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Evaluation of the pattern and mechanism of bony invasion in gingivobuccal sulcus and gingival squamous cell carcinoma and its correlation with the regional lymph node metastasis: A histopathological study

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ABSTRACT

Objective: The purpose of this study was to assess the frequency of bony invasion and to evaluate the pattern and mechanism of tumor invasion into the bone and its correlation with the regional lymph node metastasis in gingivobuccal sulcus (GBS) and gingival squamous cell carcinoma.

Study design: A prospective study in which 25 resected specimens of the jaws along with the associated lymph nodes of patients treated for GBS and gingival squamous cell carcinomas were evaluated for the frequency, pattern and mechanism of tumor invasion into the bone and the regional lymph node metastasis, using a light microscope.

Results: 8 of the 25 cases showed bony invasion, among which 5 (20%) showed invasive pattern of tumor invasion while 3 (12%) showed the erosive pattern into the bone. The main mechanism of bony invasion was via the cortical plate (20%) than the periodontal ligament (12%). Regional lymph node metastasis was seen in 6 of the 8 cases showing bony invasion. No significant correlation was found between any of the above parameters.

Conclusion: In our attempt to study the tumor invasion into the bone, we found no significant correlation between the pattern and mechanism of invasion and the regional lymph node metastasis. A possible treatment guide through our study to the surgeon from our side is to prevent aggressive resections and to preserve the integrity of the jaw and thus, to provide the maximum probability of cure and maintain the quality of life.

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1. Introduction

Oral squamous cell carcinoma (OSCC) remains the 6th most common malignant neoplasm worldwide, constituting about 95% of all oral cancers.[1] OSCCs are characterized by an aggressive behavior and associated with a low 5-year survival rate, mainly because of metastatic disease.[2] The most common affected sites are the floor of the mouth, the ventrolateral part of the tongue, the soft palate complex[3]

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and the gingivobuccal complex (GBC).[4] The GBC carcinomas constitute the buccal mucosa, gingivobuccal sulcus (GBS), the gingiva and the retromolar trigone (RMT)[4] with 40% in the GBS,[5] 63.75% involving the buccal mucosa,[6] 15% in the RMT[6] and less than 10% on the gingiva.[7]

Gingival/GBS SCC has its own unique clinical significance. Because the thickness of gingiva overlying the alveolar bone does not exceed 2–3 mm, they have a strong predilection for the tumor invading the bone.[8] Histopathologically, two patterns of bony invasion are identified: the erosive/arrosive pattern and the infiltrative/invasive pattern.[7] In the erosive/arrosive pattern of bony invasion, the tumor cells invade in a broad front, with no bony remnants within the tumor mass and the tumor cells separated from the normal bone by a well demarcated fibrous zone with active osteoclasts separating the tumor from the bone. On the other hand, the infiltrative or the invasive pattern shows tumor cells invading as irregular cords and islands. Partially lysed bony spicules with little osteoclastic activity are present within the tumor mass with no clear cut demarcating tissue between the tumor and bone.[9]

The pattern of bony invasion plays a role in predicting prognosis of the disease with a 5-year cumulative survival rate of 76.6% in erosive pattern and 53.9% for the infiltrative pattern.[10] Therefore, it would be of considerable advantage to the surgeon to know the pattern of invasion prior to surgery.

Gingival and GBS SCCs have more predilection for bony invasion and variable lymph node metastasis.[5] Cervical lymph node metastases were 11.1% in those cases without bony invasion, while those with bony invasion ranges from 22.2% to 45.5%. The 5-year survival rate of 100% was seen in patients with no bony invasion but it is not the case for those with bony invasions. For the cases with bony invasion, depending on the depth of invasion, the 5-year survival rate ranges from 28.2% to 76.2%.[11]

Knowledge of the pathway of entry of tumor into the bone and of the patterns of spread within the bone is essential in adopting a logical approach to bone resection in oral cancer surgery. Hence, we intend to evaluate in our study, the pattern and mechanism of bony invasion by the tumor and if there is any correlation with regional lymph node metastasis.

2. Materials and methods

The study consisted of 25 resected specimens of maxillary and mandibular jaws of subjects who were diagnosed with either OSCC of GBS or gingiva and were treated with radical neck dissections. It is a prospective study in which the resected specimens along with the associated lymph nodes were collected from the Department of Oral and Maxillofacial Pathology, The Oxford Dental College and Hospital, Bangalore, from November 2012 to May 2014. All grades of OSCC of the gingiva and GBS were included in the study. Association with any form of habits and systemic diseases was not assessed which is considered as a drawback.

The specimens were grossed and the bone was kept for decalcification in 10% formic acid. After decalcification, the tissues were continued with routine processing and paraffin wax embedding. The associated lymph nodes were also grossed and taken for routine processing and embedding. The embedded tissue was then cut into 5 μm thick sections, stained with haematoxylin and eosin stain and viewed under the light microscope. The lymph nodes were cut into 2 μm thick sections and were also viewed under the light microscope. The tissues were histopathologically assessed for pathological jaw invasion, the type of invasion and the route of invasion or spread. The type of invasion was classified as (i) erosive and (ii) invasive.[9] The mechanism of tumor invasion/route of spread into the bone was through various ways as suggested by Brown and Browne et al.[9] Any tumor cells in and around the periosteum were not considered bony invasion if there were not clear evidence of invasion into the periosteum, periodontal space, or bone. The lymph node involvement was confirmed, if there was presence of any tumor cells in the lymph nodes. The results obtained were then statistically analyzed for correlation between the pattern and mechanism of tumor invasion into the bone and lymph node metastasis using Pearson's Chi-Square correlation test using SPSS11 software.

3. Results

The study comprised of 25 resected specimens of jaws as a part of the treatment for gingival/GBS SCC. Out of these 25, 16 (64%) were male, showing male predilection. All the cases were that of patients who were over 30 years of age, and it showed almost equal distribution from 4th to 7th decades of life. Slight increase was seen in the 6th and 7th decades.

The frequency of tumor invasion into the bone was found to be 32%, that is, in 8 of the 25 cases. Among these 8 cases, 4 were in the maxilla and 4 in the mandible.

As per our aim, the pattern of tumor invasion was examined histopathologically in those cases showing tumor invasion into the bone and was found that 20% of the cases showed invasive pattern (Fig. 1) of invasion into the bone while 12% had the erosive pattern (Fig. 2) (Table 1). 68% did not show any evidence of tumor invasion into the bone.

Histopathological examination was also done to evaluate the mechanism of tumor invasion into the bone or the route in

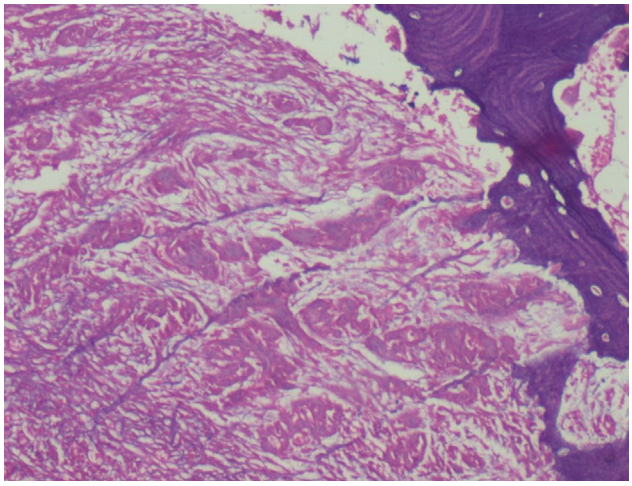


Fig. 1 – Photomicrograph of invasive pattern of tumor invasion into the bone (10×).

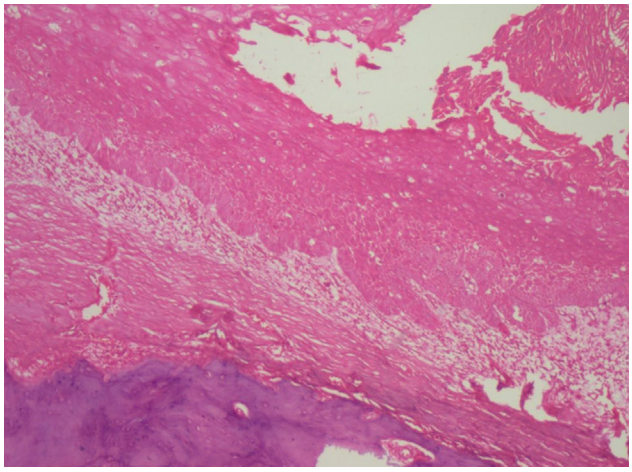


Fig. 2 – Photomicrograph showing histopathologically the erosive pattern of invasion into the bone (10×).

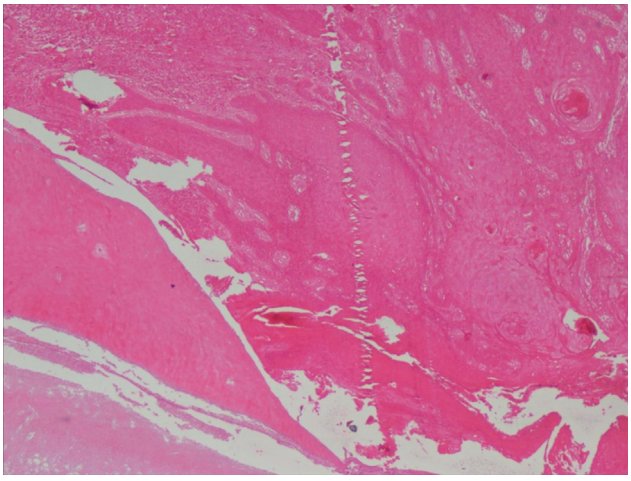


Fig. 4 – Photomicrograph showing tumor invasion into the bone via the periodontal ligament (10×).

Table 1 – Pattern of tumor invasion into the bone.

Bone invasion	Pattern of invasion	Number	Percentage
Yes	Erosive	3	12%
	Invasive	5	20%
No	No invasion	17	68%
Total		25	100%

Table 2 – Mechanism of tumor invasion into the bone.

Bony invasion	Mechanism of invasion	Number	Percentage
No	No invasion	17	68%
Yes	Periodontal ligament	3	12%
	Cortical	5	20%
	Total	25	100%

which the tumor invaded the bone. It was found that the tumor invaded the bone through the cortical plate (Fig. 3) in 5 (20%) cases and 12% was found to be invading the bone via the PDL (Fig. 4) (Table 2).

Our main aim was to correlate the pattern and mechanism of tumor invasion into the bone and regional lymph node metastasis. Out of the 8 cases showing bony invasion, 6 cases had lymph node involvement (Fig. 5). A Pearson's Chi-Square test was performed at null hypothesis with a p value of ≤0.05, to know the correlation among the above parameters. The pattern of tumor invasion was correlated with the regional

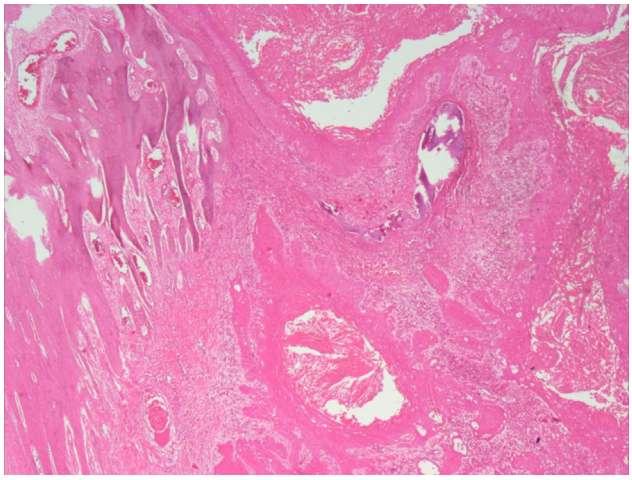


Fig. 3 – Photomicrograph showing tumor invasion into the bone via the cortical plate (10×).

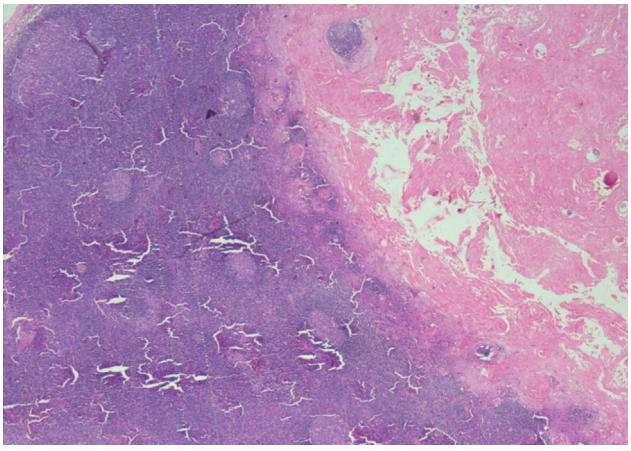


Fig. 5 – Photomicrograph showing histopathologically the regional lymph node metastasis (4×).

lymph node metastasis and a value of 4.444 was obtained with a p value of 0.107 (Table 3). The result showed no significant correlation between the pattern of tumor invasion into the bone and the regional lymph node metastasis.

The mechanism of tumor invasion into the bone was also correlated with the regional lymph node metastasis and a value of 0.178 was obtained with a p value of 1.000 (Table 4), showing no significant correlation.

We also had tried to correlate the pattern of bony invasion with the mechanism of tumor invasion into the bone and a value of 1.742 was obtained with a p value of 0.464. This result

Table 3 – Correlation of the regional lymph node metastasis with the pattern of tumor invasion into the bone.

		Pattern of invasion		Total
		Erosive	Invasive	
Lymph node metastasis ($n = 8$)	Positive	1	5	6
	Percentage	12.50%	62.50%	75%
	Negative	2	0	2
	Percentage	25%	0%	25%
Total		37.50%	62.50%	100%

Chi-Square tests

	Value	*df*	*p* Value
Pearson's Chi-Square	4.444	1	0.107
N of valid cases	8		

Table 4 – Correlation of the regional lymph node metastasis with the mechanism of tumor invasion into the bone.

		Mechanism of invasion		Total
		Periodontal ligament	Cortical plate	
Lymph node metastasis ($n = 8$)	Positive	2	4	6
	Percentage	25.00%	50.00%	75%
	Negative	1	1	2
	Percentage	12.50%	12.50%	25%
Total		37.50%	62.50%	100%

Chi-Square tests

	Value	*df*	*p* Value
Pearson Chi-Square	.178	1	1.000
N of valid cases	8		

Table 5 – Correlation of the pattern and mechanism of tumor invasion into the bone.

		Pattern of tumor invasion		Total
		Invasive	Erosive	
Mechanism of tumor invasion	Cortical Plate ($n = 5$)	4	1	5
	Percentage	80%	20%	100%
	Periodontal ligament ($n = 3$)	1	2	3
	Percentage	33.30%	66.70%	100%

Chi-Square tests

	Value	*df*	*p* Value
Pearson's Chi-Square	1.742	1	0.464
N of valid cases	8		

concludes that there is no significant correlation between the pattern and mechanism of tumor invasion into the bone (Table 5).

4. Discussion

Gingival/GBS SCC has its own unique clinical significance. Because the thickness of gingiva overlying the alveolar bone does not exceed 2–3 mm, they have a strong predilection for the tumor invading the bone.[8] Histopathologically, two patterns of tumor invasion into the bone were described by Brown and Browne et al.: the erosive and the invasive patterns. Our study comprised of 25 resected specimens of the jaws as part of the treatment for GBS/gingival OSCCs of which 17 were in the mandible and 8 were in the maxilla and showed male predilection. Out of the 25 jaw specimens considered in our study, only 8 (32%) cases showed bony invasion, which were slightly increased than that shown in a study conducted by Fitzpatrick et al.[7] on 519 cases of gingival SCC and also with the study conducted by Lubek et al.[10] Our estimate of bone involvement may be minimal as the sample size was small.

Histpathological examination for pattern of tumor invasion showed invasive pattern in 20% cases and 12% erosive pattern which is in accordance with the study conducted by Pandey et al.[12] The cases with invasive pattern of bone involvement

are aggressive forms as the tumor infiltrated the bone with no broad connective tissue layer in the resorbing front.

20% of the cases invaded the bone via the cortical plate while 12% invaded through the PDL and the result is as that found by Brown and Browne et al.[9] in their study, which is because most of the gingival tumor invade the bone via the attached mucosa with its firm collagen attachment to the bone.

There was no significant correlation between the pattern and mechanism of bony invasion with the regional lymph node metastasis as that found in a literature review by Woolgar[13] which mentioned that tumors of gingiva and alveolar ridges are the most likely to involve bone, but the risk of nodal metastasis in this sites is low. No literature was found which correlates the pattern and mechanism of bony invasion as done in our study.

Based on the understanding of pattern of bony invasion, mechanism of bony invasion and its correlation with regional lymph node metastasis, our study can possibly be used to guide the surgeons for an adequate treatment plan. From a therapeutic perspective, it is crucial to determine bone involvement and its extension based on sufficient understandings on patterns of tumor spread. In the management of gingival and GBS SCCs with bony invasion, surgeons have no specific guidelines in determining the appropriate extent of bony resection while entirely clearing the tumor cells and preserving the functions whenever possible. Therefore, studies like ours can be used in guiding the surgeons in preserving the margins and maintaining the integrity of the jaw during treatment procedure, so that the functions and esthetics of the oro-maxillofacial region are preserved.

Some of the gingival/GBS SCCs could have been controlled by resection of the periosteum without aggressive resections like maxillectomy or mandibulectomy. Thus, the treatment should provide the maximum probability of cure and maintain quality of life. But yes, it is difficult to decide the procedure of choice before surgery. So, a clinical, radiographic and histopathological examination combined together will help in preserving the jaws. There are various studies that have helped to understand the pattern and extent of bony invasion by OSCCs, but accurate preoperative estimation of bony invasion remains challenging.[14]

The main drawback of our study is that, we had a very small sample size as we have considered only the GBS SCC and the gingival SCC which accounts for only 10%[7] of all OSCC cases. We have not taken into consideration the radiographic features of the cases before resection which when combined with the clinical and histopathological features could have provided a better guideline towards the treatment plan. Also, we have not taken into consideration the tumor size of all these 25 cases, if considered, we would have understood if there is any difference in the tumor size of the cases showing tumor invasion into the bone to those showing no evidence of tumor invasion into the bone. Also, GBS SCC and gingival SCC were taken together and not evaluated separately.

Although limited, our data show that there are minimal invasion of the tumor into the bone in cases of gingival/GBS SCC. It also shows that the tumor mainly invaded the bone via the cortical plate more than the PDL which was suggested to be the preferred route of entry of tumor into the bone in dentate jaws. So through our study, we wanted to guide the surgeons in making an appropriate treatment plan, preserve the integrity of the jaws and thus improve the quality of life of the patients.

5. Conclusion

Through our study, we tried to correlate pattern of tumor invasion and mechanism of tumor invasion with the regional lymph node metastasis. No significant correlation was found between these parameters. Thus, a possible treatment guide or treatment plan through our study to the surgeon from our side is to prevent aggressive resections like maxillectomy or mandibulectomy and to preserve the integrity of the jaw.

Some drawbacks or limitations of our study were that, we had not taken into consideration the radiographic feature of the cases before resection and also other features like tumor size and grades of the OSCC. Our sample size also was minimal. Further studies including a large number of sample size and rectification of the above-mentioned drawbacks may provide in making an appropriate guideline for treating the gingival/GBS SCCs.

Conflicts of interest

The authors have none to declare.

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