Section: Radiodiagnosis

Original Research Article

RADIOLOGICAL, HISTOPATHOLOGICAL ASSESSMENT, AND SURGICAL OUTCOMES FOR RECURRENCE PREDICTION IN AMELOBLASTOMAS: A SINGLE-CENTER RETROSPECTIVE STUDY

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Abstract

Background: Ameloblastomas are complex, benign yet aggressive odontogenic tumours known for their high recurrence rates, particularly influenced by factors such as tumour location, histological subtype, and surgical approach. Effective management requires advanced imaging, precise histopathological evaluation, and tailored surgical strategies to optimize patient outcomes and minimize recurrence. This study analyses predictive factors associated with recurrence following surgical intervention. **Materials and Methods:** This retrospective analysis examined 50 cases of ameloblastoma diagnosed and treated at our institution from 2017 to 2018. Inclusion criteria required preoperative CT imaging and 5–6 years of postoperative follow-up, while patients lost to follow-up were excluded. Radiological assessments focused on lesion characteristics and surgical outcomes varied from conservative to radical approaches, with histopathological subtypes reviewed for recurrence risk. **Result:** The mean age of recurrent ameloblastoma cases was 36.18 years, with a higher prevalence in maxillary tumours than in mandibular ones. The follicular variant was most commonly associated with recurrence, particularly in tumours larger than 6 cm or those involving adjacent soft tissue. Significant risk factors for recurrence included root resorption and invasion into cortical bone. Among 20 recurrences analysed, solid/multiloculated types predominated, with radical surgery often failing to prevent recurrence, underscoring the need for meticulous surgical techniques and advanced imaging. **Conclusion:** This study underscores the importance of a multidisciplinary approach in managing ameloblastomas. CT imaging, combined with HPE, provides a robust framework for predicting recurrence and guiding treatment strategies. Larger cohort studies with extended follow-ups are warranted to validate these findings.

INTRODUCTION

Ameloblastomas are enigmatic tumours, often challenging clinicians due to their potential for recurrence. The anatomical complexity of the maxilla and mandible and variable histological subtypes necessitate tailored therapeutic approaches. Ameloblastomas, benign yet aggressive odontogenic tumours, present significant management challenges due to their high recurrence rates. They arise from enamel-forming cells and, if not managed effectively, can lead to extensive local destruction. Recurrence is influenced by several factors, including tumour location, histopathological features, and surgical approach.[1-4]

Tumours in the maxilla are more likely to recur due to anatomical complexity, which often limits complete surgical excision.[1,2] Multilocular ameloblastomas and solid/multicystic variants demonstrate aggressive behaviour and higher recurrence rates compared to unilocular and unicystic types.[2,3] Histological subtypes such as the follicular and granular variants are particularly associated with increased recurrence risks.[1,4]

Advanced imaging modalities, including CT and CBCT, play a pivotal role in tumour assessment by visualizing the lesion's size and extent.[3-5] This aids

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in distinguishing ameloblastomas from other odontogenic lesions like dentigerous cysts and keratocysts.[4-6] Integration of imaging findings with histopathology enhances the understanding of tumour behaviour, allowing for tailored surgical strategies. Conservative treatments, though less invasive, are linked to higher recurrence rates (41%) compared to radical surgeries (21%), especially in solid/ multicystic types.[7,8]

Histopathological evaluation remains crucial, with markers such as Ki-67 and p53 correlating with higher proliferative activity and recurrence.[1-4] Immunohistochemical advancements have furthered the understanding of tumour biology and genetic mutations, including PTCH1, emphasizing personalized treatment approaches.[5,6]

Overall, effective ameloblastoma management necessitates a multidisciplinary approach, integrating advanced diagnostics, precise histopathology, and appropriate surgical intervention. This approach not only minimizes recurrence but also ensures optimal patient outcomes.[7,8]

The examination of ameloblastomas, a benign yet aggressive form of odontogenic tumour, presents significant challenges in clinical management due to their propensity for recurrence. Understanding the complexities of these tumours involves not only their radiological and histopathological characteristics but also the surgical approaches utilized in their treatment.[1] This study aims to provide a retrospective analysis, focusing on the predictive factors associated with recurrence rates following surgical intervention. By scrutinizing patient data, imaging studies, and histological findings, the research seeks to identify patterns and correlations that may enhance prognostic accuracy for ameloblastomas. Ultimately, this comprehensive evaluation not only contributes to the existing body of knowledge but also emphasizes the importance of individualized patient care in surgical oncology. Through a careful synthesis of evidence from multiple domains, the study strives to inform future strategies in the management of this complex neoplasm.

Aims and objectives:

To predict factors influencing recurrence rates of Ameloblastomas. In correlation with Computed Tomography (CT) findings Histopathological (HPE)analysis and surgical outcomes.

MATERIALS AND METHODS

Study Design: A retrospective analysis of 50 cases of ameloblastoma diagnosed and treated between 2017 and 2018 at our institution. Patients with preoperative CT imaging and postoperative follow-up CT over 5–6 years were included in the study and the patients who lost to follow-up were excluded from the study.

Radiological Assessment

Preoperative CT characteristics analysed included:

- Size and location of the lesion
- Unilocular vs. multilocular appearance
- Impact on adjacent dentition and cortical expansion
- Soft tissue invasion

Surgical Outcomes: Surgical approaches ranged from conservative measures (enucleation, marsupialization) to radical interventions (segmental resection, hemimandibulectomy).

Histopathological Variants: HPE subtypes were reviewed to assess recurrence risk.

RESULTS

Age and Location

The mean age of recurrent cases was 36.18 years. Recurrences were more prevalent in maxillary tumours compared to mandibular, consistent with previous studies.

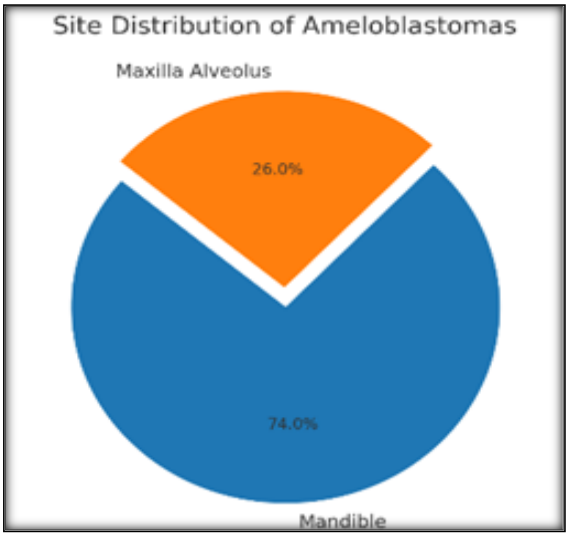

Figure 1: Distribution of participants according to site of distribution of Ameloblastoma

Histopathological Variants

The follicular variant was most associated with recurrence. Lesions exceeding 6 cm or involving adjacent soft tissue demonstrated higher recurrence rates.

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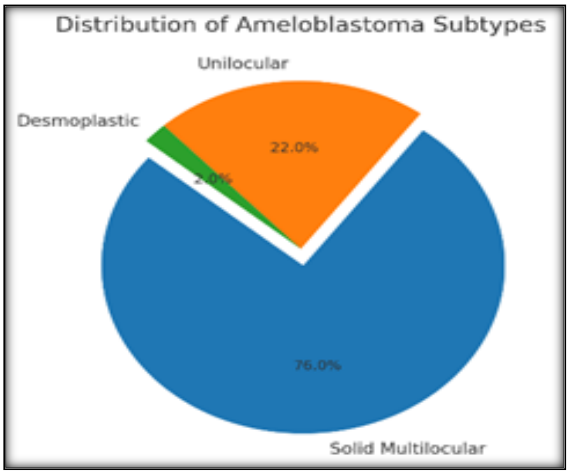

Figure 2: Distribution of participants according to subtypes

Our study had tumours who size averaged between 5-20 cm. Wherein we observed that in tumours larger than 6 cm, tumours involving adjacent structures, and soft tissue were associated with a higher recurrence rate. This was irrespective of the type of treatment done. The findings of our study were in accordance with the studies done by Rong Yang et al.

In our study we found that root resorption and bone cortex/soft tissue invasion were risk factors for disease recurrence especially in unicystic ameloblastoma patients.

The choice of treatment also plays a pivotal role in ameloblastoma recurrences. Surgical options available include: Radical surgery, Conservative surgery, Segmental resection, Enucleation, Marginal resection, Bone curettage, Hemimandibulectomy and Marsupialization.

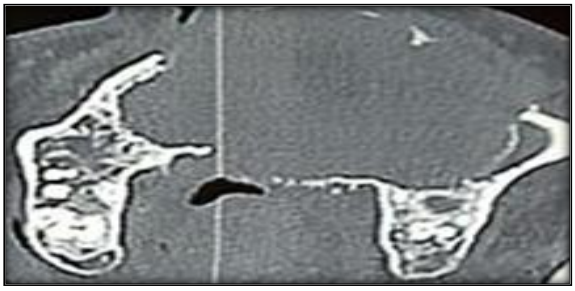

Figure 3: Preoperative CT image

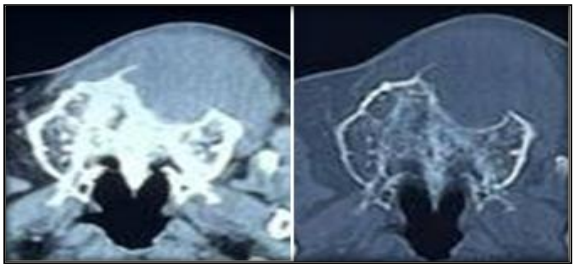

Figure 4: Postoperative follow up: Recurrence in soft tissue

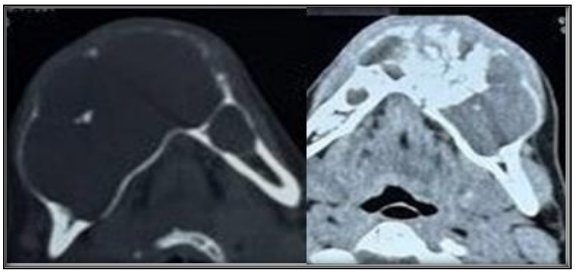

Figure 5: Preoperative CT image

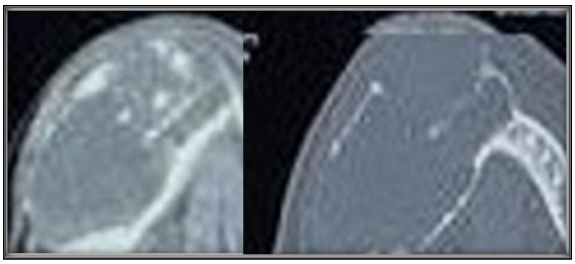

Figure 6: Postoperative follow up: Recurrence in soft tissue

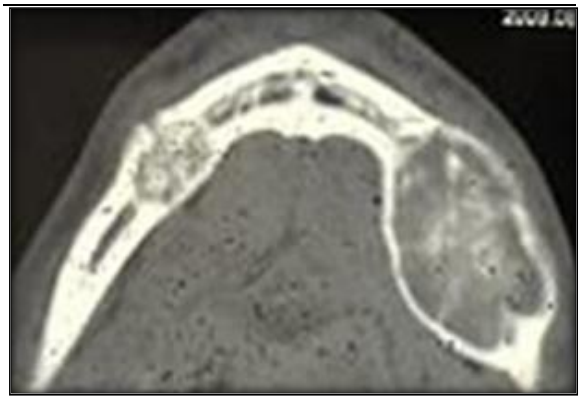

Figure 7: Preoperative CT image

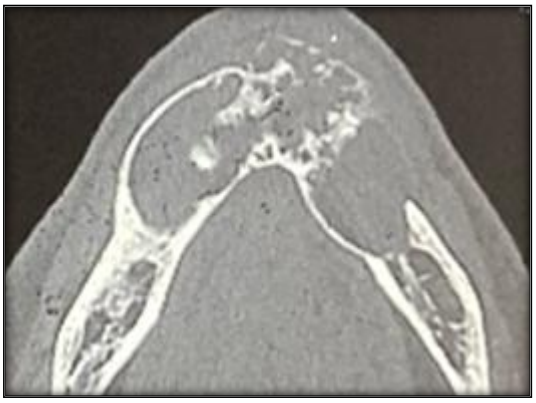

Figure 8: Postoperative follow up: Recurrence in soft tissue

In our study, which analysed 20 cases of ameloblastoma recurrences, a significant observation was the predominance of solid/multiloculated ameloblastomas as the recurrent subtype, accounting for 16 cases. Among these 16 cases, 12 patients underwent radical surgical interventions, including wide local excision and resection with adequate margins, aiming to minimize recurrence by ensuring complete removal of the tumour. Despite these aggressive measures, recurrences still occurred,

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underscoring the challenging nature of managing this aggressive variant.

The remaining 4 cases of solid/multiloculated ameloblastomas were treated conservatively, as patients either deferred radical treatment due to personal or health-related reasons. Conservative measures, such as enucleation or curettage, are less invasive but often associated with higher recurrence rates. This outcome reinforces the necessity of radical treatment approaches, especially for multilocular tumours, to mitigate the risk of recurrence effectively.

In addition to the solid/multiloculated variant, 4 cases of recurrences were attributed to the unilocular type. All these cases were treated with conservative methods such as enucleation, likely due to the perceived less aggressive nature of unilocular ameloblastomas. However, the findings suggest that even unilocular variants can recur, particularly when conservative approaches fail to eliminate all tumour components.

One of the critical factors contributing to recurrence in multilocular ameloblastomas is the incomplete surgical removal of microcysts and daughter cysts, which may be embedded within the surrounding bone or soft tissue. These microscopic remnants can evade detection during surgery and subsequently lead to tumour regrowth. This highlights the importance of employing advanced imaging techniques pre- and intra-operatively to identify the full extent of the lesion, as well as ensuring meticulous surgical execution to achieve clear margins.

Overall, the findings emphasize the aggressive nature of multilocular ameloblastomas and the necessity for radical treatment strategies, while also cautioning against underestimating the recurrence potential of unilocular variants.

Table 1: Distribution of participants according to age and gender.

Age Group (years)	No. of Patients	Percentage (%)	No. of Males	No. of Females
22–29	20	40%	13	7
30–39	13	26%	11	5
40–49	8	16%	5	2
50–59	6	12%	3	1
60–68	3	6%	2	1
Total	50	100%	34	16

Table 2: Distribution of participants according to histopathological variants

S. No	Variant	n = 50
1	Follicular	30
2	Plexiform	10
3	Basal	2
4	Acanthomatous	2
5	Granular	4
6	Desmoplastic	2
Total		50

DISCUSSION

Ameloblastoma is a benign yet locally aggressive odontogenic tumour with a notable tendency for recurrence. Several factors have been identified that significantly influence the likelihood of recurrence after treatment. Below are the key factors along with relevant references.

1. Maxillary Location of the Lesion: Lesions located in the maxilla exhibit a higher recurrence rate compared to those in the mandible.[10-12]
2. Multilocular Ameloblastomas: The multilocular subtype of ameloblastoma demonstrates a greater propensity for recurrence due to its aggressive growth patterns and the challenges associated with ensuring complete surgical removal.[10-13]
3. Histological Variants: The follicular variant is most commonly associated with recurrence, followed by the granular variant. These histological types are considered more aggressive, exhibiting a higher potential for local invasion and recurrence post-treatment.[10,11,13]
4. Tumour Size: Tumours larger than 6 cm are linked to a higher likelihood of recurrence. Their increased size often results in involvement of surrounding structures, making it more challenging to achieve clear surgical margins and increasing the risk of incomplete removal.[10,12,13]
5. Involvement of Adjacent Structures and Soft Tissue: When ameloblastomas extend into adjacent anatomical structures or involve surrounding soft tissues, achieving complete excision becomes more complex.[10,11]
6. Root Resorption and Cortical Bone/Soft Tissue Invasion in Unicystic Types: In unicystic ameloblastomas, features such as root resorption and invasion into cortical bone or soft tissues suggest more aggressive behaviour, increasing the likelihood of recurrence even after treatment.[10,13]
7. Treatment Modality: Conservative treatments (e.g., enucleation or curettage) are associated with higher recurrence rates compared to radical surgery, which includes segmental or marginal resection.[10-12]

The recurrence of ameloblastoma is a significant concern in clinical practice, and various studies have provided insights into factors influencing recurrence rates. This analysis synthesizes findings related to

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age, location, and surgical approaches based on the literature reviewed.

Our findings indicate that recurrences are more prevalent in the maxilla compared to the mandible. This observation is attributed to the anatomical complexities of the maxilla, which often lead to inadequate tumour-free margins during surgical treatment. The literature supports this conclusion:

Azadi M, Mohammadi F, and Hajiani N reported similar findings in their case report on recurrent maxillary ameloblastoma, emphasizing the challenges posed by the maxillary anatomy.[14]

Mendenhall et al. also noted that the thin cortical bone in the maxilla contributes to a higher likelihood of recurrence compared to the mandible.[15]

The average age of patients experiencing recurrence of ameloblastoma was reported as 36.18 ± 5.47 years. This aligns with the general occurrence age for ameloblastomas, suggesting that recurrences typically manifest within a few years post-treatment. Studies by Arotiba et al. and Milman et al. corroborate this finding, indicating that the highest recurrence rates are observed in individuals during their third and fourth decades of life.[16]

Surgical Approaches

The type of surgical intervention significantly impacts recurrence rates:

- Radical Surgeries: These approaches tend to yield lower recurrence rates than conservative methods. The comprehensive removal of tumour tissue during radical surgeries minimizes residual disease.
- Conservative Approaches: Procedures such as enucleation or curettage are associated with higher recurrence rates due to potential incomplete removal of the tumour, particularly in multilocular cases where residual microcysts may remain.[17]

In summary, addressing factors such as age, anatomical location, and surgical technique is crucial for reducing the risk of recurrence in ameloblastoma patients.

Clinical Relevance: Computed tomography (CT) evaluation of ameloblastomas is invaluable in guiding treatment strategies and assessing prognosis. Key CT parameters such as size, locularity, location, cortical breach, and soft tissue involvement play a critical role in tailoring individualized treatment approaches.

- **Size:** Larger tumours (>6 cm) are often associated with more aggressive behaviour, higher recurrence rates, and a need for radical surgical interventions. CT imaging provides precise measurements that aid in determining the extent of surgical resection required.
- **Locularity:** The distinction between unilocular and multilocular ameloblastomas on CT influences treatment decisions. While unilocular tumours may be treated conservatively with enucleation or curettage, multilocular tumours, due to their aggressive nature, often necessitate radical measures such as resection with wide margins to minimize the risk of recurrence.
- **Location:** Tumours located in the maxilla pose unique challenges due to proximity to vital structures, such as the orbit and cranial base. CT imaging helps delineate these critical anatomical boundaries, enabling surgeons to plan precise and safe resections. Mandibular lesions, though more common, require assessment for potential invasion into the mandibular canal or surrounding structures.
- **Cortical breach and soft tissue involvement:** The detection of cortical bone erosion and infiltration into adjacent soft tissues is a significant predictor of recurrence and guides the choice between radical and conservative approaches. CT imaging accurately identifies these features, emphasizing the need for more aggressive treatment when soft tissue involvement is evident.

CT, when combined with histopathological evaluation (HPE), ensures a comprehensive approach in managing ameloblastomas. This synergy allows for effective planning of initial treatments and post-operative surveillance, helping to differentiate cases that require aggressive re-intervention from those suitable for conservative management. By integrating radiological and pathological insights, clinicians can improve outcomes and reduce recurrence rates.

Similar results were reported by Hendra et al. and Andrii Hresk et al., along with several other studies. Hendra et al. emphasized the significance of tumour size and locularity in predicting recurrence, highlighting the higher recurrence rates associated with multilocular ameloblastomas treated conservatively. They suggested that incomplete surgical removal, particularly of microcysts and daughter cysts, plays a crucial role in recurrence, aligning with findings in our study.

Limitations: Although WHO guidelines state that 50% ameloblastomas recur within 5 years, a longer follow up period of 10-15 years and sometimes up to 25 years might be able to yield better insights with respect to factors influencing recurrence. A Large Sample volume might help in better reinforcing the findings of our present study.

CONCLUSION

These findings underscore the value of CT imaging as a valuable tool in the diagnosis and management of ameloblastomas. By providing detailed insights into tumour size, locularity, location, and involvement of surrounding structures, CT plays a pivotal role in guiding treatment decisions. The use of CT, alongside histopathological examination (HPE), helps determine the most appropriate course of action, whether radical surgery or conservative treatment is indicated. Additionally, CT assists in identifying critical factors such as cortical breach and soft tissue involvement, which are crucial for

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assessing recurrence risk and planning further interventions.

Our study, along with similar findings from other authors, highlights the importance of integrating radiological evaluations into the clinical workflow to enhance prognostic accuracy and optimize patient outcomes. The evidence strongly supports the notion that comprehensive imaging, when combined with careful surgical planning, can significantly improve the management of ameloblastomas, ensuring the best possible treatment strategy is chosen based on individual patient factors.

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