

# Clinicopathologic Significance of P63, Maspin and MMP-2 Expression in Mucoepidermoid Carcinoma

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## Abstract

**Background and Aim:** Mucoepidermoid carcinoma (MEC) is the most common malignant neoplasm of the salivary glands with complex histopathologic features and clinical behavior. The aim of this study was to evaluate the clinicopathologic significance of p63, Maspin and matrix metalloproteinase (MMP)-2 expression in MEC.

**Materials and Methods:** In this retrospective study, immunohistochemical staining was performed to detect the expression of p63, Maspin and MMP-2 in 35 cases of MEC. In addition, to detect the presence of myoepithelial differentiation, smooth muscle actin (SMA) staining was performed. Data were analyzed using non-parametric tests.

**Results:** P63 expression, intensity of staining for p63 and MMP-2 total score showed significant correlations with histologic grade ( $P=0.008$ ,  $P=0.035$  and  $P=0.003$ , respectively). The association between p63 expression and MMP-2 total score was significant ( $P=0.033$ ). P63 positive cases did not express SMA.

**Conclusion:** Findings suggest that p63 and MMP-2 may be useful prognostic indicators in MEC. MEC is devoid of myoepithelial cells.

**Key Words:** TP63 Protein, Human, SERPIN-B5, Matrix Metalloproteinase 2, Carcinoma, Mucoepidermoid

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## Introduction

Mucoepidermoid carcinoma (MEC) is the most common malignant salivary gland tumor. The peak age of incidence is in the fourth and sixth decades of life [1]. Its clinical behavior varies from asymptomatic swelling to rapidly growing mass with invasion to the surrounding structures [2]. MEC is composed of epidermoid cells, mucus cells, intermediate cells and clear cells [2,3]. Participation of myoepithelial cells in tumorigenesis of MEC is still elusive. Controversial results have been reported by

immunohistochemistry and ultrastructural studies [4].

P63 protein is expressed in the nuclei of different cells, such as normal stratified epithelial cells in the oral cavity, esophagus and cervix [1]. In malignant tissues, p63 is expressed by transitional and oral squamous cell carcinoma (OSCC) and several salivary gland tumors such as adenoid cystic carcinoma and polymorphous low-grade adenocarcinoma. To date, few studies have focused on the diagnostic role of p63 expression in malignant salivary gland tumors [1,5]. However,

the prognostic and clinicopathologic implication of p63 expression in malignant salivary gland tumors is not clear.

Maspin (mammary serine protease inhibitor) is a member of serine protease inhibitor (serpin) family. It is documented that Maspin is expressed in normal cells and down-regulated in neoplastic tissues. In vivo and in vitro studies demonstrate that Maspin suppresses tumor growth and metastasis by inhibiting tumor cell invasion and antiangiogenic effect through microvessel density reduction [6]. Loss of Maspin has been associated with unfavorable prognosis in OSCC, lung and prostate cancer [7-9].

Extracellular matrix (ECM) molecules are modified by matrix metalloproteinases (MMPs), a family of enzymes that can modulate cell density by creating space for migration, releasing ECM-bound growth factors and activating signaling molecules. MMP-2 and MMP-9 are type IV collagenases that degrade the major structural protein of extracellular matrix and basement membrane [10]. The prognostic significance of MMP-2, 9 expressions has been reported in prostate cancer and OSCC [11,12]. The aim of the present study was to determine the clinicopathologic significance of p63, Maspin and MMP-2 in MEC and their mutual correlation.

## Materials and Methods

This retrospective descriptive study was conducted on 35 cases of MEC diagnosed in the Pathology Department, Shahid Beheshti University of Medical Sciences, Tehran, Iran. Demographic and clinicopathologic information of each patient including age, sex, location of tumor, size of tumor, histologic grade and lymph node metastasis were obtained from the medical records of patients and slides. Brandwein system was used to determine the histological grade of MEC [3].

### *Immunohistochemistry:*

Sections (3mm thickness) of formalin-fixed paraffin-embedded blocks were mounted on silane-coated slides (silanized S 3003; Dako, Copenhagen, Denmark), dewaxed in xylene, rehydrated in graded ethanol and treated with 3% hydrogen peroxide. Antigen retrieval was carried out in 10mM citrate solution (pH 6.0) in a microwave oven (750W) for 10 minutes.

The sections were incubated with mouse monoclonal antibody against p63 (ready-to-use; Dako, Glostrup, Denmark), Maspin (1:50; Novocastra, Newcastle, UK), MMP-2 (1:60; Novocastra, Newcastle, UK) and smooth muscle actin (SMA; 1:50; Novocastra, Newcastle, UK) and were then treated with Dako Envision TM. Finally, the sections were incubated with 3, 3'-diaminobenzidine (K3468; Dako) for 2-5 minutes at room temperature and counterstained with Mayer's hematoxylin. Human breast tissue, ulcerative colitis, normal salivary gland and bowel wall tissues were used as positive controls for p63, MMP-2, Maspin and SMA, respectively. The primary antibody was omitted as negative control. P63 immunostaining was graded semi-quantitatively, with negative indicating less than 10% of cells staining. Positive nuclear staining was graded as follows: 10-25% of tumor cells stained weakly positive; 26-75% of tumor cells stained moderately positive, and 76-100% of tumor cells stained highly positive. The staining intensity was classified as: 0, no staining; 1, weak staining; 2, moderate staining and 3, strong staining [13].

Maspin immunoreaction was scored in three groups according to the percentage of positive tumor cells: high ( $\geq 50\%$  of cells stained); intermediate (20-49% of cells stained), or low (up to 20% of cells stained) [14]. Staining intensity was evaluated similar to that for p63.

MMP-2 expression was determined using a semi-quantitative scoring system from 0 to 6 based on the percentage of positive tumor cells (0-3) and staining intensity (0-3). Finally, the two scores were multiplied, providing a final score: 0-1, negative (-); 2-3 (+); and  $\geq 4$  (++) [15]. Identification of p63 positive cells as myoepithelial cells was confirmed by SMA immunoexpression.

### *Statistical analysis:*

The data were analyzed using SPSS version 18 Software (SPSS Inc., Chicago, IL, USA). The Kruskal Wallis test was used to assess the correlation of p63, Maspin and MMP-2 expression with histologic grade. In order to evaluate the correlation of p63, Maspin and MMP-2 expression with lymph node metastasis and tumor size, the Mann Whitney test was applied. In addition, the Kruskal Wallis and Mann Whitney tests were used

to assess the correlation of MMP-2 total score with histologic grade and metastasis, respectively. The Spearman's correlation coefficient was used to assess the correlation of expression of markers.  $P < 0.05$  was considered statistically significant.

## Results

Thirty-five patients with MEC (22 females and 13 males) were evaluated. The mean age of patients was  $42.14 \pm 17.13$  years (range 12-74 years). Tumor size ranged from 0.9 to 7cm (mean of  $3.07 \pm 1.49$ cm). The distribution of histologic grade 1 to 3 was 14 (40%), 6 (17.1%) and 15 (49.9%), respectively. Perineural invasion was seen in 3 (8.6%) cases and lymph node metastasis was seen in 1 (2.9%) case (Table 1).

### *P63 immunoexpression:*

P63 was expressed in all cases as nuclear staining mostly in epidermoid cells and sparsely in intermediate cells (Figure 1). Nineteen cases (54.3%) showed high expression, 10 (28.6%) cases showed moderate staining and the remaining six (17.1%) cases showed weak p63 expression. Evaluation of staining intensity showed strong intensity in 20 (57.1%) cases. P63 positive cell percentage and staining intensity showed significant correlations with histologic grade ( $P=0.008$  and  $P=0.03$ , respectively; Table 2). The correlation of p63 expression and intensity of staining and lymph node metastasis was not significant ( $P=0.629$  and  $P=0.571$ , respectively). P63 positive cells did not express SMA.

### *Maspin immunoexpression:*

Maspin was expressed in 88.6% (31/35) of the cases by epidermoid and intermediate cells (Figure 2). Most of the cases (45.2%, 14/35) showed high expression of Maspin. Regarding staining intensity, most of the cases (67.7%, 21/35) showed moderate intensity; 26 (83.9%) cases expressed Maspin in both nucleus and cytoplasm, 4 (12.9%) cases in cytoplasm and 1 (3.2%) case in nucleus. No significant correlation between Maspin expression and intensity of staining with histologic grade ( $P=0.133$  and  $P=0.447$ , respectively) or lymph node metastasis ( $P=0.914$  and  $P=0.800$ , respectively) was found (Table 3).

### *MMP-2 immunoexpression:*

MMP-2 was expressed in 74.3% (26/35) of cases (40% of grade 1, 17% of grade 2, 43% of grade 3)

as cytoplasmic staining (Figure 3). Data analysis showed a significant correlation between MMP-2 total score and histologic grade ( $P=0.003$ ). No association between lymph node metastasis and Maspin expression was seen (Table 4).

### *Relationship between p63, Maspin, and MMP-2 expression:*

Our results showed significant correlations between p63 and MMP-2 expression ( $r=0.36$ ,  $P=0.033$ ). No association between p63 and Maspin expression ( $r=0.173$ ,  $P=0.321$ ), or Maspin and MMP-2 expression ( $r=0.425$ ,  $P=0.134$ ) was noted.

## Discussion

MEC comprises 12-15% of malignant salivary gland tumors, with peculiar histopathologic features [2,3]. In the present study, we investigated p63, Maspin and MMP-2 expression in MEC.

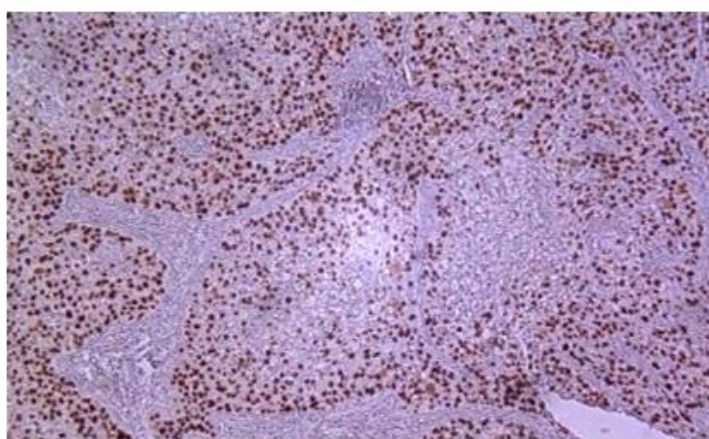
The role of p63 in tumorigenesis is debatable. Overexpression of p63 has been reported in many solid tumors in particular, head and neck squamous cell carcinoma, urothelial carcinoma and adenoid cystic carcinoma [16-18]. P63 expression has been recommended as a reliable indicator of histologic grade and prognosis in breast cancer, meningioma and OSCC. It may be due to oncogenic role of one p63 isotype,  $\Delta NP63$ , in proliferation and differentiation [19-21]. Additionally, p63 has been demonstrated as a helpful marker in distinguishing low-grade MEC from papillary cystadenoma of salivary glands [1].

This is the first study to examine the prognostic significance of p63 expression in MEC. P63 was expressed in all cases of MEC. Epidermoid and intermediate cells expressed p63. A significant correlation was found between p63 expression and intensity of staining with histologic grade as p63 expression was higher in less differentiated tumors compared to more differentiated ones. It was in agreement with previous studies conducted on breast cancer and prostate cancer (21) that suggested p63 expression as a prognostic marker.

Few studies on squamous cell carcinoma have addressed the correlation of p63 and MMPs expression. It seems that p63, through different pathways and mediators including snail-mediated epithelial-mesenchymal transition and repression of Wnt/ $\beta$  catenin response, regulates MMPs expression. These findings propose a peculiar role

**Table 1.** Clinicopathologic characteristics of patients with mucoepidermoid carcinoma

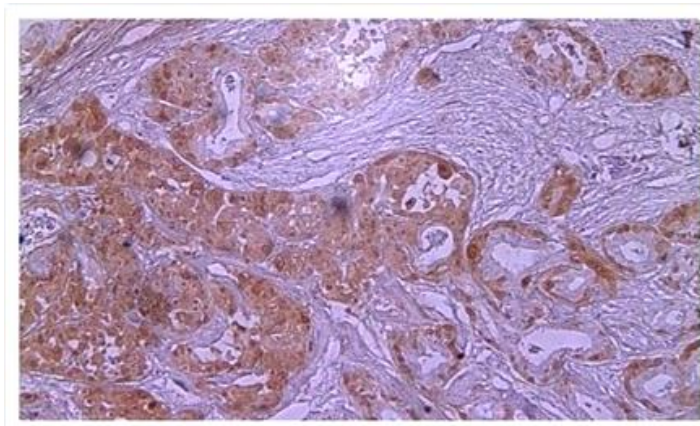
Characteristics	Total number of patients (%)
Patients	35
<b>Age (years)</b>	
Mean (SD)	42.14(17.13)
Range	12-74
<b>Gender</b>	
Female	22(62.9)
Male	13(37.1)
<b>Location</b>	
Major salivary gland	17 (48.6)
Minor salivary gland	18 (51.4)
<b>Size (cm)</b>	
<4	25(71)
≥4	10(29)
<b>Grade</b>	
1	14 (40)
2	6(17.1)
3	15(49.9)
<b>Neural invasion</b>	
No	32(91.4)
Yes	3(8.6)
<b>Lymph node metastasis</b>	
No	34(97.1)
Yes	1(2.9)

**Figure 1.** Nuclear p63 immunopositivity in mucoepidermoid carcinoma (x200)

**Table 2.** P63 expression profile: Association with grade and metastasis in mucoepidermoid carcinoma

Percentage of positive cells					P-value					P-value
Parameter	0(n)	10-25% (n)	26-75% (n)	76-100% (n)		0 (n)	1(n )	2(n )	3(n )	
Grade										
1	0	4	5	5	0.008*	0	1	8	5	0.0358*
2	9	2	2	2		0	0	2	4	
3	0	0	3	12		0	0	4	11	
Metastasis										
No	0	6	9	19	0.629	0	1	14	19	0.571
Yes	0	0	1	0		0	0	0	1	

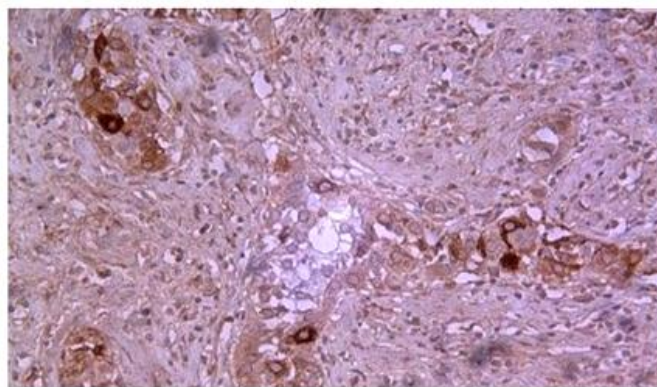
\*: P<0.05



**Figure 2.** Nuclear-cytoplasmic Maspin immunoexpression in mucoepidermoid carcinoma (x100)

**Table 3.** Maspin expression profile: Association with grade and metastasis in mucoepidermoid carcinoma

Percentage of positive cells					P-value					P-value
Parameter	0(n)	10-25% (n)	26-75% (n)	76-100% (n)		0 (n)	1 (n )	2(n )	3(n )	
Grade										
1	1	2	3	8	0.133	1	3	7	3	0.447
2	0	2	2	2		0	3	3	0	
3	3	2	6	4		3	1	11	0	
Metastasis										
No	4	6	10	14	0.914	4	7	20	3	0.800
Yes	0	0	1	0		0	0	1	0	



**Figure 3.** Cytoplasmic MMP-2 immunoexpression in mucoepidermoid carcinoma (x200)

**Table 4.** MMP-2 expression profile: Association with grade and metastasis in mucoepidermoid carcinoma

Percentage of positive cells					P-value	Intensity				P-value	Total score			P-value
Parameter	0(n)	1(n)	2(n)	3(n)		0(n)	1(n)	2(n)	3(n)		0(n)	+(n)	++(n)	
Grade														
1	7	2	2	3	0.001*	7	3	2	2	0.0358*	7	2	5	0.003*
2	0	0	1	5		0	1	4	1		0	0	6	
3	2	0	0	13		2	2	5	6		2	0	13	
Metastasis														
No	9	2	3	20	0.629	9	5	11	9	0.571	9	2	23	0.800
Yes	0	0	0	1		0	1	0	0		0	0	1	

\*: P<0.05

for  $\Delta$ NP63 $\alpha$  regulated by MMP-2 expression and invasiveness of squamous cell carcinoma cells through expression of inhibitor of differentiation-3 (id-3) protein [22,23]. It was of great interest to verify the association of p63 and MMP-2 expression in the present study. However, the underlying mechanism remains to be elucidated and needs further investigation.

Maspin is a 42KDa cytoplasmic protein, which functions as a tumor suppressor by inhibiting tumor cell invasion and cell motility. Of note, Maspin apoptotic effect is tumor-specific [24,25]. Regulation of Maspin expression may be due to transactivation of elements in the Maspin promoter and hormonal response [14]. Moreover, review of literature denotes that tumor suppressive effect of

Maspin is related to Maspin cellular localization. Nuclear Maspin expression is indicative of favorable prognosis in non-small cell lung adenocarcinoma, pancreatic cancer and prostate adenocarcinoma [24,25], indicating the suppressive effect of Maspin. Most of the cases in our study expressed Maspin in both nucleus and cytoplasm. We did not observe a significant correlation between Maspin expression and histologic grade or lymph node metastasis confirming the previous studies on salivary gland tumors [26,27] and impact of Maspin cellular localization.

All ECM components can be degraded by MMPs and each element is cleaved by a specific member of the MMP family. The MMP family plays a critical role in the process of tumor cell invasion

into the tumor stroma and tumor-inducing vascularization [28-30]. The MMP activity is regulated at different levels, such as cellular receptors, presence of inhibitors, compartmentalization and gene expression. Among identified MMPs, MMP-2 has a significant role in tumor development and tumor invasion.

Up-regulation of MMP-2 in malignant salivary gland tumors compared to benign neoplasms and normal salivary gland tissue was reported by Zhou et al. [28]. However, no significant correlation was noted between MMP-2 expression and histologic grade in their study. Expression of MMP-2, MMP-9 and their tissue inhibitors in benign and malignant salivary gland tumors showed an imbalance between MMPs and their tissue inhibitors in malignant neoplasms and invasive properties related to MMP-2 [15]. Guan et al, [10] also evaluated MMP-2 expression in salivary gland adenoid cystic carcinoma. Their result emphasized on the role of high levels of MMP-2 expression in aggressive behavior of tumor. In accordance with previous studies, our findings showed the significant correlation of MMP-2 expression and histologic grade [15]. It disagrees with the findings of Taher et al [30]. The difference may be due to smaller sample size in the study by Taher et al, [30] which comprised of 15 cases of MEC.

In conclusion, the expression and intensity of staining of p63 and MMP-2 showed significant correlations with histologic grade and may be useful prognostic indicators for MEC. Moreover, all cases were devoid of myoepithelial cells.

## References

1. Fonseca FP, de Andrade BA, Lopes MA, Pontes HA, Vargas PA, de Almeida OP. P63 expression in papillary cystadenoma and mucoepidermoid carcinoma of minor salivary glands. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2013 Jan;115(1):79-86.
2. Taghavi N, Sargolzaei S, Mashhadiabbas F, Akbarzadeh A, Kardouni P. Salivary Gland Tumors: A 15- year Report from Iran. *Turk Patoloji Derg*. 2016 Oct;32(1):35-9.
3. Brandwein MS, Ivanov K, Wallace DI, Hille JJ, Wang B, Fahmy A, et al. Mucoepidermoid carcinoma: a clinicopathologic study of 80 patients with special reference to histological grading. *Am J Surg Pathol*. 2001 Jul;25(7):835-45.
4. Saveria AT, Zarbo RJ. Defining the role of myoepithelium in salivary gland neoplasia. *Adv Anat Pathol*. 2004 Mar;11(2):69-85.
5. Maruya SI, Kies MS, Williams M, Myers JN, Weber RS, Batsakis JG, et al. Differential expression of p63 isotypes (DN and TA) in salivary gland neoplasms: biological and diagnostic implications. *Hum Pathol* 2005 July;36(7):821-7.
6. Zhang M, Volpert O, Shi YH, Bouck N. Maspin is an angiogenesis inhibitor. *Nat Med*. 2000 Feb;6(2):196-9.
7. Yasumatsu R, Nakashima T, Hirakawa N, Kumamoto Y, Kuratomi K, Tomita K, et al. Maspin expression in stage I and II oral tongue squamous cell carcinoma. *Head Neck* 2001 Nov; 23(11):962-6.
8. Lonardo F, Li X, Siddiq F, Singh R, Al-Abbadi M, Pass HI, et al. Maspin nuclear localization is linked to favorable morphological features in pulmonary adenocarcinoma. *Lung Cancer*. 2006 Jan;51(1):31-39.
9. Machtens S, Serth J, Bokemeyer C, Bathke W, Minssen A, Kollmannsberger C, et al. Expression of the p53 and Maspin protein in primary prostate cancer: correlation with clinical features. *Int J Cancer*. 2001 Sep 20;95(5):337-42.
10. Guan H, Tan J, Zhang F, Gao L, Bai L, Qi D, et al. Myofibroblasts from salivary gland adenoid cystic carcinomas promote cancer invasion by expressing MMP and CXCL12. *Histopathology*. 2015 May;66(6):781-90.
11. Elahi M, Rakhshan V, Ghasemian NT, Moshref M. Prognostic value of transforming growth factor beta 1 [TGF- $\beta$ 1] and matrix metalloproteinase 9 [MMP-9] in oral squamous cell carcinoma. *Biomarkers*. 2012 Feb;17(1):21-7.
12. Giannoni E, Bianchini F, Masieri L, Serni S, Torre E, Calorini L, et al. Reciprocal activation of prostate cancer cells and cancer-associated fibroblasts stimulates epithelial-mesenchymal transition and cancer stemness. *Cancer Res*. 2010 Sep 1;70(17):6945-56.
13. Sams RN, Gnepp DR. P63 expression can be used in differential diagnosis of salivary gland acinic cell and mucoepidermoid carcinomas. *Head*



Neck Pathol. 2013 Mar;7(1):64-8.

14. Xia W, Lau YK, Hu MC, Li L, Johnston DA, Sheng Sj, et al. High tumoral maspin expression is associated with improved survival of patients with oral squamous cell carcinoma. *Oncogene*. 2000 May 11;19(20):2398-403.
15. Nagel H, Laskawi R, Wahlers A, Hemmerlein B. Expression of matrix metalloproteinases MMP-2, MMP-9 and their tissue inhibitors TIMP-1, -2, and -3 in benign and malignant tumours of the salivary gland. *Histopathology*. 2004 Mar;44(3):222-31.
16. Ramer N, Wu H, Sabo E, Ramer Y, Emanuel P, Orta L, et al. Prognostic value of quantitative p63 immunostaining in adenoid cystic carcinoma of salivary gland assessed by computerized image analysis. *Cancer*. 2010 Jan 1;116(1):77-83.
17. Lo Muzio L, Santarelli A, Caltabiano R, Rubini C, Pieramici T, Trevisiol L, et al. p63 overexpression associated with poor prognosis in head and neck squamous cell carcinoma. *Hum Pathol*. 2005 Feb;36(2):187-94.
18. Koga F, Kawakami S, Fujii Y, Saito K, Ohtsuka Y, Iwai A, et al. Impaired p63 expression associates with poor prognosis and uroplakin III expression in invasive urothelial carcinoma of the bladder. *Clin Cancer Res*. 2003 Nov 15;9(15):5501-7.
19. Di Franco S, Sala G, Todaro M. p63 role in breast cancer. *Aging (Albany NY)*. 2016 Oct;8(10):2256-2257.
20. Rushing EJ, Olsen C, Man YG. Correlation of p63 immunoreactivity with tumor grade in meningiomas. *Int J Surg Pathol*. 2008 Jan; 16(1):38-42.
21. Graziano V, De Laurenzi V. Role of p63 in cancer development. *Biochim Biophys Acta*. 2011 Aug;1816(1):57-66.
22. Higashikawa K, Yoneda S, Tobiume K, Saitoh M, Taki M, Mitani Y, et al. Delta Np63 alpha-dependent expression of Id-3 distinctively suppresses the invasiveness of human squamous cell carcinoma. *Int J Cancer*. 2009 June; 124(12):2837-2844.
23. Celardo I, Antonov A, Amelio I, Annicchiarico-Petruzzelli M, Melino G. p63 transcriptionally regulates the expression of matrix metalloproteinase 13. *Oncotarget*. 2014 Mar 15;5(5):1279-89.
24. Sood AK<sup>1</sup>, Fletcher MS, Gruman LM, Coffin JE, Jabbari S, Khalkhali-Ellis Z, et al. The paradoxical expression of maspin in ovarian carcinoma. *Clin Cancer Res*. 2002 Sep;8(9):2924-32.
25. Hojo T, Akiyama Y, Nagasaki K, Maruyama K, Kikuchi K, Ikeda T, et al. Association of Maspin expression with the malignancy grade and tumor vascularization in breast cancer tissues. *Cancer Lett*. 2001 Sep 28;171(1):103-10.
26. Ghazy SE, Helmy IM, Baghdadi HM. Maspin and MCM2 immunoprofiling in salivary gland carcinomas. *Diagn Pathol*. 2011 Sep 26;6:89.doi: 10.1186/1746-1596-6-89.
27. Schwarz S, Ettl T, Kleinsasser N, Hartmann A, Reichert TE, Driemel O. Loss of Maspin expression is a negative prognostic factor in common salivary gland tumors. *Oral Oncol*. 2008 Jun;44(6):563-70.
28. Zhou X, Huang S, Jiang L, Zhang S, Li W, Chen Z, et al. Expression of RECK and MMP-2 in salivary adenoid cystic carcinoma: Correlation with tumor progression and patient prognosis. *Oncol Lett*. 2014 May;7(5):1549-1555.
29. López-Otín C, Matrisian LM. Emerging roles of proteases in tumor suppression. *Nat Rev Cancer*. 2007 Oct;7(10):800-8.
30. Taher MG, Abdullah BH, Al-Kari LE. Expression of MMP-2 as biological markers of invasion potential in mucoepidermoid carcinoma of the oral and maxillofacial region (immunohistochemical study). *Diyala J Med*. 2012; 3:67-72.