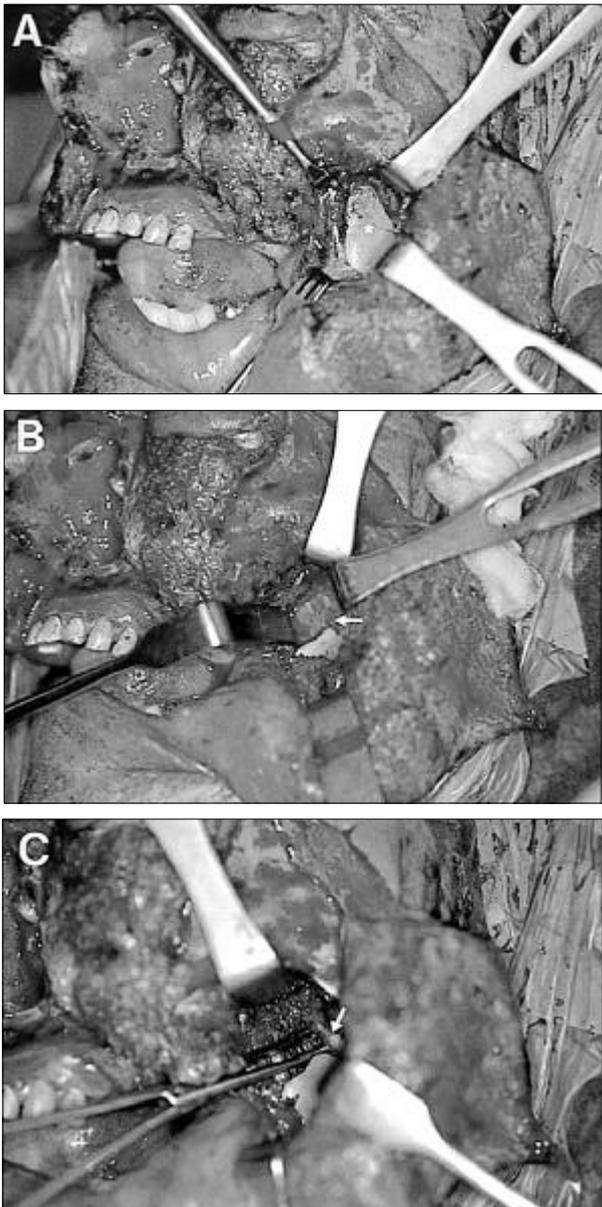
However, radical maxillectomy has the advantage of being able to remove the tumor en bloc whilst leaving sufficient safety margins. Few studies have been undertaken on surgical outcomes. Although total and radical maxillectomy have different surgical indications, preventing an exact comparison, the authors analyzed the results of radical maxillectomy in advanced cases of maxillary sinus cancers.

The most important factor in the treatment of maxillary sinus cancer is the prevention of local recurrence, which varies from 35 to 80% by study.<sup>8,9,14,15</sup> Kondo et al. reported that 80% of maxillary sinus cancers recur locally within 2 years of operation.<sup>8</sup> Lavertu et al. found that 48% recurred within 10 months,<sup>15</sup> and Shankar re-

ported a 57% recurrence rate in patients that underwent combined surgery and radiotherapy,<sup>16</sup> whereas Tatsuya found 36% recurrence rate in patients who underwent surgery, radiotherapy, and chemotherapy.<sup>17</sup> Recurrence rate was been usually found to increase with cancer stage. In contrast to the above reports, in the present study, the 2-year recurrence rate was low; i.e., in one case (8.3%) of total maxillectomy and in 3 cases (18.7%) of radical maxillectomy. The reason for such a lower recurrence rate, is attributed to the adoption of radical maxillectomy in advanced cases, which allows for the complete resection of the tumor and a sufficient safety margins without direct vision of the tumor, thus lowering the possibility of residual cancer. Accordingly, we strongly recommend the use of radical maxillectomy in the cases of advanced maxillary sinus cancers despite its disadvantages. In addition, all four cases of local recurrence, were due to lung metastasis, and these patients died within 2 years of surgery due to respiratory failure or sepsis. Taken together, these findings suggest that the prevention of local recurrence has an important effect on the success of treatment.<sup>8,9</sup>

There are two important points should be emphasized concerning radical maxillectomy procedure. The first involves the reduction of intraoperative bleeding. The maxillary artery, which is medial to the temporalis muscle, can be palpated under the fat plane containing the pterygoid plexus, and is always ligated just behind the coronoid process of the mandible beforehand (Fig. 5). The second point is that when the osteotomy is performed at the root of the pterygoid plate, it is done slightly away from the skull base to avoid injury to the emissary vein.

Orbital exenteration is known to be related with local recurrence but not with survival.<sup>10</sup> Stern et al. reported that invasion into the orbital fossa is seen in 45% of maxillary sinus cancer patients at the time of diagnosis. The authors have experienced similar results with a percentage of 46.4%.<sup>18</sup> Orbital exenteration was performed only when external ocular muscles were suspected to be invaded by cancer. In the present study, orbital exenteration was performed in 41.7% of total maxillectomy patients and in 50.0% of radical maxillectomy patients. And, in all 4 cases of local



**Fig. 5.** Maxillary artery ligation. The upper portion of coronoid process (A, asterisk) is removed to expose the maxillary artery. After removing the coronoid process, the fat plane (B, arrow) containing pterygoid plexus is identified. After dissection of the fat plane lateral to the lateral pterygoid muscle, maxillary artery (C, arrow) can be identified.

recurrence, no recurrence was shown in the orbital fossa. These findings suggest that orbital exenteration when the orbital fossa is invaded, provides a superior safety margins. In addition, this is one of the reasons that most local recurrences occurs in the posterior margin of maxillary

sinus cancers.

Ample scope for discussion remains regarding the relation between the histopathologic type and differentiation of a cancer and the local recurrence and survival rate.<sup>9,14</sup> The authors report that 67.9% of maxillary sinus cancer patients showed moderate differentiation and 3 cases out of the 4 cases of local recurrence were moderately differentiated. Therefore the authors believe that the degree of differentiation may not affect the rate of local recurrence. However, since the number of recurrence cases was low and the state of perineural invasion, a factor in local recurrence, was not mentioned on original pathologic report, a definite conclusion cannot be drawn. The authors thought that the perineural invasion might have been the cause of local recurrence.

Survival analysis using the Wilcoxon rank sum test showed that the 2-year survival rate was 75%, regardless as to whether total or radical maxillectomy had been performed.<sup>8</sup> In cases of death within 2 years, the patients who underwent radical maxillectomy had a recurrence at a more later date although they were at a more advanced stage. This is also shown by the survival rate analysis according to T3 and T4a staging (Fig. 2, 3 and 4). Analyzing these results, the authors feel that performing radical maxillectomy in cases of advanced maxillary sinus cancer patients with infratemporal fossa invasion, allows for wider safety margins and therefore, lowers the rate of local recurrence.

We strongly recommend the use of radical maxillectomy in cases of advanced maxillary sinus cancers invading the infratemporal fossa despite its disadvantages.

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