

# Prevalence of Sclerotic Pterygoid Plate in Pretreatment Nasopharyngeal Carcinoma

Arunnit Boonrod<sup>1</sup>, Warinthorn Phuttharak<sup>1\*</sup>, Natta Ounjaroen<sup>2</sup>

## Abstract

**Objectives:** The objective of our study was to determine the prevalence of sclerotic pterygoid plate in pretreatment CT of nasopharyngeal carcinoma compared with the control group. **Materials and Methods:** A total of 51 nasopharyngeal carcinoma patients (37 men, 14 women) with a mean age of 51.94±13 years, and 51 controls (30 men, 21 women) with a mean age, 49.31±15 years were included in this study in a retrospective fashion. All computed tomographic (CT) images were evaluated by two neuroradiologists. Sclerosis of pterygoid plate and other findings included pterygoid plate erosion, adjacent tumor enhancement, and parapharyngeal extension which were assessed. MRI findings were also recorded. The prevalence of pterygoid plate sclerosis was compared using Chi-square statistical tests. Imaging findings were analyzed by binary logistic regression analyses. **Results:** The prevalence of pterygoid plate sclerosis in nasopharyngeal carcinoma was 53.9% compared to the control group (16.7%) and the difference was statistically significant (P-value< 0.001). In nasopharyngeal carcinoma, the prevalence of tumor adjacent to the pterygoid plate, parapharyngeal extension and pterygoid plate erosion were 69.6%, 81.4%, 38.2%, respectively. No erosion of pterygoid plate was detected in the control group. The odds of adjacent tumor enhancement and pterygoid plate erosion was 7.29 and 20.56 times higher in the sclerotic pterygoid plate (p-values of 0.019 and 0.000, respectively). MRI was available for four nasopharyngeal carcinoma cases with five sclerotic pterygoid plates, where two showed enhancements. All non-sclerotic pterygoid plates showed no enhancement on MRI. **Conclusion:** The prevalence of sclerotic pterygoid plate is significantly higher in patients with nasopharyngeal carcinoma with a considerably higher chance of adjacent tumor enhancement and pterygoid plate erosion.

**Keywords:** Nasopharyngeal carcinoma- pretreatment- sclerosis pterygoid plate- tumor extension

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## Introduction

Nasopharyngeal carcinoma is a common carcinoma in Asia with squamous cell carcinoma type. Diagnosis can be delayed because of its deep anatomic location, and the symptoms are usually present when an invasion of adjacent structures occurs, representing a more invasive disease (Chong and Fan, 1996; Marks et al., 1998; Titcomb 2001; Brennan 2006; Thompson, 2007). Evaluation of tumor extension in nasopharyngeal carcinoma by physical examination is limited due to its location, and the primary management of the disease is non-operative treatment. As a consequence, cross-sectional imaging, computed tomographic (CT) images or magnetic resonance images (MRI), has a major role in evaluating tumor extension, staging, and pretreatment mapping. (Weber et al., 2003) The most common modality is by CT scan because of the lower cost and accessibility. Increasing use of intensity-modulated radiation therapy is a radiation therapy technique for treatment of nasopharyngeal carcinoma to improve the physical dose distribution, thereby delivering

a higher dose to the tumor target, in which pretreatment CT or MRI is mandatory. (Sultanem et al., 2000)

Skull base erosion has been reported to be a finding suggestive of skull base involvement or perineural spreading of nasopharyngeal carcinoma. (Sham et al., 1991b, 1991a). A previous study has recorded that sclerosis of the pterygoid plate was an additional finding in nasopharyngeal carcinoma patients that underwent CT scan. Results of this study result were highly significant compared with the control group which may be associated with tumor contact or initial tumoral invasion. (Shatzkes et al., 2006)

The objective of our study was to determine the prevalence of sclerotic pterygoid plate in pretreatment CT of nasopharyngeal carcinoma compared with the control group. Evaluation of MRI as compared to CT was also determined.

<sup>1</sup>Department of Radiology, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand. <sup>2</sup>Department of Radiology, Institute of medicine Suranaree University of Technology, Nakhon Ratchasima, Thailand. \*For Correspondence: pwarin@kku.ac.th

## Materials and Methods

### Patients

The local institutional ethics committee approved this retrospective analytical study with a waiver of inform consent. All nasopharyngeal carcinoma patients in Srinagarind hospital from January 2014 to December 2016 with pretreatment CT and pathologically proven of nasopharyngeal carcinoma was included. Invasive tumor causing obvious destruction of the pterygoid plate was excluded because sclerosis or erosion would not be an appropriate description in those cases. Fifty-one nasopharyngeal carcinoma patients, 37 men and 14 women with a mean age $\pm$ SD; 51.94 $\pm$ 13 years (age range; 14-80 years), and 51 controls, 30 men, 21 women with a mean age 50.43 $\pm$ 16 years (age range; 19-76 years) were included in the study.

### Imaging protocols

All patients received non-contrast and post-contrast CT scans by either a 128-detector row helical scanner (Brilliance ICT-SP128, Phillips) or a dual source 64-detector row helical scanner (Somatom, Definition Flash, Siemens) with axial, coronal, sagittal nasopharyngeal planes reconstruction. Images were obtained with parameters as follows, 80-100 kVp, section thickness interval of 1-3 mm, iodinated contrast 1ml/kg, and 40-50 seconds delayed scan after contrast injection.

Pre-treatment MRI was performed in four patients by either 3T MR scanner (Phillips Achieva; Philips, Best, the Netherlands) or 1.5T MR scanner (MAGNETOM Aera; Siemens, Erlangen, Germany) in nasopharyngeal planes. Images were performed using a routine nasopharyngeal protocol [axial, coronal and sagittal pre-contrast T1-weighted imaging (T1WI), axial and coronal T2-weighted imaging with fat suppression (T2FS) of nasopharynx, axial, coronal and sagittal T1-weighted fat-suppressed after administration of gadolinium-based contrast (0.1 mmol/kg), with a T2FS with a field of view included neck for evaluation of the cervical lymph node.



Figure 1. Axial Bone Window CT Image of Nasopharyngeal Carcinoma Patient Shows Sclerosis of the Right Pterygoid Process (Arrow)

### Imaging interpretation

Two neuroradiologists reviewed CT and MRI on a picture archiving and communication system version 1.0.0.2 workstation monitor by consensus in sclerosis and erosion of pterygoid plate, the presence of adjacent enhancing tumor and parapharyngeal extension of CT with pterygoid plate signal intensity on T1WI, T2WI fat suppression and post-contrast T1WI was determined. All findings were recorded as presence or absence in each side of the pterygoid plate. The definitions of each finding were as follows; Sclerosis was the increase attenuation in the bone medulla with or without thickening of bony cortex, erosion was the decrease or loss of the cortical bone surface with or without loss of the adjacent trabecular bone, adjacent tumor enhancement was the detectable tumor which enhanced on post-contrast study abutting the pterygoid plate, and parapharyngeal extension was the detectable tumor which enhanced on post-contrast study extending posterolaterally beyond the pharyngobasilar fascia.

### Statistical analysis

All data were analyzed with IBM SPSS statistics software version 19. Demographic data and imaging findings were interpreted by descriptive analysis. The prevalence of sclerotic pterygoid plate was compared between nasopharyngeal carcinoma and control groups by Chi square tests. The recorded findings were analyzed by binary logistic regression analysis. The p-values less than 0.05 indicates statistically significant of all statistic test and using 95% CI.

## Results

According to the tumor staging (T-staging) from the 7th edition of American Joint Committee on Cancer staging Classification, three patients (5.9%) were T1, 27 patients (52.8%) were T2, nine patients (17.6%) were T3, and 12 patients (23.5%) were T4. The prevalence of sclerotic pterygoid plate in nasopharyngeal carcinoma (Figure 1.) was 53.92% (55 of 102 pterygoid plates), and the prevalence was 16.66% (17 of 102) in control group (P-value<0.01). The prevalence of adjacent tumor to the pterygoid plate, parapharyngeal extension (Figure 2.,3.) and pterygoid plate erosion (Figure 3.) were 69.6% (71 of 102), 81.37% (83 of 102), 38.23% (39 of 102), respectively. All 39 subjects detected with pterygoid plate erosion had adjacent tumor enhancement. The odds ratio of adjacent tumor enhancement and pterygoid plate erosion was 7.29 (95% CI, 1.38 to 38.54) and 20.56 (95% CI, 3.97 to 106.29) times in the sclerotic pterygoid plate (p-values

Table 1. Logistic Regression Analysis of Other Findings with Pterygoid Process Sclerosis

Characteristic	Binary logistic regression	
	OR (95%CI)	P-value
Adjacent tumor enhancement	7.29 (1.38-38.54)	0.019*
Pterygoid process erosion	20.56 (3.97-106.29)	0.000*
Parapharyngeal extension	10.41 (0.6-178.87)	0.106

Pseudo R-squared, 0.4911; \*, significant p-value

Table 2. MRI Findings of the Five Sclerotic Pterygoid Plates

Subjects	MRI			CT scan	
	T1WI	T2FS	Post-contrast T1WI	Pterygoid process sclerosis	Adjacent tumor enhancement
1 Left	↓	↑	Faint enhancement	Present	Present
2 Right	↓	↓	No enhancement	Present	Present
2 Left	↓	↑	Obvious enhancement	Present	Present
3 Right	↓	↓	No enhancement	Present	Present
4 Left	↓	↓	No enhancement	Present	Present

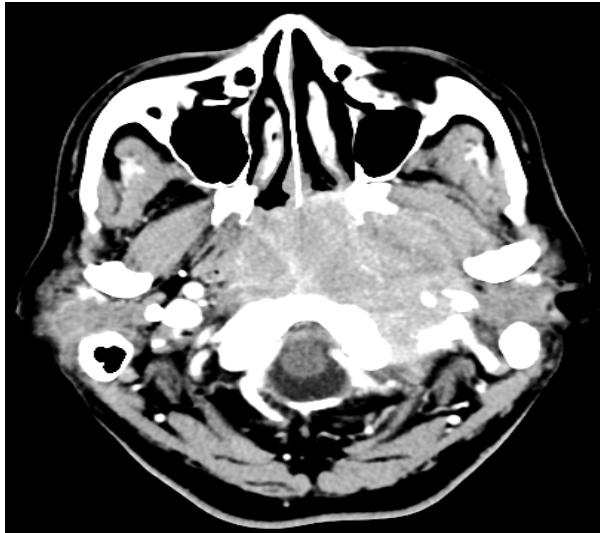


Figure 2. Axial Soft Tissue Image with Contrast Administration Shows Bilateral Parapharyngeal Extension.

of 0.019 and 0.000, respectively) (Table 1).

Pretreatment MRI was available in four nasopharyngeal carcinoma cases with five sclerotic pterygoid plates on CT. Two of these cases showed enhancement with hyposignal on T1WI and hypersignal on T2FS. The rest (three of five) demonstrated hyposignal on T1WI, T2FS with no enhancement. Three non-sclerotic pterygoid plates were iso-hypersignal on T1WI, isosignal on T2WI, and had no enhancement on MRI (Figure 4) (Table 2).

Table 3. Diagnosis of Control Group

Diagnosis	Number of patient
Trauma	11
Infection	11
Congenital cyst	10
Vascular abnormality	3
Benign neck mass	3
Foreign body	3
Work up for other cause such as odynophagia	10

For the control group the indications for CT scan were trauma and infection, distance to the pharyngeal area. (Table 3) No erosion of pterygoid plate in control group was identified.

## Discussion

According to the National Comprehensive Cancer Network guideline version 1.2016 for nasopharyngeal cancer, the primary treatment for nasopharyngeal carcinoma is non-operative treatment. Radiotherapy is one of the primary treatments that must be given with either three-dimensional conformal radiotherapy or intensity modulated RT technique (Lee et al., 2009). Due to the limitation to assess extension from physical examination and pathological tissue, CT and MRI are the modality for tumor staging and for delineating the extension of the

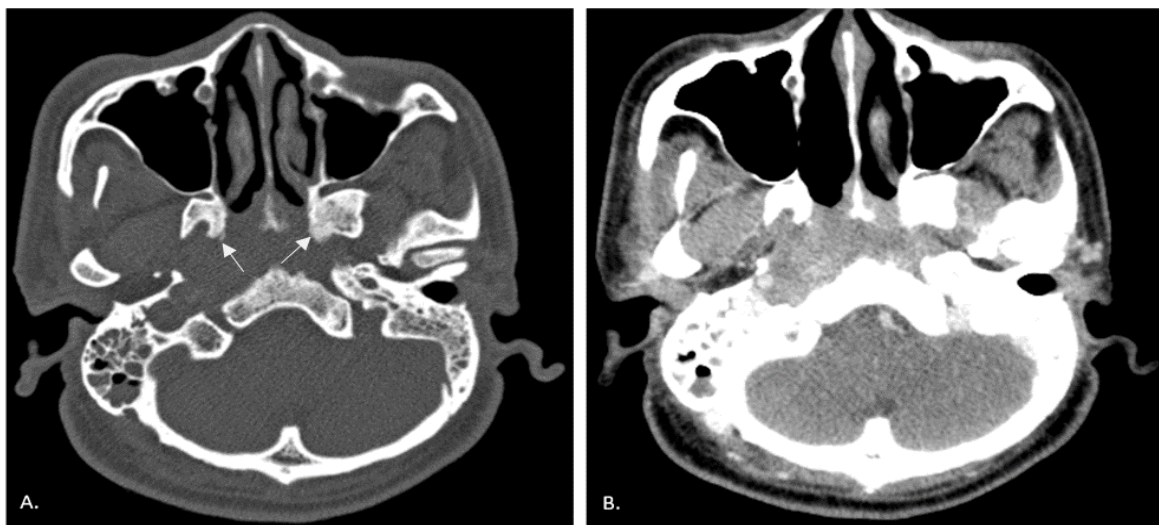


Figure 3. Axial CT Images of a Nasopharyngeal Carcinoma Patient (A) Bone window image shows bilateral sclerotic pterygoid plates with erosion (arrow) (B) Soft tissue window image with contrast administration shows adjacent tumor enhancement (arrowhead) and bilateral parapharyngeal extension

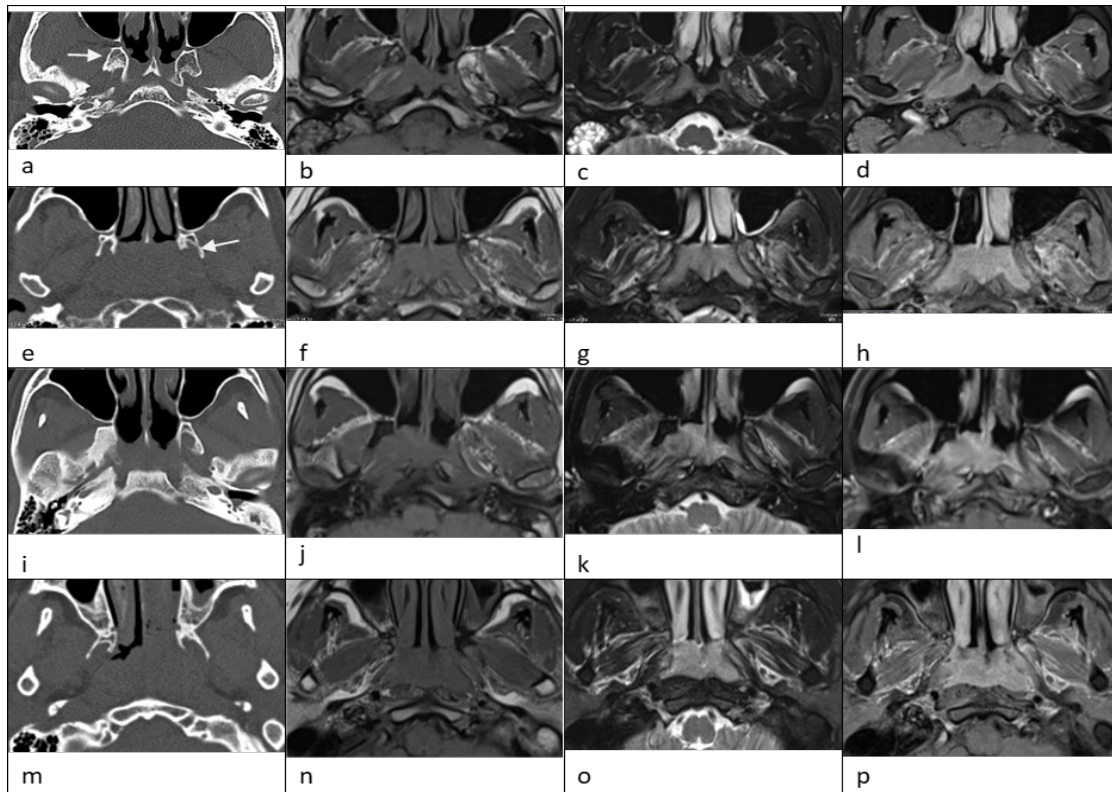


Figure 4. (a), (b), (c) and (d) showed CT scan bone window, T1WI, T2FS, and post-contrast T1WI of the same patient. Sclerosis pterygoid plate is observed on the right side on CT, and MRI demonstrates hyposignal on T1WI, hypersignal on T2FS and faint enhancement on post-contrast T1WI. (e)-(h) are the image set of another patient showing similar pattern at the sclerotic left pterygoid plate. The sclerotic right pterygoid plate in this patient shows hyposignal on T1WI, T2FS and no contrast enhancement. (i)-(l) and (m)-(p) are the image sets of another two patients with sclerosis of pterygoid plates on the right and left sides respectively. The sclerotic pterygoid plates in these two patients demonstrate hyposignal on T1WI, T2FS and no contrast enhancement. The two enhanced pterygoid plates are arrowed in (a) and (e).

tumor (Sham et al., 1991b; Weber et al., 2003).

Nasopharyngeal carcinoma with and without skull base involvement is considered to be different tumor staging according to the 7<sup>th</sup> edition of American Joint Committee on Cancer staging Classification, which may have different treatment protocols. (Sultanem et al., 2000; Edge and Compton, 2010). CT imaging findings of tumor involvement of the skull base have been reported as bone erosion and associated perineural spreading (Sham et al., 1991b, 1991a). A recent report by Shatzkes et al., (2006) found a significantly higher prevalence of sclerotic pterygoid plate in patients with nasopharyngeal carcinoma. They postulated that sclerosis might occur because of tumor proximity or tumor invasion.

They compared the finding with the sclerotic appearing laryngeal cartilage in laryngeal carcinoma which has been found, histopathology, to be related with cartilaginous invasion (Muñoz et al., 1993). However, due to the lack of histopathology of the pterygoid plate in patients with nasopharyngeal carcinoma, the correlation of this observed finding with histopathology is not possible. MRI is known to be superior to CT for outlining anatomical structures of the nasopharynx, and evaluation of skull base involvement (King and Bhatia, 2010; Razek and King, 2012). Five sclerotic pterygoid plates on MRI in our study showed two patterns. For instance, two pterygoid plates were shown to be hyposignal on

T1WI, hypersignal on T2FS and enhanced, which would represent tumor involvement or bone marrow edema. We found that three cases on the other hand were hyposignal on T1WI, T2FS with no enhancement which would represent simple sclerosis (King and Bhatia, 2010). None of the non-sclerotic pterygoid plates were enhanced. As there are a small number of MRI cases, we can only speculate that about 40% of sclerotic pterygoid plates on CT scan may have a true tumor involvement which requires further detailed examination.

Shatzkes et al., (2006) found higher prevalence of sclerotic pterygoid plate in their nasopharyngeal carcinoma group but with no statistical significance, however, our study with a larger sample size, found a significantly higher prevalence of sclerotic pterygoid plate in nasopharyngeal carcinoma patients as compared to the control group (P-value<0.01). The sclerotic pterygoid plates also have a high chance of having adjacent tumor enhancement and pterygoid plate erosion (p-values of 0.019 and 0.000, respectively). Additionally, we found that all pterygoid plate with erosion had adjacent tumor enhancement representing tumor invasion of the skull base, similar to the prior study by Razek and King (2012)

The major limitation of our study was the lack of proven histopathological evidence of early tumor extension of pterygoid plate from tumor because the treatment of nasopharyngeal carcinoma is not tumor

resection. However, with the concurrent usage of MRI, we found that sclerotic pterygoid plate may indeed be related to tumor involvement. A more substantial number of MRI studies, in correlation with CT scans, can provide an assessment of these results.

In conclusion, the prevalence of sclerotic pterygoid plate is significantly higher in patients with nasopharyngeal carcinoma with a considerably higher chance of adjacent tumor enhancement and pterygoid plate erosion. Apart from histopathology, MRI can be a promising tool to depict the correlation between a sclerotic pterygoid plate and true tumor extension.

### Author Contribution Statement

A.B., W.P. and N.O. conceived of the presented idea, developed the theory and performed the computations. N.O. contributed to sample preparation. A.B. and W.P. verified the analytical methods. W.P. supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

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