SCOPING REVIEW

Conservative and Radical Surgery *vs.* BRAF-Target Therapy for Recurrent Ameloblastoma

Dimas Bramanto Satrya Utama[1]*, Nadia Maulida Andini[1], Afif Surya Adena[2]
[1]Department of Oral & Maxillofacial Surgery, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.
[2]Department of Prosthodontics, Faculty of Dental Medicine, Universitas Jember, Jember, Indonesia.

Article Info

Article history:
Received 27-12-2024
Revised 18-05-2025
Accepted 24-05-2025
Published 31-07-2025

Keywords:
Ameloblastoma
Recurrency
Conservative surgery
Radical surgery
BRAF-Target Therapy
Good Health and Well Being

***Corresponding author**:
Dimas Bramanto Satrya Utama
sippuden@gmail.com

ABSTRACT

Background: Ameloblastoma is a benign odontogenic tumor that can affect surrounding tissues and is prone to recurrence if not completely excised. Surgical therapy is currently the primary treatment modality. However, recurrences are common following prior surgical interventions. Recently, a novel approach involving BRAF (B-Rapidly Accelerated Fibrosarcoma)-targeted therapy has been introduced, aiming to prevent molecular mutations. This therapy is non-invasive, but its efficacy in treating recurrent ameloblastoma remains uncertain. **Objective:** This article aimed to compare the outcomes of conservative and radical surgery with BRAF-targeted therapy in the management of recurrent ameloblastoma. **Material and Method:** An electronic search was conducted using the PubMed and Scopus databases. Relevant studies were selected based on predefined inclusion criteria. **Results:** A total of nine studies were included in the analytical synthesis. Recurrence in ameloblastoma is often due to residual tumor tissue located in anatomically challenging areas following surgery. BRAF-targeted therapy has emerged as a promising option for patients with recurrent disease, offering precise tumor targeting and potentially reducing the need for further surgical intervention. **Conclusion:** Surgical and BRAF-targeted therapies each offer benefits in managing recurrent ameloblastoma. While recurrence is often linked to residual tumors in complex anatomical areas, BRAF-targeted therapy provides a non-invasive, precise alternative—especially for patients with multiple recurrences. It can reduce tumor size, improve lesion localization, and potentially limit the need for extensive surgery.

How to cite:
Utama, D. B. S., Andini, N. M., Adena, A. S. 2025. Conservative and Radical Surgery vs BRAF-Target Therapy for Recurrent Ameloblastoma. Majalah Biomorfologi-Biomorphology Journal, 35(2): 140-148

***Majalah Biomorfologi* (Biomorphology Journal)** p.ISSN:0215-8833, e.ISSN: 2716-0920
doi: 10.20473/mbiom.v35i1.2025.140-148

Highlights

1. Ameloblastoma is a widely discussed odontogenic tumor, yet research on less invasive treatment options for recurrent cases remains limited.
2. BRAF-targeted therapy offers a less invasive approach that may reduce the extent of surgical intervention required.

BACKGROUND

Ameloblastoma is a benign odontogenic tumor of the oral cavity, accounting for approximately 10% of all tumors arising in the mandible and maxilla (Ghai, 2022). Around 80% of ameloblastomas occur in the mandible, particularly in the third molar region, while the remaining 20% occur in the maxilla. The tumor originates from remnants of the dental germinal epithelium, enamel organ epithelium, stratified squamous epithelium, and odontogenic cyst epithelium (Masthan, et al., 2015). The global incidence of ameloblastoma is estimated at 0.92 cases per million person-years, with geographical variations in prevalence (Hendra, et al., 2020).

Ameloblastoma typically presents asymptomatically and grows slowly but invasively. It has a high recurrence potential and may undergo malignant transformation and metastasis (Ranchod, et al., 2021). Swelling without pain is a common clinical feature, often leading to delayed diagnosis. The World Health Organization (WHO) classified ameloblastoma into four types in 2017: conventional ameloblastoma, unicystic ameloblastoma, extraosseous/peripheral ameloblastoma, and metastasizing ameloblastoma (Ghai, 2022).

There are two main surgical approaches to ameloblastoma treatment: conservative surgery and radical surgery. Conservative procedures, such as enucleation or curettage, are less invasive and involve shorter operative times. These are commonly used for unicystic ameloblastomas, with a recommended surgical margin of 1–1.5 cm (Adeel, et al., 2018). In contrast, radical procedures—including marginal resection, segmental resection, hemimandibulectomy, and maxillectomy—are more invasive and often require extensive reconstructive surgery (Hresko, et al., 2022).

In terms of recurrence, conservative surgical methods are associated with high recurrence rates, ranging from 55% to 90%, frequently necessitating secondary surgeries. Radical methods, on the other hand, have lower recurrence rates (15% to 25%) but may significantly impact patients' quality of life due to aesthetic and functional deficits (Hendra, et al., 2019).

Recurrence often results from residual tumor cells at the osteotomy site, particularly in complex anatomical regions such as the infratemporal fossa. Contributing factors include the tumor's histological type and location (Verma & Das, 2022). The follicular type exhibits a higher recurrence risk than the plexiform or other subtypes. Anatomically, the posterior mandible is more prone to recurrence than the maxilla (Aramanadka, et al., 2018). Additionally, cortical bone perforation is a significant risk factor, as it allows tumor invasion beyond the trabecular margin and into soft tissues, especially if the periosteum is breached (Verma & Das, 2022; Y.-C. Yang et al., 2021). Hresko, et al., (2022) have documented recurrences in soft tissues such as the infratemporal fossa, even in the absence of bony involvement.

Recent advances in ameloblastoma management include the development of targeted therapies directed at specific genetic mutations. One of the most significant findings is the high frequency of mutations in the mitogen-activated protein kinase (MAPK) pathway, particularly involving the BRAF (B-Rapidly Accelerated Fibrosarcoma) gene, in mandibular ameloblastomas (Malakar, et al., 2023). The BRAF gene encodes the B-Raf protein (serine/threonine-protein kinase B-Raf), a proto-oncogene that plays a pivotal role in the MAPK and NF-κB signaling pathways. Mutations—most commonly the V600E substitution—can dysregulate these pathways and promote tumorigenesis (Angelina & Kodariah, 2016).

Current therapeutic strategies include the use of BRAF inhibitors, such as vemurafenib, dabrafenib, and encorafenib, which are primarily approved for malignancies like melanoma harboring BRAF mutations. These drugs selectively inhibit BRAF kinase, thereby disrupting the MAPK signaling cascade, which is essential for cell proliferation, survival, and migration. In addition to their targeted action, BRAF inhibitors have demonstrated immunomodulatory properties (Proietti, et al., 2020).

Although extensive research supports the use of BRAF-targeted therapy in cancers such as melanoma, its application in ameloblastoma, particularly recurrent ameloblastoma, is still underexplored in the literature. This gap in research has motivated the current study, which seeks to evaluate and compare the outcomes of conservative or radical surgery with BRAF-targeted therapy for recurrent ameloblastoma, by reviewing a series of available case reports.

OBJECTIVE

This article aimed to compare the effects of conservative and radical surgical approaches with BRAF-targeted therapy in the management of recurrent ameloblastoma.

MATERIAL AND METHOD

This scoping review was conducted through a comprehensive and systematic search of the PubMed and Scopus databases. The keywords used in the search included recurrent ameloblastoma, BRAF, targeted therapy, conservative surgery, radical surgery, and treatment. The studies were then filtered through both qualitative and quantitative selection processes. The inclusion criteria were limited to articles published in English between the years 2014 and 2024. This review specifically focused on case reports that described patients with ameloblastoma who had initially been treated with conservative or radical surgery, experienced recurrence, and were subsequently managed using BRAF-targeted therapy.

To ensure the accuracy and reliability of the findings, all selected studies were carefully examined by experienced reviewers. The screening process began with an evaluation of the study titles to narrow the scope, followed by an abstract review as part of the initial screening. Full texts of potentially relevant studies were then retrieved and analyzed for inclusion in a qualitative synthesis. The search of the electronic databases initially identified 46 manuscripts. After removing 31 duplicate entries, 34 papers remained for full-text evaluation. Of these, 17 full texts were unavailable, and 8 papers were excluded due to irrelevance to the study objective. In the end, 9 studies met all the inclusion criteria and were included in the final analytical synthesis, supporting the integrity and relevance of this review's conclusions.

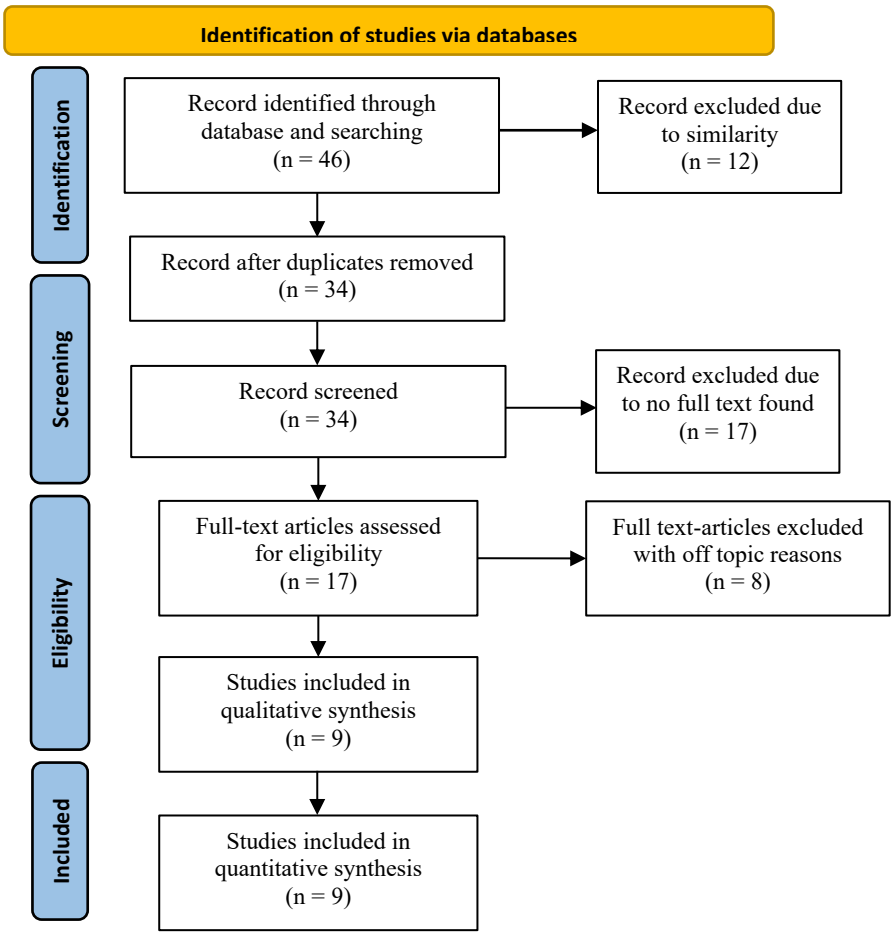

Figure 1. ScR PRISMA flowchart (Page, et al., 2021).

RESULT

The main comparative outcomes between conservative or radical surgery and BRAF-targeted therapy for recurrent ameloblastoma are schematically presented and summarized in the table below.

Table 1. Comparison table between conservative or radical surgery and BRAF-targeted therapy.

Reference	Tumor staging	Previous Treatment	Outcome Previous Treatment	Subsequent Treatment	Outcome Subsequent treatment
Brunet, et al., (2019) doi: 10.3389/fonc.2019.01204.	Recurrent and metastatic	Conservative surgery	There was no evidence of locoregional relapse until 13 years later, when metastasis to the lungs occurred.	BRAF-targeted therapy (Dabrafenib, Trametinib)	Complete remission was achieved after 30 weeks.
Faden & Algazi, (2017) doi: 10.1093/jnci/djw190.	Recurrent and locally advanced	Twice treated with Conservative surgery	Lesion relapsed and grew larger	BRAF-targeted therapy (Dabrafenib)	At 12 months, the tumor continued to visibly reduce in size.
Fernandes, et al., (2018) doi: 10.1186/s12885-018-4802-y.	Recurrent and locally advanced	Several times of Conservative and Radical surgeries	The lesion recurred multiple times over a period of 16 years	BRAF-targeted therapy (Vemurafenib)	Complete resolution of symptoms was observed. Prior to treatment, the lesion measured 24 × 21 × 19 mm. After one year of therapy, the lesion size was reduced to 18 × 13 × 14 mm.
Broudic-Guibert, et al., (2019) doi: 10.1186/s13256-019-2140-6.	Recurrent and metastatic	Radical surgery	Relapse and lung metastases 11 years after surgery	BRAF-targeted therapy (Vemurafenib)	After 26 months, there was sustained improvement in symptoms along with a continuous reduction in both tumor size and metastases.
Kaye, et al., (2014) doi: 10.1093/jnci/dju378.	Recurrent and metastatic	Several times of Radical surgery	After 4 resections and radiation therapy, recurrence was marked by bilateral tumor growth over the following 6 years.	BRAF-targeted therapy (Dabrafenib, Trametinib)	A persistent reduction in tumor mass in the face, jaw, and neck was observed over a period of 20 weeks.
Tan, et al., (2016) doi: 10.1016/j.ooo.2015.12.016.	Recurrent and locally advanced	Conservative surgery and bone grafting	Lesion relapsed after 4 months	BRAF-targeted therapy (Dabrafenib)	The ameloblastoma demonstrated a gradual yet significant response, resulting in a reduction of more than 90% in tumor volume.
Büttner, et al., (2023) doi: 10.1016/j.heliyon.2023.e23206.	Recurrent and locally advanced	Local resection	Lesion relapsed after 5 years	Combined B-RAF-/MEK-inhibitors (Dabrafenib and Trametinib) and extensive surgery followed by	Following neoadjuvant therapy, the tumor size decreased from 72.6 mm in July 2019 to approximately 55.9 mm by November 2020.

				autologous bone implantation.	
Abramson, et al., (2022) doi: 10.1016/j.oraloncology.2022.105854.	Recurrent and metastatic	Surgical resections and radiation therapy	Lesion relapsed with bilateral lung metastases	BRAF-targeted therapy (Dabrafenib and Trametinib)	A decrease in size and enhancement of the left mandibular mass, along with increased calcification, was observed after seven months of therapy in August 2021. The patient remained symptom-free through April 2022.
Zhukov, et al., (2019) doi: 10.1200/PO.19.00282.	Recurrent and locally advanced	Surgical resection	Lesion relapsed 3 times	BRAF-targeted therapy (Vemurafenib and Cobimetinib)	The patient has survived for 18 months since initiating targeted therapy and has remained disease-free for 11 months following the most recent surgery.

From the nine case reports analyzed, all patients presented with recurrent ameloblastoma, many of which had progressed to locally advanced or metastatic disease, particularly with lung involvement. Most patients had previously undergone either conservative or radical surgical procedures, and in some cases, radiation therapy. However, these interventions frequently failed to prevent long-term recurrence. Following relapse, all patients received BRAF-targeted therapy, either as monotherapy or in combination with MEK inhibitors such as Dabrafenib and Trametinib. The outcomes consistently demonstrated favorable clinical responses, including complete remission, significant tumor reduction, symptom resolution, and long-term disease stability. In several cases, BRAF-targeted therapy was used as a neoadjuvant approach to reduce tumor size prior to additional surgical resection and reconstruction. These findings suggest that BRAF-targeted therapy offers a promising treatment option, particularly for patients with recurrent ameloblastoma who do not respond adequately to repeated surgical interventions.

DISCUSSION

Ameloblastoma originates from epithelial tissues such as remnants of the enamel organ, dental follicles, periodontal ligaments, or the lining of odontogenic cysts (Adeel, et al., 2018). It typically manifests as a gradually enlarging, painless swelling that may cause expansion or perforation of the cortical bone. Without intervention, it has the potential to grow significantly, leading to facial deformity (Shi, et al., 2021). This tumor tends to invade surrounding tissues and poses a high risk of recurrence if not completely excised (Aramanadka, et al., 2018).

Surgical therapy remains the primary treatment for ameloblastoma. It includes conservative procedures, such as enucleation and curettage, as well as radical surgeries, including marginal resection, segmental resection, hemimandibulectomy, and maxillectomy (Hendra, et al., 2019). While radical surgery reduces recurrence rates, it may lead to significant facial deformities and impaired mastication, negatively impacting patients' physical and psychological well-being and overall quality of life. In contrast, conservative surgery is less invasive and preserves facial aesthetics and function, but it is associated with a higher recurrence rate (Yang, et al., 2022). Reported recurrence rates range from 55% to 90% following conservative approaches. Segmental resection has a recurrence rate of 4.5%, and marginal resection around 11.6% (Verma & Das, 2022).

Several case studies have documented recurrence after multiple surgeries. Kaye, et al., (2014) reported recurrence and metastasis after four resections and radiation therapy. Faden & Algazi, (2017) described persistent recurrence and tumor progression. Similarly, Brunet, et al., (2019), Broudic-Guibert, et al., (2019), and Abramson, et al., (2022) observed tumor relapse post-surgery, with metastasis to the lungs.

Recurrence may result from residual tumor cells in complex anatomical areas, such as the infratemporal fossa a pyramidal region beneath the zygomatic arch and behind the maxilla, bordered by

the mandibular ramus and skull base. Its deep location, proximity to critical structures (e.g., nasopharynx, maxillary artery, calvaria), and limited surgical accessibility increase the risk of incomplete resection (Aramanadka, et al., 2018; Bilici, et al., 2016).

The BRAF gene plays a key role in cellular signaling pathways involved in proliferation and survival. BRAF mutations, particularly V600E, occur in 60–80% of ameloblastoma cases and lead to constitutive BRAF activation and uncontrolled cell growth. If molecular testing identifies a BRAF V600E mutation, targeted therapy becomes a rational treatment option. This approach inhibits the aberrant pathway while sparing normal tissues (Gutiérrez-Castañeda, et al., 2020). Though BRAF-targeted therapies have demonstrated strong responses in tumors like melanoma, their efficacy can vary across cancers—e.g., in colorectal cancer, outcomes may be limited in the presence of morphological transformation (Shan, et al., 2024; Zhukov, et al., 2019).

In 2011, the FDA approved vemurafenib, the first BRAF V600E-specific inhibitor for melanoma. Subsequently, dabrafenib and encorafenib were approved, with dabrafenib commonly combined with trametinib for enhanced outcomes in stage III BRAF-mutant melanoma (Poulikakos, et al., 2022). Vemurafenib selectively inhibits the BRAF V600E mutation by targeting the MAPK pathway, but it can cause side effects such as rash, fatigue, and photosensitivity (Jang & Atkins, 2013; Proietti, et al., 2020). Dabrafenib, another ATP-competitive inhibitor, has a shorter half-life and similar side effects, including keratoacanthoma and squamous cell carcinoma.

MEK inhibitors, such as trametinib and cobimetinib, can be used in combination. Trametinib inhibits MEK1/2 and shows tumor response in vemurafenib-resistant cases. Cobimetinib also targets MEK1/2 and blocks Ras/Raf signaling. It was FDA-approved in 2015 for combination use with vemurafenib (Gong, et al., 2018; Jang & Atkins, 2013).

Case reports illustrate a wide range of indications for BRAF-targeted therapy in ameloblastoma. Brunet, et al., (2019) administered therapy after observing long-term relapse. Faden & Algazi, (2017) opted for targeted therapy due to patient comorbidities. Fernandes, et al., (2018) reported multiple recurrences over 16 years and used BRAF inhibitors after the patient declined further surgery. Zhukov et al., (2019) used combination therapy after repeated recurrences.

Metastatic cases also benefited: Broudic-Guibert, et al., (2019) observed a 30% reduction in lung lesions, and Kaye, et al., (2014) treated a stage IV case effectively. Neoadjuvant therapy was chosen by Tan, et al., (2016) after a pathological fracture and by Büttner, et al., (2023) to reduce tumor burden before extensive surgery. Abramson, et al., (2022) showed additional benefits in managing hypercalcemia with BRAF-targeted treatment.

These cases suggest BRAF inhibitors are suitable for recurrent, inoperable, metastatic, or large-volume tumors, and in patients with comorbidities. Yang, et al., (2021) highlight the broader value of molecular targeted therapy. It minimizes harm to healthy tissue, selectively targets tumor cells, and reduces surgical extent allowing for more conservative resection (Büttner, et al., 2023).

However, long-term evidence remains limited. Most follow-up durations for BRAF-targeted cases are relatively short compared to those treated surgically. Among the nine reviewed papers, follow-ups ranged from 7 months to 30 months. In contrast, surgical recurrence was observed after 11–13 years in cases reported by Brunet, et al., (2019) and Broudic-Guibert, et al., (2019). This short follow-up limits understanding of long-term recurrence potential after targeted therapy. Therefore, extended observation is essential to fully assess the durability of BRAF-targeted therapy in recurrent ameloblastoma.

Strength and limitations

This study offers an analysis of treatment outcomes in recurrent ameloblastoma by comparing conventional and radical surgical approaches with BRAF-targeted therapy, thereby addressing the challenges associated with recurrence following treatment. A key strength lies in its focus on recent clinical cases and the emerging role of targeted molecular therapy. However, a limitation of this review is the lack of detailed differentiation regarding the specific types of surgical procedures performed and the particular BRAF-targeted agents used. As such, future studies with more standardized reporting are needed to enable a more precise and comprehensive comparison of treatment modalities.

CONCLUSION

Both surgical therapy and BRAF-targeted therapy present distinct advantages in the management of recurrent ameloblastoma. Recurrence frequently arises due to residual tumor cells, particularly in anatomically complex regions such as the infratemporal fossa, which pose significant surgical challenges. For patients who have undergone multiple surgeries and continue to experience recurrence, BRAF-targeted therapy emerges as a promising alternative. In addition to its non-invasive nature, this therapy directly targets the molecular drivers of tumor growth, offering enhanced precision and therapeutic effectiveness. BRAF inhibitors can contribute to tumor size reduction, improved lesion localization, and may ultimately minimize the extent of surgical resection required.

Acknowledgment
The authors would like to thank the Department of Oral & Maxillofacial Surgery, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia.

Conflict of Interest
All authors have no conflict of interest.

Funding Disclosure
This research was self-funded by the authors.

Author Contribution
DBSU and NMA is involved in conceiving and designing the study, analyzing and interpreting data, drafting the article, critically revising it for important intellectual content, giving final approval for publication, and providing study materials. ASA provide administrative, technical, or logistical support and contribute to supplying study materials.

Data Availability
None.

REFERENCES

Abramson, Z., Dayton, O. L., Drane, W. E., Mendenhall, W. M., Kaye, F. J. 2022. Managing stage 4 ameloblastoma with dual BRAF/MEK inhibition: A case report with 8-year clinical follow-up. Oral Oncology, 128: 105854. doi: 10.1016/j.oraloncology.2022.105854.

Adeel, M., Rajput, M. S. A., Arain, A. A., Baloch, M., Khan, M. 2018. Ameloblastoma: Management and outcome. Cureus. doi: 10.7759/cureus.3437.

Angelina, R., Kodariah, R. 2016. The role and mechanism of BRAF in malignancy. Pratista Patologi, 5(1). Available at: https://majalahpratistapatologi.com/p/index.php/journal/article/view/50.

Aramanadka, C., Kamath, A. T., Kudva, A. 2018. Recurrent ameloblastoma: A surgical challenge. Case Reports in Dentistry, 2018: 1–6. doi: 10.1155/2018/8271205.

Bilici, I. Ş., Emes, Y., Yalçın, S., Aybar, B. 2016. Infratemporal fossa infection with inferior alveolar nerve involvement. Journal of Istanbul University Faculty of Dentistry, 50(3). doi: 10.17096/jiufd.34851.

Broudic-Guibert, M., Blay, J.Y., Vazquez, L., Evrard, A., Karanian, M., Taïeb, S., Hoog-Labouret, N., Oukhatar, C. M. A., Boustany-Grenier, R., Arnaud, A. 2019. Persistent response to vemurafenib in metastatic ameloblastoma with BRAF mutation: A case report. Journal of Medical Case Reports, 13(1): 245. doi: 10.1186/s13256-019-2140-6.

Brunet, M., Khalifa, E., Italiano, A. 2019. Enabling precision medicine for rare head and neck tumors: The example of BRAF/MEK targeting in patients with metastatic ameloblastoma. Frontiers in Oncology, 9. doi: 10.3389/fonc.2019.01204.

Büttner, R., Gültekin, S. E., Heydt, C., Nogova, L., Meemboor, S., Kreppel, M., Aziz-Heiloun, R. 2023. Efficiency of B-RAF-/MEK-inhibitors in B-RAF mutated ameloblastoma: Case report and review of literature. Heliyon, 9(12): e23206. doi: 10.1016/j.heliyon.2023.e23206.

Faden, D. L., Algazi, A. 2017. Durable treatment of ameloblastoma with single agent BRAFi Re:

Clinical and radiographic response with combined BRAF-targeted therapy in stage 4 ameloblastoma. JNCI: Journal of the National Cancer Institute, 109(1). doi: 10.1093/jnci/djw190.

Fernandes, G. S., Girardi, D. M., Bernardes, J. P. G., Fonseca, F. P., Fregnani, E. R. 2018. Clinical benefit and radiological response with BRAF inhibitor in a patient with recurrent ameloblastoma harboring V600E mutation. BMC Cancer, 18(1): 887. doi: 10.1186/s12885-018-4802-y.

Ghai, S. 2022. Ameloblastoma: An updated narrative review of an enigmatic tumor. Cureus. doi: 10.7759/cureus.27734.

Gong, S., Xu, D., Zhu, J., Zou, F., Peng, R. 2018. Efficacy of the MEK inhibitor cobimetinib and its potential application to colorectal cancer cells. Cellular Physiology and Biochemistry, 47(2): 680–693. doi: 10.1159/000490022.

Gutiérrez-Castañeda, L. D., Nova, J. A., Tovar-Parra, J. D. 2020. Frequency of mutations in BRAF, NRAS, and KIT in different populations and histological subtypes of melanoma: A systemic review. Melanoma Research, 30(1): 62–70. doi: 10.1097/CMR.0000000000000628.

Hendra, F. N., Natsir Kalla, D. S., Van Cann, E. M., de Vet, H. C. W., Helder, M. N., Forouzanfar, T. 2019. Radical vs. conservative treatment of intraosseous ameloblastoma: Systematic review and meta-analysis. Oral Diseases, 25(7): 1683–1696. doi: 10.1111/odi.13014.

Hendra, F. N., Van Cann, E. M., Helder, M. N., Ruslin, M., de Visscher, J. G., Forouzanfar, T., de Vet, H. C. W. 2020. Global incidence and profile of ameloblastoma: A systematic review and meta-analysis. Oral Diseases, 26(1): 12–21. doi: 10.1111/odi.13031.

Hresko, A., Palyvoda, R., Burtyn, O., Chepurnyi, Y., Kopchak, A., Helder, M., Forouzanfar, T. 2022. Recurrent ameloblastoma: Clinical manifestation and disease-free survival rate. Journal of Oncology, 2022: 1–6. doi: 10.1155/2022/2148086.

Jang, S., Atkins, M. B. 2013. Treatment of BRAF-mutant melanoma: The role of vemurafenib and other therapies. Clinical Pharmacology & Therapeutics, 95(1): 24–31. doi: 10.1038/clpt.2013.197.

Kaye, F. J., Ivey, A. M., Drane, W. E., Mendenhall, W. M., Allan, R. W. 2014. Clinical and radiographic response with combined BRAF-targeted therapy in stage 4 ameloblastoma. JNCI Journal of the National Cancer Institute, 107(1): 378–378. doi: 10.1093/jnci/dju378.

Malakar, A., Kumar, V. R., Yadav, P., Bhardwaj, V., Barua, C. G., Bhardwaj, G. 2023. The role of BRAF inhibitors in the management of ameloblastoma: A literature review. Cureus. doi: 10.7759/cureus.47682.

Masthan, K. M. K., Anitha, N., Krupaa, J., Manikkam, S. 2015. Ameloblastoma. Journal of Pharmacy And Bioallied Sciences, 7(5): 167. doi: 10.4103/0975-7406.155891.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., McGuinness, L. A., … Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ (Clinical research ed.), 372, n71. doi: 10.1136/bmj.n71.

Poulikakos, P. I., Sullivan, R. J., Yaeger, R. 2022. Molecular pathways and mechanisms of BRAF in cancer therapy. Clinical Cancer Research, 28(21): 4618–4628. doi: 10.1158/1078-0432.CCR-21-2138.

Proietti, I., Skroza, N., Michelini, S., Mambrin, A., Balduzzi, V., Bernardini, N., Marchesiello, A., Tolino, E., Volpe, S., Maddalena, P., Di Fraia, M., Mangino, G., Romeo, G., Potenza, C. 2020. BRAF inhibitors: Molecular targeting and immunomodulatory actions. Cancers, 12(7): 1823. doi: 10.3390/cancers12071823.

Ranchod, S., Titinchi, F., Behardien, N., Morkel, J. 2021. Ameloblastoma of the mandible: analysis of radiographic and histopathological features. Journal of Oral Medicine and Oral Surgery, 27(1): 6. doi: 10.1051/mbcb/2020051.

Shan, K. S., Rehman, T. U., Ivanov, S., Domingo, G., Raez, L. E. 2024. Molecular targeting of the BRAF proto-oncogene/mitogen-activated protein kinase (MAPK) pathway across cancers. International Journal of Molecular Sciences, 25(1): 624. doi: 10.3390/ijms25010624.

Shi, H. A., Ng, C. W. B., Kwa, C. T., Sim, Q. X. C. 2021. Ameloblastoma: A succinct review of the classification, genetic understanding and novel molecular targeted therapies. The Surgeon, 19(4): 238–243. doi: 10.1016/j.surge.2020.06.009.

Tan, S., Pollack, J. R., Kaplan, M. J., Colevas, A. D., West, R. B. 2016. BRAF inhibitor treatment of primary BRAF -mutant ameloblastoma with pathologic assessment of response. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 122(1): e5–e7. doi: 10.1016/j.oooo.2015.12.016.

Verma, D. S., Das, D. D. 2022. Recurrent ameloblastoma of mandible - A case report. International Journal of Applied Dental Sciences, 8(3): 29–32. doi: 10.22271/oral.2022.v8.i3a.1576.

Yang, Y.C., Wang, J.J., Huang, Y., Cai, W.X., Tao, Q. 2021. Development and validation of a prognostic nomogram for postoperative recurrence-free survival of ameloblastoma. Cancer Management and Research, 13: 4403–4416. doi: 10.2147/CMAR.S307517.

Yang, Z., Chen, S., Ying, H., Yao, W. 2022. Targeting syndecan-1: New opportunities in cancer therapy. American Journal of Physiology-Cell Physiology, 323(1): C29–C45. doi: 10.1152/ajpcell.00024.2022.

Zhukov, N., Mareeva, Y., Konovalov, D., Druy, A., Grachev, N., Litvinov, D. 2019. Potentially curative targeted therapy for undifferentiated high-grade sarcoma developing after malignant transformation of a BRAF V600E–mutated ameloblastic fibroma. JCO Precision Oncology, 3: 1–6. doi: 10.1200/PO.19.00282.