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THERAPEUTIC APPROACHES AND RESULTS IN THE MANAGEMENT OF INTRAMEDULLARY SPINAL CORD TUMORS: AN UPDATED REVIEW

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Abstract: Objective: To evaluate the most effective clinical presentations, diagnostic methods and therapeutic approaches in the management of intramedullary spinal cord tumors, as well as to analyze the impact of these interventions on functional outcomes and associated complications. **Methodology**: A narrative literature review was carried out, analyzing articles selected from PubMed databases. Discussion: The research highlighted the importance of advanced neuroimaging techniques, such as magnetic resonance imaging, in the accurate diagnosis of these tumors. The efficacy of surgical treatments was analyzed, considering factors such as tumor location, histological type and preoperative functional status. Surgical resection remains the gold standard for low-grade tumors, while radiotherapy is reserved for specific cases. **Discussion**: Early diagnosis and individualized treatment are key to optimizing functional prognosis, reducing postoperative complications and improving long-term clinical outcomes. Less invasive surgical approaches, such as lateral hemilaminectomy and intraoperative contrast-enhanced ultrasound (CEUS), have shown efficacy in reducing operative risks. **Final considerations:** Despite surgical and diagnostic advances, challenges remain, such as persistent neurological deficits, chronic pain and functional restrictions, reinforcing the need for ongoing rehabilitation and psychological support. Further prospective studies are needed to reduce bias, control variables and foster new effective therapeutic approaches.

Keywords: Intramedullary tumors; Spinal cord neoplasms; Spinal cord tumors; Surgical treatment.

INTRODUCTION

Intramedullary spinal cord tumors, although rare, represent a significant challenge for diagnosis and clinical management. Corresponding to approximately 2-4% of neoplasms of the central nervous system, ependymomas and astrocytomas stand out as the most common types, presenting distinct characteristics between adults and children (Westphal & Mohme, 2024). (2020), the management of these tumours has evolved significantly in recent decades, driven by advances in imaging techniques and modern surgical approaches.

Ependymomas, which are more prevalent in adults, are predominantly located in the cervical region and have well-defined dissection planes, which facilitates complete surgical resection. In contrast, astrocytomas, due to their infiltrative behavior, present greater difficulty for total resection, resulting in a worse prognosis (Alizada et al., 2020). Zhang *et al*. (2023) and Akinduro *et al*. (2023) corroborate that ependymomas are the most frequent intramedullary tumors and emphasize that total resection should be the main therapeutic goal.

Advances in imaging techniques, such as contrast-enhanced magnetic resonance imaging, represent a milestone in the early diagnosis and therapeutic planning of these tumors, and are currently the gold standard for evaluation (Alizada *et al*., 2020; Westphal & Mohme, 2024). (2023), the integration of multidisciplinary strategies has shown benefits in the management of these tumors, including the use of intraoperative neurophysiological monitoring and laminoplasty techniques, contributing to safer and more effective outcomes.

However, the literature differs as to the ideal therapeutic approach. Zhang *et al*. (2023) argues that although some professionals opt for conservative treatments, aggressive surgical resection significantly improves overall survival, especially in extensive ependymomas. On the other hand, Akinduro *et al*. (2023) point out that external limitations, such as access to specialized care, can restrict the scope of this intervention, reinforcing the need for further studies to standardize the best clinical practice.

In light of this, this review seeks to explore the therapeutic approaches and results associated with the management of intramedullary spinal cord tumors, focusing on recent advances and the gaps that still need to be overcome. This updated overview aims to contribute to more informed therapeutic decisions, promoting better functional outcomes and quality of life for patients.

METHODOLOGY

This study is a literature review developed according to the criteria of the PVO strategy (Research Population or Problem, Variables and Outcome). This strategy was used to develop the following research question: "*What are the management approaches and outcomes in the treatment of intramedullary spinal cord tumors?*". The searches were carried out in the PubMed/MEDLINE (*Medical Literature Analysis and Retrieval System Online*) database, using the combination of terms with the Boolean operators "AND" and "OR" in the following search strategy: "*intramedullary spinal cord tumors AND management OR surgical outcomes*".

Initially, 512 articles were identified. The inclusion criteria were then applied: articles published in English and Portuguese; in the period from 2020 to 2024; that addressed the clinical presentation, diagnostic methods, treatments and complications associated with the management of intramedullary tumors. Review, meta-analysis, observational and experimental studies were considered. The exclusion criteria adopted were: duplicate articles; articles available only in abstract form; studies that did not directly address the proposed theme; and those that did not meet the inclusion criteria mentioned.

After applying the inclusion and exclusion criteria, 17 articles were selected from the PubMed database, which make up the collection of this study. The careful and systematic analysis of these studies made it possible to draw up an up-to-date summary of therapeutic approaches and functional results in the treatment of intramedullary spinal cord tumours, highlighting the most effective strategies and the main clinical challenges involved.

DISCUSSION

The clinical presentation of intramedullary tumors is highly variable, influenced by factors such as tumor type, location, size and individual patient characteristics. According to Yüe *et al*. (2021), most intramedullary tumors are located in the cervical or thoracic regions, with ependymomas and low-grade astrocytomas being the most prevalent. The most frequent symptoms include back pain, radiculopathy, motor weakness, sensory deficit and sphincter dysfunction. Pain is the most commonly reported initial symptom, present in up to 55% of patients, followed by progressive motor and sensory symptoms (Júnior *et al*., 2022; Behmanesh *et al.*, 2020).

Early diagnosis is essential for improving clinical outcomes, but is often delayed due to the insidious nature of the symptoms. Hussain *et al.* (2020) point out that radiographic findings, such as peritumoral syrinx and reactive edema, are important indicators for differential diagnosis. Contrast-enhanced MRI is considered the gold standard for diagnosing these tumors, with high sensitivity and specificity in detecting primary spinal cord lesions (Won *et al*., 2022). This examination not only allows the lesion to be identified, but also allows more precise surgical interventions to be planned.

Studies such as that by Hijikata *et al*. (2022) highlight the challenges of diagnosis in tumors with atypical characteristics, reinforcing the need for integration between clinical, radiological and histopathological data. Yang, Wu and Xia (2022) corroborate that early and accurate diagnosis is essential to improve outcomes, highlighting that total resections generally have better functional results compared to subtotal resections, which are associated with a higher risk of recurrence.

Surgical resection is widely considered the treatment of choice for intramedullary tumors. According to Yüe *et al*. (2021), total laminectomy is one of the most widely used techniques, although it can lead to vertebral instability. Alternatively, lateral hemilaminectomy, a minimally invasive approach, offers benefits such as preservation of spinal stability and good neurological results. Pojskić *et al*. (2020) point out that laminoplasty is preferred in young patients and in cases with multiple affected levels, due to greater structural preservation.

Low-grade tumors, such as astrocytomas, generally require microsurgical resection with a focus on preserving neurological function (Konovalov *et al*., 2023). On the other hand, ependymomas, which have well-defined margins, allow for a greater extent of resection (EOR), resulting in lower recurrence rates and less need for adjuvant therapies (Richards *et al*., 2020).

Radiotherapy and chemotherapy play a secondary role in the management of these tumors, and are more commonly indicated in cases of incomplete resections or high-grade tumors (Hussain *et al*., 2020).

Post-operative results vary widely, influenced by factors such as the location of the tumor, the extent of the resection and the patient's pre-operative clinical status. Tumors located in the cervical region have a better functional prognosis compared to thoracic tumors, which tend to be associated with poorer outcomes (Yüe *et al*., 2021). The longitudinal extension of the tumor, especially in cases involving three or more vertebral levels, is also correlated with worse outcomes (Behmanesh *et al*., 2020).

Intraoperative technology plays a key role in improving outcomes. Barkley, McGrath Jr. and Hofstetter (2021) highlight the use of contrast-enhanced ultrasound (CEUS) as a valuable tool for identifying tumor boundaries and minimizing damage during resection. However, complications such as neurological deficits, chronic pain and sphincter dysfunction still pose significant challenges in the postoperative period (Hachicha *et al*., 2021; Hijikata *et al*., 2022). Tufo *et al*. (2023) point out that technological advances, such as intraoperative neurophysiological monitoring, have contributed to reducing neurological damage and improving functional outcomes.

In addition to physical complications, patients often face emotional and functional challenges after surgery. Tufo *et al*. (2023) point out that persistent pain and limitations in daily activities negatively impact patients' quality of life. Hijikata *et al*. (2022) highlight the importance of psychological support and multidisciplinary rehabilitation programs to improve overall outcomes and emotional well-being. Gwak *et* al. (2020) point out that infrastructure limitations and access to specialized resources can negatively impact outcomes in low-income regions.

Although significant advances have been made in the management of intramedullary tumors, important gaps remain. Hijikata *et al*. (2022) point out the need for longitudinal studies to evaluate the efficacy of adjuvant therapies such as radiotherapy and chemotherapy, particularly in high-grade astrocytomas. In addition, Tufo *et al*. (2023) suggest that research into molecular biomarkers could help stratify patients and guide personalized treatments.

Konovalov *et al*. (2023) highlight the lack of consensus on the ideal extent of resection and the most appropriate timing for surgical interventions in primary spinal cord tumors. Standardization of surgical and rehabilitation protocols is essential to improve functional outcomes and reduce inequalities in access to treatment. Finally, investments in intraoperative technologies and training of multidisciplinary teams can significantly transform the approach to these tumors in resource-limited settings.

FINAL CONSIDERATIONS

Intramedullary spinal cord tumors present significant challenges in diagnosis and management, requiring precise approaches to improve functional outcomes. This review highlighted that magnetic resonance imaging is essential for diagnosis, while surgical resection remains the main therapeutic intervention, especially for ependymomas. Radiotherapy and chemotherapy have a limited role, being indicated in specific cases. Important gaps remain, such as the need for longitudinal studies on adjuvant therapies and the standardization of surgical protocols. Research into molecular biomarkers is essential to guide personalized treatments and reduce inequalities in access to quality care. Multicenter studies are suggested to assess the functional impact of different therapeutic approaches, as well as greater collaboration between institutions to advance research and clinical practice. Although progress has been made, progress in the management of these tumors depends on continued investment in research and technology.

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