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Review

Cementoblastoma: An updated analysis of 258 cases reported in the literature

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ABSTRACT

Purpose: To investigate the recurrence rate of cementoblastomas for different variables aside from the clinical/radiologic features.**Methods:** An electronic search was undertaken in November/2016. Eligibility criteria included publications having enough clinical/radiological/histological information to confirm the diagnosis.**Results:** 141 publications (258 cementoblastomas) were included. There was an equal sex distribution. There was a high prevalence in the second/third decades of life, in the posterior regions, and in mandibular first molars. Lesions were commonly associated with bone expansion (74.9%), presence of clinical symptoms (70.2%), vital teeth (78%), root resorption (59.8%). Observations not as frequent: cortical bone perforation (16.3%), inferior displacement of the mandibular canal (23.6%). Treatment was reported for 229 cases. Twenty (11.8%) out of 170 recurred. Preservation of the involved teeth and location seem to not influence the recurrence rate, but there was a 687% higher probability (odds ratio 7.875; $p = 0.048$) of recurrence for lesions associated with bone expansion, and a 217% higher probability (odds ratio 3.173; $p = 0.023$) of recurrence for lesions presenting cortical bone perforation.**Conclusions:** Although the recurrence rate of cementoblastomas is not as high as previously believed, it is a relevant phenomenon (11.8%). The presence of bone expansion and cortical bone perforation seem to influence the recurrence rate.

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1. Introduction

A cementoblastoma is a benign neoplasia characterized by the formation of cementum-like tissue in connection with the root of a tooth. The tumor consists of a rounded or nodular mass attached to one or more tooth roots, the criterion which differentiates the cementoblastoma from an osteoblastoma (WHO, 2005). Cementoblastoma is considered to be a relatively rare lesion. The epidemiological study of such lesions is of great importance because it provides information that can improve the diagnostic accuracy and allows pathologists and surgeons to make informed decisions and refine the treatment plan to optimize the clinical outcome.

Different protocols for cementoblastoma treatment have been advocated in the literature, but no systematic review about this topic has been performed. The aim of the present study was to integrate the available data published in the literature on cementoblastoma into an updated comprehensive comparative analysis of their clinical and radiologic features, and investigate the probability of recurrence of the tumor for different variables and treatment approaches.

2. Materials and methods

This study followed the PRISMA Statement guidelines (Moher et al., 2009). A review protocol does not exist.

2.1. Search strategies

An electronic search without time restrictions was undertaken in November 2016 in the following databases: PubMed/Medline,

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Web of Science, and Science Direct. The following term was used in the search strategies:

(cementoblastoma)

Moreover, Google Scholar was also checked. A manual search of related journals, including *Acta Odontologica Scandinavica*, *Acta Oto-Laryngologica*, *Annals of Otolaryngology and Laryngology*, *British Journal of Oral and Maxillofacial Surgery*, *Cancer, Head & Neck, Head and Neck Pathology*, *International Journal of Oral and Maxillofacial Surgery*, *Japanese Journal of Oral and Maxillofacial Surgery*, *Journal of Dental Research*, *Journal of Craniofacial Surgery*, *Journal of Cranio-Maxillofacial Surgery*, *Journal of Japanese Society of Oral Oncology*, *Journal of the Japanese Stomatological Society*, *Journal of Laryngology and Otolaryngology*, *Journal of Maxillofacial and Oral Surgery*, *Journal of Nihon University School of Dentistry*, *Journal of Oral and Maxillofacial Surgery*, *Journal of Oral Pathology and Medicine*, *Journal of the Stomatological Society*, *Laryngoscope*, *Oral Diseases*, *Oral Oncology*, *Oral Surgery Oral Medicine Oral Pathology Oral Radiology*, *Otolaryngology – Head and Neck Surgery*, and *Quintessence International*, was performed. The reference list of the identified studies and the relevant reviews on the subject were also scanned for possible additional studies. Publications with lesions identified by other authors as being cementoblastomas, even not having the terms “cementoblastoma” in the title of the article, were also re-evaluated by an author of the present study.

2.2. Inclusion and exclusion criteria

Eligibility criteria included publications reporting cases of cementoblastomas. The studies needed to have enough clinical, radiological and histological information to confirm the diagnosis of cementoblastoma (WHO, 2005). The tumors needed to show direct continuity with the root of a tooth. Randomized and controlled clinical trials, cohort studies, case-control studies, cross-sectional studies, case series, and case reports were included. Exclusion criteria were immunohistochemical studies, histomorphometric studies, radiological studies, genetic expression studies, histopathological studies, cytological studies, cell proliferation/apoptosis studies, *in vitro* studies, and review papers, unless any of these publications categories had reported any case with enough clinical, radiological and histological information.

2.3. Study selection

The titles and abstracts of all reports identified through the electronic searches were read independently by the authors. For studies appearing to meet the inclusion criteria, or for which there were insufficient data in the title and abstract to make a clear decision, the full report was obtained. Disagreements were solved by discussion between the authors. The clinical and radiological aspects, as well as the histological description of the lesions reported by the publications were thoroughly assessed by one of the authors of the present study, who is expert in oral pathology (R.S.G.), in order to confirm the diagnosis of cementoblastoma.

2.4. Data extraction

The authors independently extracted data using specially designed data extraction forms. Disagreements were solved by discussion. For each of the identified studies included, the following data were then extracted on a standard form, when available: year of publication, number of patients, patient's sex, age and race, follow-up period, duration of the lesion previously to treatment, lesion location (maxilla/mandible), anterior/posterior location (three categories: [a] anterior: lesions in the incisors/canine region; [b] premolar region; [c] posterior: lesions in the molars/retromolar

region), recurrence, time between treatment and recurrence, lesion size, perforation of cortical bone, expansion of the osseous region adjacent to the tumor, presence of clinical symptoms, vitality of the tooth associated with the lesion, displacement (or lack of eruption) of a tooth because of the lesion, inferior displacement of the mandibular canal due to growth of the lesion, root resorption of the tooth involved, treatment performed (excision, partial resection, resection with continuity, other), and maintenance or not of the tooth associated with the lesion. The lesion size was determined according to the largest diameter reported in the publications. Contact with authors for possible missing data was performed.

2.5. Analyses

The mean, standard deviation (SD), and percentages were presented as descriptive statistics. Kolmogorov–Smirnov test was performed to evaluate the normal distribution of the variables, and Levene's test evaluated homoscedasticity. The performed tests for two independent groups were Student's t-test or Mann–Whitney test, depending on the normality. Pearson's chi-squared or Fisher's exact tests were used for categorical variables, depending on the expected count of events in a 2×2 contingency table. The probability of recurrence was calculated for four variables, in odds ratio (95% confidence interval). These four variables were ‘preservation of the involved tooth’, ‘expansion of the osseous region adjacent to the tumor’, ‘perforation of cortical bone’, and ‘lesion location (maxilla/mandible)’. The degree of statistical significance was considered $p < 0.05$. All data were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) version 23 software (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Literature search

The study selection process is summarized in Fig. 1. The search strategy in the databases resulted in 1115 papers. The search in Google Scholar resulted in 26 eligible papers not found in the three main databases. A number of 452 articles were cited in more than one database (duplicates). The reviewers independently screened the abstracts for those articles related to the focus question. Of the resulted 689 studies, 520 were excluded for not being related to the topic. Additional hand-searching of journals and of the reference lists of selected studies yielded 17 additional papers. The full-text reports of the remaining 186 articles led to the exclusion of 45 because they did not meet the inclusion criteria (see Supplemental Appendix). The excluded studies did not have enough clinical, radiological and histological information to confirm the diagnosis of cementoblastoma. Thus, a total of 141 publications were included in the review.

3.2. Description of the studies and analyses

Some studies reporting series of odontogenic tumors and including cementoblastomas were found, but their cases were not included here due to lack of enough clinical, radiological and histological information to confirm the diagnosis of cementoblastomas. These include, for example, Ross et al. (1973) with 49 cases, Tamme et al. (2004) with 6 cases, Jing et al. (2007) with 33 cases, Avelar et al. (2008) with 4 cases, and Luo and Li (2009) with 22 cases.

Table 1 presents demographic and clinical features of all 258 cementoblastomas reported in the 141 publications (Abrams et al., 1974; Adkins and Monsour, 1973; Agrawal et al., 2014; Ahmad et al., 2014; Aiyer and Rajagopal, 2000; Anjum and S., 2014; Anneroth

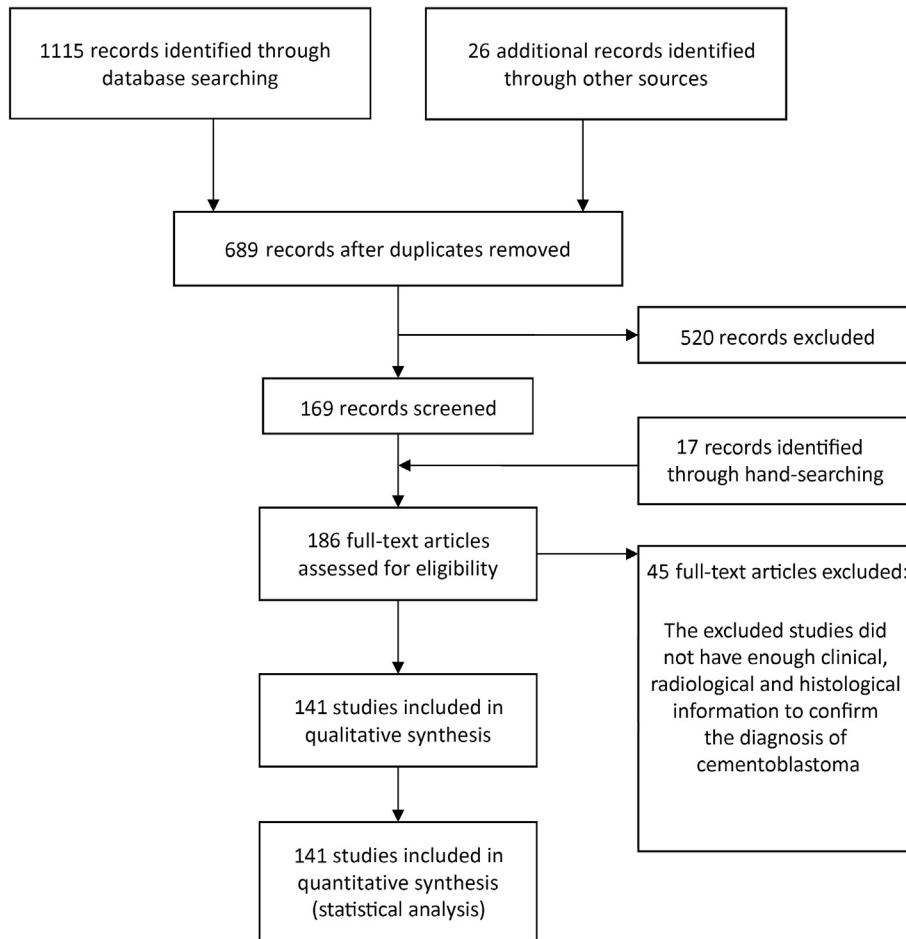


Fig. 1. Study screening process.

et al., 1975; Assis et al., 2014; Astacio and Mendez, 1974; Baart et al., 1991; Barker et al., 2009; Baughman, 2004; Berwick et al., 1990; Biggs and Benenati, 1995; Brannon et al., 2002; Brocheriou et al., 1979; Buyukkurt et al., 2010; Calb et al., 1998; Caliskan et al., 2016; Cannell, 1991; Carrion Zabarain et al., 1985; Cavadini and Cambiaggi, 1977; Cherrick et al., 1974; Collins and Asturias, 2011; Corio et al., 1976; Costa et al., 2016, 2011, 2012; Cundiff, 2000; Curran and Collins, 1973; da Costa Lomar, 1974; Dadhich and Niles, 2015; Damm, 2015; de Amorim et al., 2010; de Noronha Santos Netto et al., 2012; Dinakar et al., 2010; Donohue Cornejo et al., 2009; Esguep et al., 1983; Eversole et al., 1973; Fantasia and Damm, 2002; Farman et al., 1979; Flaitz, 1993; Fleming and Ryan, 2002; Forsslund et al., 1988; Fujii et al., 2016; Fujimoto and Tamaki, 1992; Fujita et al., 1989; Garlick et al., 1990; Ghom et al., 2010; Goerig et al., 1984; Gouvêa et al., 2016; Gulses et al., 2012; Hachimi et al., 2005; Hamdi et al., 2008; Harada et al., 2011; Herzog, 1987; Hirai et al., 2010; Huber and Folk, 2009; Hugar et al., 2013; Huvar and Butura, 1995; Hönl, 1991; Infante-Cossio et al., 2008; Ishida et al., 1994; Iwaki et al., 2001; Jelic et al., 1993; Jolehar et al., 2016; Kage et al., 1981; Kamikawa et al., 1994; Keyes and Hilderbrand, 1987; Kikuchi et al., 1986; Kitamura et al., 1992, 2000; Kline et al., 1961; Kumar et al., 2011; Langdon, 1976; Larsson et al., 1978; Lazarde et al., 1999; Lemberg et al., 2007; Levin et al., 1984; MacDonald-Jankowski and Wu, 1992; Mader and Wendelburg, 1979; Mahl et al., 2003; Makek and Lello, 1982; McNamara et al., 2010; Milani et al., 2012; Mogi et al., 1996; Moraes et al., 2009; Nair and Paul, 1986; Neelakandan et al., 2012; Neves et al., 2009;

Nowparast, 1978; Nuvvula et al., 2016; Ohki et al., 2004; Oliveira et al., 2013; Orsini et al., 2001; Papageorge et al., 1987; Paranjyothi et al., 2013; Pattyn et al., 2007; Peña et al., 2010; Piattelli et al., 1990, 1998; Pontes et al., 2008; Prakash et al., 2013; Pynn et al., 2001; Revathi et al., 2016; Rezvani and Dehghani Nazhvani, 2012; Rubino et al., 1999; Ruprecht and Ross, 1983; Saito et al., 1985, 1990; Sankari and Ramakrishnan, 2011; Schafer et al., 2001; Sharma, 2014; Shastry et al., 2012; Shoji et al., 1992; Sirigala et al., 2015; Slimani et al., 2009; Slootweg, 1992; Souza et al., 2013; Stanimirov et al., 2014; Sumer et al., 2006; Takagi et al., 1978; Towns et al., 1979; Trivedi, 1986; Ulmansky et al., 1994; Urs et al., 2016; Wang et al., 2005; Watanabe et al., 1994; Wertheimer et al., 1961; Vieira et al., 2007; Wiggins and Karian, 1975; Vilasco et al., 1969; Vindenes et al., 1979; Xu et al., 2015; Yamaguchi et al., 1990; Yamasaki et al., 1977; Yasui et al., 1995; Yoshida et al., 1993; Zachariades et al., 1985; Zaitoun et al., 2007; Zanda et al., 2012) included in the present review. The mean age of the patients was 23.6 years, and women were affected at a higher mean age than men, even though the difference was not statistically significant. Fig. 2 shows the distribution of the lesions according to age, with a high prevalence in the second and then third decades of life. The patients were aware of the lesion for a mean \pm SD of 16.6 ± 20.3 months (min–max, 1–96; $n = 107$) before seeking treatment. There was no sex predilection. The race was reported for 149 patients. Fifty-eight cases (38.9%) occurred in whites, 33 in Asians, 23 in Indians, 16 in blacks, 6 in Hispanics, 4 in Turks, 3 in Persians, and 6 in others. The lesions were more prevalent in the mandible in comparison to the maxilla (ratio

Table 1
Demographic and clinical features of cementoblastomas (n = 258) described in the literature.

Variable	
Age (year), mean ± SD (min–max)	23.6 ± 13.2 (4–75)
Men	20.9 ± 10.0 (4–64)
Women	25.8 ± 15.2 (7–75)
p Value ^a	0.075
Gender, n (%)	
Men	129 (50.2)
Women	128 (49.8)
Unknown	1
Jaw, n (%)	
Maxilla	57 (22.5)
Mandible	196 (77.5)
Unknown	5
Bone expansion, n (%)	
Yes	164 (74.9)
No	55 (25.1)
Unknown	39
Symptomatic, n (%)	
Yes	158 (70.2)
No	67 (29.8)
Unknown	33
Tooth response to pulp test, n (%)	
Yes (vital tooth)	71 (78.0)
No (non-vital tooth)	20 (22.0)
Unknown	167
Pulpal involvement, n (%)	
Yes	16 (30.8)
No	36 (69.2)
Unknown	206
Cortical bone perforation, n (%)	
Yes	35 (16.3)
No	180 (83.7)
Unknown	43
Radiopaque lesion, n (%)	
Yes	220 (98.2)
No	4 (1.8)
Unknown	34
Tooth displacement, ^b n (%)	
Yes	27 (13.4)
No	175 (86.6)
Unknown	56
Inferior displacement of mandibular canal, n (%)	
Yes	30 (23.6)
No	97 (76.4)
Unknown/lesion in maxilla/unknown jaw	68/57/6
Tooth root resorption, n (%)	
Yes	128 (59.8)
No	86 (40.2)
Unknown	44
Treatment, n (%)	
None	2 (0.9)
Endodontic treatment	1 (0.4)
Tooth extraction only	4 (1.7)
Excision	209 (91.3)
Marginal resection	6 (2.6)
Segmental resection ^c	7 (3.1)
Unknown	29
Tooth preserved?, n (%)	
Yes	26 (12.1)
No	189 (87.9)
Unknown/no treatment	41/2
Recurrence, n (%)	
Yes	20 (11.8)
No	150 (88.2)
Unknown	88
Follow-up time (months), mean ± SD (min–max) (n = 105)	30.6 ± 34.1 (1–132)
Lesion size (cm), mean ± SD (min–max) (n = 184)	2.2 ± 1.1 (0.5–8.0)

SD – standard deviation.

^a Mann–Whitney test.

^b Displacement or lack of eruption of a tooth because of the lesion.

^c Resection with continuity defect.

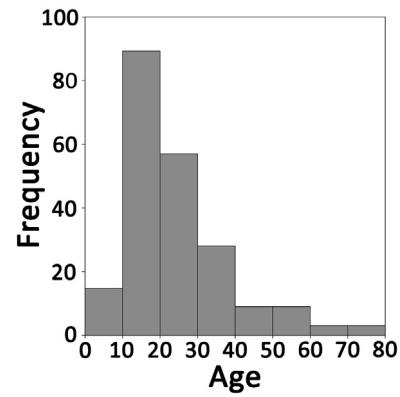


Fig. 2. Distribution of cementoblastomas according to age (for the cases which the patients' age were informed, n = 214).

3.4:1), and at the posterior region in comparison to the anterior region of the jaws (Fig. 3), with the highest occurrence in the region of the mandibular first molars. Only a few cases (n = 6) were reported in incisors. The lesions were usually associated with expansion of osseous region adjacent to the tumor (74.9%) and presence of clinical symptoms (70.2%). Few cases (n = 4) were purely radiolucent. Almost 80% of the teeth that were associated with the lesion presented vitality, nearly 60% of the teeth involved presented root resorption, and there was displacement or lack of eruption of a tooth because of the lesion in about 13% of the cases. About 16% of the lesions showed signs of cortical bone perforation, and there was inferior displacement of the mandibular canal due to growth of the lesion in 23.6% of the cases in the mandible. The mean ± SD lesion size was 2.2 ± 1.1 cm (min–max, 0.5–8.0; n = 184).

Treatment of the lesions was known in 229 cases, of which 216 were conservative surgery (209 excisions, 4 cases treated only by extraction of the involved tooth, 1 case with endodontic treatment, and 2 cases received no intervention), and 13 cases were treated by resection (6 marginal resections and 7 segmental resections). When the information was available, the tooth directly involved by the lesion was preserved in 26 (12.1%) out of 215 cases. Time of

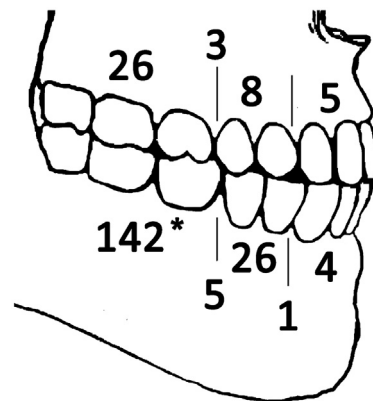


Fig. 3. Topographical distribution of the cementoblastomas with known precise locations (n = 220). Numbers at the top and bottom of the lines indicate cases involving both adjoining regions: anterior/premolar, premolar/molar. (*) 106 cases affected the mandibular first molar alone. For the rest of the lesions (n = 38), the location was the 'maxilla' (n = 13), 'right maxilla' (n = 2), 'mandible' (n = 9), 'left mandible' (n = 3), 'right mandible' (n = 4), 'anterior mandible' (n = 1), and 'posterior mandible' (n = 1). The location was not informed for 5 lesions. The maxillary sinus was clearly affected by the lesion in 5 cases.

follow-up was informed for 105 lesions, with a mean \pm SD of 30.6 ± 34.1 months (min–max, 1–132). There was information about recurrence for 170 lesions, of which 20 (11.8%) recurred. The interval from initial treatment to recurrence ranged from 6 to 24 months, with a mean interval of 16.8 ± 9.0 months ($n = 5$).

Table 2 shows the recurrence rate according to some variables. Recurrences occurred only when the lesions were treated by excision, but this also was the most common treatment performed. The preservation of the involved teeth and the location of the lesion (maxilla/mandible) seem to not influence the recurrence rate. However, cementoblastomas tended to have a statistically significantly higher recurrence rate when the lesions were associated with expansion of osseous region adjacent to the tumor and when there was perforation of the cortical bone adjacent to the lesion. There was a 687% higher probability (odds ratio 7.875; $p = 0.048$) of recurrence for lesions associated with bone expansion in comparison to those with no bone expansion, and a 217% higher probability (odds ratio 3.173; $p = 0.023$) of recurrence for lesions presenting cortical bone perforation in comparison to those not presenting perforation of the adjacent cortical bone.

4. Discussion

The present review of the literature revealed that cementoblastoma is a rare lesion, with less than 300 cases described in the literature. The great majority of the cases described appear as isolated case reports or reports of a small series of cases. The lesion presents no sex predilection, and it mostly occurs in the second and third decades of life. It appears that incisor involvement by cementoblastoma is extremely rare, with only 6 cases being previously reported. On the other hand, the most involved tooth was the mandibular first molar, with approximately 40% of all cases. Radiographically, most cementoblastomas exhibit a central opacity surrounded by a radiolucent halo, but they rarely may be purely radiolucent (Brannon et al., 2002; Eversole et al., 1973; Langdon, 1976). When the intimate relation with roots is present, the radiographic picture is nearly pathognomonic (Ulmansky et al., 1994).

Some cases have exhibited signs of local aggressiveness and destruction, including bony expansion, perforation of cortical plates, displacement of adjacent teeth, maxillary sinus involvement,

invasion of pulp chamber and root canals, and extension to and incorporation of adjacent teeth. Although about 60% of the cases reviewed here showed root resorption of the involved teeth, the authors of the present study believe that the prevalence can nearly reach 100% of the cases, as Brannon et al. (2002) have shown. The reason for that is because Brannon et al. (2002) performed a carefully histological assessment of this parameter for all their 44 cases, showing that this is an invariable characteristic of the tumor. Most of the other publications, however, reported this information based on radiological exams alone, which could have underestimated the actual figures.

Cases have also been treated successfully by root amputation in conjunction with endodontic therapy (Biggs and Benenati, 1995; Costa et al., 2016; Ulmansky et al., 1994). However, the literature has also shown that retaining the tooth by means of the aforementioned therapy has ultimately ended with subsequent extraction of the endodontically treated tooth (Adkins and Monsour, 1973; Wiggins and Karian, 1975). Even though the present results suggest that the preservation of the involved teeth seems to not influence the recurrence rate, it is difficult to say whether this may truly reflect the reality. As most of the lesions were treated in the same way (excision), the analysis of the best therapeutic approach was impaired.

Expansion of the osseous region adjacent to the tumor seems to be associated with a higher recurrence rate in comparison to the lesions with no bone expansion, as well as perforation of cortical plates in comparison to those not presenting this change. Future studies should address whether tooth preservation would not be appropriate in cases presenting the aforementioned alterations.

The study of Brannon et al. (2002), reported a high recurrence rate (37.1%) in their series, and the authors did not suggest the reasons of such high recurrence. They also reviewed the literature and came up with 69 cases with follow-up data, with a 21.7% recurrence rate. However, the consensus among investigators is that the cementoblastoma is a benign neoplasm with unlimited growth potential but with little tendency to recur. The results of the present review, including a greater amount of lesions, are more consistent with a lower recurrence rate (11.8%).

The results of the present study have to be interpreted with caution because of its limitations. First, all included studies were

Table 2

Recurrence – for the lesions with available information on both the variables and recurrence.

Variable	Recurrence/total (% recurrence)	<i>p</i> Value	Odds ratio (95% CI)	<i>p</i> Value
<i>Treatment</i>				
Endodontic treatment	0/1 (0)			
Excision	20/157 (12.7)			
Marginal resection	0/6 (0)			
Segmental resection ^a	0/4 (0)			
Total	20/168 (12.0)			
<i>Tooth preserved?</i>				
Yes	4/25 (16) ^b	0.356 ^c	1.486 (0.449, 4.917)	0.517
No	15/132 (11.4)			
<i>Bone expansion</i>				
Yes	18/114 (15.8)	0.021 ^d	7.875 (1.018, 60.932)	0.048
No	1/43 (2.3)			
<i>Cortical bone perforation</i>				
Yes	8/33 (24.2)	0.024 ^c	3.173 (1.175, 8.567)	0.023
No	12/131 (9.2)			
<i>Location</i>				
Maxilla	5/39 (12.8)	0.504 ^c	1.137 (0.385, 3.355)	0.816
Mandible	15/131 (11.5)			

CI – confidence interval.

^a Resection with continuity defect.

^b Not included the two cases for which no treatment/intervention was performed.

^c Fisher's exact test.

^d Pearson chi-squared test.

retrospective reports, which inherently results in flaws, manifested by the gaps in information and incomplete records. Second, many of the cases have a short follow-up, which could have led to an underestimation of the actual recurrence rate, because a longer follow-up period can lead to an increase in the recurrence rate. However, it is hard to define what would be considered a short follow-up period to evaluate the recurrence of cementoblastomas. Third, the great majority of the cases described were published as isolated case reports or small case series.

5. Conclusions

The recurrence rate of cementoblastomas was 11.8%. The preservation of the involved teeth and the location of the lesion seem to not influence the recurrence rate, but there was a high probability of recurrence for lesions associated with bone expansion and presenting cortical bone perforation.

Declaration of conflicting interests

There are no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.jcms.2017.08.002>.

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