Review Article

Literature review of 86 cases of mandibular ameloblastic carcinoma

ABSTRACT

Ameloblastic carcinoma is considered to be a rare epithelial malignant neoplasm of odontogenic origin occurring mainly in the mandible. Ameloblastic carcinoma has been a topic of controversy regarding management from past many years. We reviewed 86 cases of mandibular ameloblastic carcinoma from 1981 to 2014, on the basis of the electronic search of peer-reviewed journals in MEDLINE (PubMed) database. Age, sex, tumor size, treatment delivered, recurrence, metastasis, follow-up period, and dead/alive status are tabulated, and the data are analyzed. The mean age was 43.47 years with standard deviation ± 21.09. The age range was between 15 and 91 years, and male to female ratio was 2.18:1. Knowledge gained from the present review would help in establishing the best therapeutic options for ameloblastic carcinoma, and it also encourages the further reporting of ameloblastic carcinoma.

Keywords: Ameloblastic carcinoma, mandible, radiotherapy, surgical resection

INTRODUCTION

Odontogenic malignancies are rare lesions that comprise 1% of all cysts and tumors occurring in the jaws.[1,2] Different terms are used to designate odontogenic carcinomas which include malignant ameloblastoma, ameloblastic carcinoma, metastatic ameloblastoma, or primary intraosseous epidermoid carcinoma.

Ameloblastic carcinoma is a rare entity that shows the histopathological signs of ameloblastoma with cytological atypia with or without distant metastasis. For past many years, ameloblastic carcinoma has been a topic of controversy regarding definition and classification due to its rarity and also due to various terminologies related to malignant or metastasizing variant of tumor.

In 1972, WHO published classification of odontogenic malignant tumors, which also included malignant ameloblastoma.[3] In 1982, Elzay[4] introduced term ameloblastic carcinoma and suggested a modified classification to distinguish between ameloblastic carcinoma (with histopathological features of malignancy) and malignant ameloblastoma (which retains histopathological features of a simple ameloblastoma at the distant metastasis site). In 1984, Slootweg and Müller[5] proposed a modification in Elzay's classification related to the origin of the tumor. In the latest update of WHO classification of odontogenic tumors[6] published in 2005, ameloblastic carcinoma is subdivided into primary type (developing *de novo*) and secondary type (developing by malignant transformation of ameloblastoma). The secondary type is further subdivided into intraosseous and peripheral type. Among the reported cases of ameloblastic carcinoma, the prevalence of mandibular ameloblastic carcinoma comprises around two-third with maxillary incidence of one-third.[7]

AIM OF PRESENT LITERATURE REVIEW

The aim of the present literature review is to collate and analyze the various modalities utilized in the management

Sandeep Pandey, Ongkila Bhutia, Ajoy Roychoudhury, Ankit Arora, Krushna Bhatt

Department of Oral and Maxillofacial Surgery, All India Institute of Medical Sciences, New Delhi, India

Address for correspondence: Dr. Krushna Bhatt, Department of Oral and Maxillofacial Surgery, All India Institute of Medical Sciences, New Delhi, India.
E-mail: bhatt_krushna@yahoo.com

Access this article online

Website: www.njms.in

DOI: 10.4103/njms.NJMS_33_16

Quick Response Code

How to cite this article: Pandey S, Bhutia O, Roychoudhury A, Arora A, Bhatt K. Literature review of 86 cases of mandibular ameloblastic carcinoma. Natl J Maxillofac Surg 2018;9:2-7.

of mandibular ameloblastic carcinoma as well as to see the recurrence and metastasis associated with the various procedures. Knowledge gained from the present review would help in establishing the best therapeutic options for ameloblastic carcinoma, and it also encourages the further reporting of ameloblastic carcinoma.

MATERIALS AND METHODS

The published cases of mandibular ameloblastic carcinoma since 1981 were presented in Table 1. Age, sex, tumor size, treatment delivered, metastasis, recurrence, follow-up period, and dead/alive status were tabulated and the data were analyzed. However, all the details for every case were not available. Search engines and medical database such as PubMed, Medline, and Pubgate were tapped for information and relevant articles related to the mandibular ameloblastic carcinoma. The search words "Ameloblastic Carcinoma," "Surgical intervention in ameloblastic carcinoma," and "Radiotherapy in ameloblastic carcinoma" were employed for retrieval of data. The analysis of various treatment modalities, reason for choice of particular modality, recurrence, and follow period was done. The search was restricted to English language articles, published from 1981 to 2014.

RESULTS

The mean age was found to be 43.47 years with standard deviation ± 21.09. The age range for the patients was between 15 and 91 years. Male to female ratio was 2.18:1. Follow-up period ranged from 0 to 540 months. Out of 86 cases reported, 50 had received surgical management only, 14 had received additional radiotherapy, two had surgery plus radiotherapy and chemotherapy, and eight patients declined any treatment. There were single cases of isolated radiotherapy and chemotherapy. In 10 reports, the treatment was not specified. Out of 68 cases, which had the treatment mentioned specifically, only 21 report ≥5 years follow-up. Out of these 21, 11 had disease-free state and 10 had either local recurrence or metastasis. Interestingly, only one of the eleven disease-free cases had received postoperative radiotherapy. On the other hand, 33/68 cases showed recurrence/metastasis at follow-up ranging from 6 to 540 months. These patients with recurrent disease had treatment distribution as follows: 18 had only surgical treatment, 11 had surgery and radiotherapy, two patients had surgery plus radiotherapy and chemotherapy, and another two patients had isolated radiotherapy and chemotherapy each. In variable follow-up period, 10 had lymph node spread and 13 had distant metastasis. These figures suggest aggressive nature and malignant potential of the pathology.

DISCUSSION

Ameloblastic carcinoma is considered to be a rare malignant neoplasm of odontogenic origin. Clinically and radiographically, ameloblastoma and ameloblastic carcinoma both resemble each other but ameloblastic carcinoma can be suspected if there is a sudden increase in the size of the swelling, pain, paresthesia, expansion, and perforation of cortical plate with soft tissue extension or if there is any foci of calcification as these features are unusual in ameloblastoma. A preoperative 18F-α-methyl tyrosine or 18-fluorodeoxyglucose positron emission tomography (PET) scan may help to differentiate the malignant and benign areas in the tumor mass.[37,45]

Histopathologic evaluation shows ameloblastic differentiation, palisading of basaloid cells, and stellate reticulum pattern in the follicles and the features of malignancy such as cellular atypia, mitotic figures, and nuclear hyperchromatism. Immunohistochemical studies may help to differentiate ameloblastic carcinoma from simple ameloblastoma. Increased expression of Ki-67 and Notch1 and decreased expression of Syndecan-1 are associated with the diagnosis of ameloblastic carcinoma over that of simple ameloblastoma.[33] In simple ameloblastoma alpha- smooth muscle actin, expression is found in only stroma close to the epithelium, whereas in ameloblastic carcinoma, this is found in both the stellate reticulum-like cells as well as in the stroma. This may signify epithelial–mesenchymal transition and may be associated with distant metastasis.[33] Hypermethylation of p16 tumor suppressor gene is thought to be related to carcinomatous transformation of a benign ameloblastoma.[46] Likewise, proliferating cell nuclear antigen marker signifies aggressiveness of any ameloblastoma and hence its potential to develop into a secondary ameloblastoma.[47] Raised matrix metalloproteinase-2 levels with reduced expression of RECK mRNA and upregulation of NK-1R are also associated with malignant transformation.[48,49]

In cases of ameloblastic carcinoma, patient should be further evaluated to rule out any nodal and distant metastasis. Staged workup including computed tomography of head and neck, chest radiograph, and abdominal ultrasonography needs to be done because even in the absence of local or regional recurrence, distant metastasis can occur.[15] PET scan is useful to monitor for recurrence and/or metastatic spread. Postoperative PET scan is also helpful to differentiate between postoperative fibrosis and tumor recurrence and for restaging local nodal or distant metastatic spread.[50] All the necessary investigations are required to rule out local recurrence and metastasis at required interval. Some studies

Table 1: Literature review of 86 cases of mandibular ameloblastic carcinoma from 1981 to 2014

Case	Year	Authors	Age (year)	Sex	Tumor size (cm)	Treatment delivered	Metastasis/recurrence	Follow-up (months)	Dead/alive status
1	1981	Azumi *et al*.[8]	23	Female			Skull/recurrence	5	A
2	1984	Slootweg and Müller[5]	75	Male		SR + CH/RT	Recurrence	12	D
3	1984	Slootweg and Müller[5]	23	Female		SR	Recurrence	540	D
4	1987	Corio *et al*.[7]	33	Male	4	S	Recurrence	8	A
5	1987	Corio *et al*.[7]	46	Female		S	LN/recurrence	12	A
6	1987	Corio *et al*.[7]	17	Male	5	SR	Recurrence	12	A
7	1987	Corio *et al*.[7]	20	Female				0	A
8	1987	Corio *et al*.[7]	23	Female				0	A
9	1987	Corio *et al*.[7]	67	Female				0	A
10	1987	Corio *et al*.[7]	84	Male				0	A
11	1988	Dorner *et al*.[9]	81	Male	8×6 × 4	SR	Lung	17	D
12	1991	Bruce and Jeckson[10]	57	Male	4×4	SR + RT	LN/lung	8	D
13	1991	Nagai *et al*.[11]	50	Male	5×4 × 3	SR	Recurrence	11	A
14	1992	Gandy *et al*.[12]	32	Female		SR		42	A
15	1992	Gandy *et al*.[12]	20	Male		SR		48	A
16	1998	Fisch-ponsot *et al*.[13]	70	Male			LN	120	A
17	1998	Lau *et al*.[14]	23	Male	5×4 × 3	SR		60	A
18	1998	Lau *et al*.[14]	73	Male		SR		24	A
19	1998	Simko *et al*.[15]	64	Female	15×6 × 5	SR + RT	Lung/brain	28	D
20	2000	Cox *et al*.[16]	25	Male	17×16×13	SR		30	A
21	2003	Mosqueda Taylor *et al*.[17]	25	Female				48	A
22	2003	Mosqueda Taylor *et al*.[17]	72	Male				2	A
23	2003	Datta *et al*.[18]	22	Male	3×3 × 3.5	SR + RT/CH	Multiple bone	48	D
24	2003	Oginni *et al*.[19]	65	Male		SR + RT		84	D
25	2003	Oginni *et al*.[19]	23	Male		SR	LN	6	A
26	2004	Carinci *et al*.[20]	81	Male		SR		24	A
27	2004	Cizmecý *et al*.[21]	44	Female	5×5	SR+RT		24	A
28	2004	Goldenberg *et al*.[22]	60	Female		SR+RT	Brain/recurrence	120	D
29	2005	Uzüm *et al*.[23]	66	Male	7.5×7 × 6	SR	Recurrence	30	A
30	2005	Arotiba *et al*.[24]	52	Male	6×5 × 4	SR		24	A
31	2006	Suomalainen *et al*.[25]	21	Female	4	SR		30	A
32	2006	Miyake *et al*.[26]	91	Female		SR		6	A
33	2007	Akrish *et al*.[27]	80	Male		SR		12	A
34	2007	Hall *et al*.[2]	27	Male		S	Recurrence	114	D
35	2007	Hall *et al*.[2]	31	Male		S + RT	Recurrence	492	A
36	2007	Hall *et al*.[2]	43	Female		S + RT	LN/recurrence	60	D
37	2007	Hall *et al*.[2]	50	Male	2.5×3	S	Recurrence	156	D
38	2007	Hall *et al*.[2]	49	Male		S + RT	Recurrence	59	D
39	2007	Hall *et al*.[2]	53	Female		S		369	D
40	2007	Hall *et al*.[2]	59	Male		S + RT	Recurrence	141	D
41	2007	Hall *et al*.[2]	17	Female		SR		122	D
42	2009	Yoon *et al*.[28]	46	Male	5	SR+RT	LN/recurrence	18	A
43	2009	Yoon *et al*.[28]	65	Male		SR+RT	LN	13	A
44	2009	Reid-Nicholson *et al*.[29]	15	Male		SR	LN	-	-
45	2009	Cherry *et al*.[30]	16	Male	7×7 × 6	SR+RT	Lung/brain		A
46	2010	Jeremic *et al*.[31]	58	Male		SR+RT	Lung	21	D
47	2010	Ndukwe *et al*.[32]	16	Male		SR		-	-
48	2010	Ndukwe *et al*.[32]	16	Female		SR		-	-
49	2010	Ndukwe *et al*.[32]	23	Male		SR		6	A
50	2010	Ndukwe *et al*.[32]	24	Male		Declined			
51	2010	Ndukwe *et al*.[32]	25	Female		Declined			
52	2010	Ndukwe *et al*.[32]	27	Male		Declined			
53	2010	Ndukwe *et al*.[32]	31	Female		SR			

Contd...

Table 1: Contd...

Case	Year	Authors	Age (year)	Sex	Tumor size (cm)	Treatment delivered	Metastasis/recurrence	Follow-up (months)	Dead/alive status
54	2010	Ndukwe *et al*.[32]	32	Male		SR	LN	12	A
55	2010	Ndukwe *et al*.[32]	33	Female		Declined			
56	2010	Ndukwe *et al*.[32]	34	Male		SR	Recurrence	18	D
57	2010	Ndukwe *et al*.[32]	34	Female		Declined			
58	2010	Ndukwe *et al*.[32]	36	Female		-			D
59	2010	Ndukwe *et al*.[32]	39	Male		Declined			
60	2010	Ndukwe *et al*.[32]	49	Male		SR			
61	2010	Ndukwe *et al*.[32]	65	Male		SR	Recurrence	96	D
62	2010	Ndukwe *et al*.[32]	65	Male		Declined			
63	2010	Ndukwe *et al*.[32]	85	Female		Declined			
64	2010	Kamath *et al*.[33]	64	Male	6×5	SR		0	
65	2010	Karakida *et al*.[34]	43	Male	5.5×4.5	SR		46	A
66	2010	Roy Chowdhury *et al*.[35]	67	Female	4×3	SR		6	A
67	2010	Ram *et al*.[36]	21	Male	2.4×5.5×6	SR		24	A
68	2010	Devenney-Cakir *et al*.[37]	16	Male	8×6×5	SR	Recurrence/lung + brain	48	A
69	2011	Maheshwari *et al*.[38]	35	Male	5×5	SR + RT		14	A
70	2012	Pirklbauer *et al*.[39]	86	Male		RT	Brain	8	D
71	2012	Horváth *et al*.[40]	17	Male		CH	Lung + bone marrow	8	D
72	2013	Yoshioka *et al*.[41]	17	Male		S	Lung/recurrence	39	D
73	2014	Jayaraj *et al*.[42]	22	Male			LN		
74	2013	Augustine *et al*.[43]	44	Female		SR			
75	2014	Srikanth *et al*.[44]	60	Male	23×11.5	SR			
76	2014	Li *et al*.[45]	36	Male		SR	Recurrence	120	
77	2014	Li *et al*.[45]	40	Female		SR		120	A
78	2014	Li *et al*.[45]	61	Male		SR		108	A
79	2014	Li *et al*.[45]	40	Male		SR		96	A
80	2014	Li *et al*.[45]	39	Female		SR		84	A
81	2014	Li *et al*.[45]	42	Male		SR		72	A
82	2014	Li *et al*.[45]	46	Male		SR		60	A
83	2014	Li *et al*.[45]	32	Male		SR		60	A
84	2014	Li *et al*.[45]	30	Male		SR		48	A
85	2014	Li *et al*.[45]	35	Male		SR		36	A
86	2014	Li *et al*.[45]	75	Male		SR	Lung	36	

SR: Surgical resection, S: Surgery, RT: Radiotherapy, CH: Chemotherapy, LN: Lymphadenopathy, A: Alive, D: Dead

have shown metastasis to the lung,[9,10,30,31,40,41] brain,[22,30,39] and bone.[8,18,40] The route of spread of malignant ameloblastoma is not clearly defined; however, the most common routes of spread are lymphatic, hematogenous, and by aspiration. Due to repeated recurrences, long-term follow-up is necessary.

There are controversies regarding management of ameloblastic carcinoma, but the most recommended treatment is jaw resection with wide surgical margins (1–2 cm) in which recurrence rate is found to be less than 15%.[18]

Besides surgery, management of ameloblastic carcinoma has included radiotherapy, chemotherapy, cryotherapy[51] as well as Gamma Knife stereotactic radiosurgery[44,45] with variable success. In cases with significant lymphadenopathy, cervical lymph node dissection should be considered. Due to less number of the reported cases and high cure rates even without lymph-node dissection and possibility of a hematogenous spread, elective neck dissection is not routinely recommended.[45] Among recent advances, carbon ion therapy can spare the adjacent normal tissues while destroying the tumor effectively.[45] It is suggested that radiotherapy should especially be given in cases with positive resection margins, positive lymph nodes, extracapsular spread, and cases with perineural invasion.[38] Gandy *et al*.[12] suggested that pre- and post-operative radiotherapy might be helpful in reducing the tumor size. However, more studies are needed to ascertain usefulness of radiotherapy.

From the available literature over the last 34 years, it is clear that ameloblastic carcinoma of the mandible is a highly malignant neoplasm with very less chances of survival. Five-year survival rate was reported to be <40%.[7] Distant

metastasis is usually fatal and may appear from 4 months to 12 years postoperatively.[52]

A longer period of close and meticulous follow-up of the patients is essential to pick up any recurrence or metastasis. Because of rarity of these lesions, it is a challenge to diagnose these malignancies and to give a prompt treatment, which can improve the prognosis. The possibility of malignant transformation should always be taken into consideration whenever ameloblastoma is diagnosed. This review paper is essential to compare the reporting and treatment of mandibular ameloblastic carcinoma to decide the most appropriate management strategies.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Benlyazid A, Lacroix-Triki M, Aziza R, Gomez-Brouchet A, Guichard M, Sarini J. Ameloblastic carcinoma of the maxilla: Case report and review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;104:e17-24.
2. Hall JM, Weathers DR, Unni KK. Ameloblastic carcinoma: An analysis of 14 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:799-807.
3. Pindborg J, Kramer I, Torloni H. Historical Typing of Odontogenic Tumors, Jaw Cysts, and Allied Lesions. Geneva, Switzerland: World Health Organization; 1972. p. 35-6.
4. Elzay RP. Primary intraosseous carcinoma of the jaws. Review and update of odontogenic carcinomas. Oral Surg Oral Med Oral Pathol 1982;54:299-303.
5. Slootweg PJ, Müller H. Malignant ameloblastoma or ameloblastic carcinoma. Oral Surg Oral Med Oral Pathol 1984;57:168-76.
6. Barnes L, Eveson JW, Reichart P, Sidransky D. World Health Organization Classification of Tumours: Pathology and Genetics of Head and Neck Tumors. Lyon: IARC Press; 2005. p. 286-95.
7. Corio RL, Goldblatt LI, Edwards PA, Hartman KS. Ameloblastic carcinoma: A clinicopathologic study and assessment of eight cases. Oral Surg Oral Med Oral Pathol 1987;64:570-6.
8. Azumi T, Nakajima T, Takeuchi S, Fukushima M, Ishiki T. Malignant ameloblastoma with metastasis to the skull: Report of case. J Oral Surg 1981;39:690-6.
9. Dorner L, Sear AJ, Smith GT. A case of ameloblastic carcinoma with pulmonary metastases. Br J Oral Maxillofac Surg 1988;26:503-10.
10. Bruce RA, Jackson IT. Ameloblastic carcinoma. Report of an aggressive case and review of the literature. J Craniomaxillofac Surg 1991;19:267-71.
11. Nagai N, Takeshita N, Nagatsuka H, Inoue M, Nishijima K, Nojima T, *et al.* Ameloblastic carcinoma: Case report and review. J Oral Pathol Med 1991;20:460-3.
12. Gandy SR, Keller EE, Unni KK. Ameloblastic carcinoma: Report of two cases. J Oral Maxillofac Surg 1992;50:1097-102.
13. Fisch-Ponsot C, Giguère C, Dorion D, Chatelain P, Brazeau-Lamontagne L. Ameloblastic carcinoma. Apropos of a case. J Radiol 1998;79:437-40.
14. Lau SK, Tideman H, Wu PC. Ameloblastic carcinoma of the jaws. A report of two cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:78-81.
15. Simko EJ, Brannon RB, Eibling DE. Ameloblastic carcinoma of the mandible. Head Neck 1998;20:654-9.
16. Cox DP, Muller S, Carlson GW, Murray D. Ameloblastic carcinoma ex ameloblastoma of the mandible with malignancy-associated hypercalcemia. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2000;90:716-22.
17. Mosqueda Taylor A, Meneses García A, Ruíz Godoy Rivera LM, Suárez Roa Mde L, Luna Ortiz K. Malignant odontogenic tumors. A retrospective and collaborative study of seven cases. Med Oral 2003;8:110-21.
18. Datta R, Winston JS, Diaz-Reyes G, Loree TR, Myers L, Kuriakose MA, *et al.* Ameloblastic carcinoma: Report of an aggressive case with multiple bony metastases. Am J Otolaryngol 2003;24:64-9.
19. Oginni FO, Ugboko VI, Owotade JF, Adebiyi KE. Ameloblastic carcinoma of the jaws. A report of three Nigerian cases. Odontostomatol Trop 2003;26:19-22.
20. Carinci F, Palmieri A, Delaiti G, Rubini C, Fioroni M, Martinelli M, *et al.* Expression profiling of ameloblastic carcinoma. J Craniofac Surg 2004;15:264-9.
21. Cizmecý O, Aslan A, Onel D, Demiryont M. Ameloblastic carcinoma ex ameloblastoma of the mandible: Case report. Otolaryngol Head Neck Surg 2004;130:633-4.
22. Goldenberg D, Sciubba J, Koch W, Tufano RP. Malignant odontogenic tumors: A 22-year experience. Laryngoscope 2004;114:1770-4.
23. Uzüm N, Akyol G, Asal K, Köybasioglu A. Ameloblastic carcinoma containing melanocyte and melanin pigment in the mandible: A case report and review of the literature. J Oral Pathol Med 2005;34:618-20.
24. Arotiba JT, Mohammed AJ, Adebola A, Adeola DS, Ajike SO, Rafindadi AH. Ameloblastic carcinoma: Report of a case. Niger J Surg Res 2005;7:222-5.
25. Suomalainen A, Hietanen J, Robinson S, Peltola JS. Ameloblastic carcinoma of the mandible resembling odontogenic cyst in a panoramic radiograph. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2006;101:638-42.
26. Miyake T, Tanaka Y, Kato K, Tanaka M, Sato Y, Ijiri R, *et al.* Gene mutation analysis and immunohistochemical study of beta-catenin in odontogenic tumors. Pathol Int 2006;56:732-7.
27. Akrish S, Buchner A, Shoshani Y, Vered M, Dayan D. Ameloblastic carcinoma: Report of a new case, literature review, and comparison to ameloblastoma. J Oral Maxillofac Surg 2007;65:777-83.
28. Yoon HJ, Hong SP, Lee JI, Lee SS, Hong SD. Ameloblastic carcinoma: An analysis of 6 cases with review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;108:904-13.
29. Reid-Nicholson M, Teague D, White B, Ramalingam P, Abdelsayed R. Fine needle aspiration findings in malignant ameloblastoma: A case report and differential diagnosis. Diagn Cytopathol 2009;37:586-91.
30. Cherry B, Mehra P, Noonan V, Baur D. Radiolucent lesion of the posterior mandible. J Oral Maxillofac Surg 2009;67:862-6.
31. Jeremic JV, Nikolic ZS, Boricic IV, Tacevic ZD, Tomanovic NR, Drcic LJ, *et al.* Total mandibular reconstruction after resection of rare "honeycomb-like" ameloblastic carcinoma – A case report. J Craniomaxillofac Surg 2010;38:465-8.
32. Ndukwe KC, Adebiyi EK, Ugboko VI, Adeyemo WL, Ajayi FO, Ladeinde AL, *et al.* Ameloblastic carcinoma: A multicenter Nigerian study. J Oral Maxillofac Surg 2010;68:2111-4.
33. Kamath KP, Vidya M, Shetty N, Karkera BV, Jogi H. Nucleolar organizing regions and alpha-smooth muscle actin expression in a case of ameloblastic carcinoma. Head Neck Pathol 2010;4:157-62.
34. Karakida K, Aoki T, Sakamoto H, Takahashi M, Akamatsu T, Ogura G, *et al.* Ameloblastic carcinoma, secondary type: A case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;110:e33-7.
35. Roy Chowdhury SK, Ramen S, Chattopadhyay PK, Moorchung N,

Rajkumar K. Ameloblastic Carcinoma of the mandible. J Maxillofac Oral Surg 2010;9:198-201.
36. Ram H, Mohammad S, Husain N, Gupta PN. Ameloblastic carcinoma. J Maxillofac Oral Surg 2010;9:415-9.
37. Devenney-Cakir B, Dunfee B, Subramaniam R, Sundararajan D, Mehra P, Spiegel J, *et al.* Ameloblastic carcinoma of the mandible with metastasis to the skull and lung: Advanced imaging appearance including computed tomography, magnetic resonance imaging and positron emission tomography computed tomography. Dentomaxillofac Radiol 2010;39:449-53.
38. Maheshwari V, Varshney M, Alam K, Jain A, Siddiqui MA, Gaur K, *et al.* Ameloblastic carcinoma: A rare entity. BMJ Case Rep 2011;2011. pii: Bcr0120113678.
39. Pirklbauer K, Kozakowski N, Russmueller G, Ewers R, Klug C. Manifestation of an ameloblastic carcinoma ten years after follicular cyst enucleation in the mandibular ramus. J Craniomaxillofac Surg 2012;40:362-5.
40. Horváth A, Horváth E, Popsor S. Mandibular ameloblastic carcinoma in a young patient. Rom J Morphol Embryol 2012;53:179-83.
41. Yoshioka Y, Toratani S, Ogawa I, Okamoto T. Ameloblastic carcinoma, secondary type, of the mandible: A case report. J Oral Maxillofac Surg 2013;71:e58-62.
42. Jayaraj G, Sherlin HJ, Ramani P, Premkumar P, Natesan A, Ramasubramanian A, *et al.* Metastasizing ameloblastoma - A perennial pathological enigma? Report of a case and review of literature. J Craniomaxillofac Surg 2014;42:772-9.
43. Augustine D, Sekar B, Murali S. Large ameloblastic carcinoma: A rare case with management. Dent Res J (Isfahan) 2013;10:809-12.
44. Srikanth MD, Radhika B, Metta K, Renuka NV. Ameloblastic carcinoma: Report of a rare case. World J Clin Cases 2014;2:48-51.
45. Li J, DU H, Li P, Zhang J, Tian W, Tang W. Ameloblastic carcinoma: An analysis of 12 cases with a review of the literature. Oncol Lett 2014;8:914-920.
46. Abiko Y, Nagayasu H, Takeshima M, Yamazaki M, Nishimura M, Kusano K, *et al.* Ameloblastic carcinoma ex ameloblastoma: Report of a case-possible involvement of CpG island hypermethylation of the p16 gene in malignant transformation. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2007;103:72-6.
47. Lin Z, Chen F, Wang T, Hu Q, Sun G. The variability and complexity of ameloblastoma: Carcinoma ex ameloblastoma or primary ameloblastic carcinoma. J Craniomaxillofac Surg 2013;41:190-3.
48. Zhang B, Zhang J, Xu ZY, Xie HL. Expression of RECK and matrix metalloproteinase-2 in ameloblastoma. BMC Cancer 2009;9:427.
49. Otero D, Lourenço SQ, Ruiz-Ávila I, Bravo M, Sousa T, de Faria PA, *et al.* Expression of proliferative markers in ameloblastomas and malignant odontogenic tumors. Oral Dis 2013;19:360-5.
50. Minami M, Kaneda T, Ozawa K, Yamamoto H, Itai Y, Ozawa M, *et al.* Cystic lesions of the maxillomandibular region: MR imaging distinction of odontogenic keratocysts and ameloblastomas from other cysts. AJR Am J Roentgenol 1996;166:943-9.
51. Daramola JO, Abioye AA, Ajagbe HA, Aghadiuno PU. Maxillary malignant ameloblastoma with intraorbital extension: Report of case. J Oral Surg 1980;38:203-6.
52. Ingram EA, Evans ML, Zitsch RP 3rd. Fine-needle aspiration cytology of ameloblastic carcinoma of the maxilla: A rare tumor. Diagn Cytopathol 1996;14:249-52.