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Treatment Modalities for Primary and Secondary Spinal Malignancies

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Introduction

Cancer of the spine is predominantly a metastatic disease as approximately 90% of spinal tumours represent a secondary malignancy. It is associated with an elderly demographic, with incidence rates projected to rise due to advanced treatment modalities for various pathologies[1]. Common primary cancers with bone metastasis to the vertebral column include; breast, lung, gastrointestinal, prostate and myeloma[1]. Treatment strategies for spinal tumours are rarely pan-applicable and must be devised on an individual basis. The purpose of this review is to discuss the individual and multimodal approaches employed in the management of spinal tumours.

Primary Cancers of the Spine

Primary musculoskeletal system sarcomas are ultimately rare in nature and are typically associated with a younger demographic[1]. Osteosarcomas, Ewing's sarcomas, and chondrosarcomas represent the most common primary cancers of the musculoskeletal system, and require multidisciplinary team input with biomechanical imbalance being a major concern.

Osteosarcoma is a high-grade malignant tumour with poor five-year survival rates of approximately 30%-40%[1]. It is characterised by the direct formation of immature bone or osteoid tissue by the tumour cells, and is classically considered a cancer of long bones and infrequently, soft tissue[3]. Ewing's sarcoma belongs to a family of tumours are characterised by chromosomal translocations of the EWS gene on chromosome 22. The cell of origin and the particular pathophysiology remains unclear to date[2]. Similarly, controversy exists regarding the first-line treatment and local management for Ewing's sarcoma of the spine[3]. Chondrosarcomas are a heterogenous group of malignant bone tumours which share the common attribute of chondroid matrix production[4]. Chondrosarcomas can develop de novo or undergo malignant transformation from a benign chondral lesion and can be managed using a variety of approaches[6]. To date, there is a lack of high-quality evidence-based guidance regarding chondrosarcomas treatment strategies due to their inherent rarity.

Several classification systems exist for spinal malignancies, such as; (i) The Enneking system (ii) The Tokuhashi Scoring System (iii) The Tomita Scoring System (iv) The Specialist Neoplastic Score (SNRS)[5]. Regardless of tumour classification and composition, treatment strategies are ultimately a collaborative interpretation of patient and prognostic factors, provided by staging and scoring systems aforementioned, which facilitates deduction of an optimal treatment strategy for each individual patient.

Haematologic Malignancies

Certain haematological malignancies such as plasmacytoma, myeloma, lymphoma can present in vertebrae. The majority of patients diagnosed with solitary bone plasmacytoma (SBP) will progress to develop multiple myeloma. Radical radiotherapy serves as the primary form of treatment[6]. Multiple solitary plasmacytomas may also be treated with radiotherapy (+/- autologous stem cell transplantation) in the absence of systemic disease due to their recurrent nature[8].

Regarding myeloma, first line therapy of the underlying malignancy entails systemic chemotherapy in combination with bisphosphonates and systemic/interventional pain control. In cases of spinal metastases, a variety of interventions may be employed such as; bracing, cement augmentation, radiotherapy, or surgery[7]. Orthotic brace application for a typical two-month period is the preferred form of conservative treatment for spinal instability due to multiple myeloma lesions. The benefits of conservative management is the aversion of potential surgical risks in addition to stabilisation of the vertebral column.

Regarding the management of lymphoma (follicular, MALT, mantle cell, diffuse large B-cell, Burkitt and peripheral T-cell), NICE guidelines suggest a variety of possible approaches to eradication, including; radiotherapy, immunotherapy, chemotherapy, immunochemotherapy and stem cell transplantation with no reference to a role for surgery[8,9]. Management is primarily non-operative, similar to above, with surgery reserved for cases which are refractory to these therapies.

Stereotactic Radiosurgery (SRS) and Intensity-Modulated Radiotherapy (IMRT)

Stereotactic Radiosurgery (SRS) and Intensity-Modulated Radiotherapy (IMRT) are precise measures of delivering radiation therapy in order to reduce injury to normal tissue. Such strategies allow for a non-invasive, highly specific method of efficacious treatment with a high local control rate and low complication rate[10]. SRS combines the principle of stereotactic localisation to achieve accurate targeting with multiple radiation beams of equal intensity to deliver a high dose of radiation to a treatment site while minimizing exposure to normal tissue. IMRT allows for modification of the intensity. It may be utilised as a first-line treatment or in combination to surgery to preoperatively reduce the resection margins[10]. This form of treatment is multidisciplinary in nature and entails extensive imaging of multiple views and modalities to accurately evaluate management strategies[10]. However, evidence for IMRT in the spine is limited, and is currently only employed as an alternative treatment should surgery be contraindicated[10].

Cement Augmentation, Kyphoplasty, Vertebroplasty

Balloon kyphoplasty (BKP) and Percutaneous Vertebroplasty (PV) aid in the management of pain and are also effective in restoring strength to the vertebral bodies[11]. Percutaneous vertebroplasty and kyphoplasty involves the percutaneous placement of one or two trocars into the vertebral bodies either via the pedicles or an extra-pedicular approach, followed by a fluoroscopic-guided injection of polymethyl methacrylate bone cement[12]. The cement stabilises the fracture and preserves spinal stability by providing anterior and middle column support[12]. Potential complications include cement embolus and neurologic dysfunction, albeit rare. Should anatomical defects exist, cement can leak into the intervertebral disc and result in subsequent fractures of other vertebral bodies[12].

Regarding kyphoplasty, the balloon is inflated prior to the injection of cement to restore the vertebral height and is reported to have a lower cement leakage rate[11,12]. BKP is predominantly implemented for back pain and fractures secondary to osteoporosis in addition to pathological vertebral fractures[11]. BKP requires extensive pre-procedural planning which includes; (i) careful clinical assessment to determine the site of pain, (ii) magnetic resonance imaging to evaluate areas of compression, and (iii) computed tomography to assess instability in combination with a SINS score[11].

Separation Surgery

Advances in modern surgical approaches to the spine can ensure circumferential cord decompression when required. Separation surgery is a technique whereby a posterolateral approach is utilised to obtain ventrolateral access to nerve roots, posterior longitudinal ligament, and ventral epidural disease[13].

Rods are fixated postero-laterally and the tumour is then resected circumferentially to allow decompression. Partial vertebrectomy allows dissection of the ventral component of the tumour. Anterior support may be required if a large portion of the vertebral body is removed. Ultrasound can be used intraoperatively to ensure adequate separation.

The primary aim of separation surgery is to completely remove the tumour from the spinal cord to accommodate postoperative delivery of stereotactic radiosurgery (SRS) with maximisation of the biologically effective tumour dose[7]. SRS is often used as a first step in patients with epidural disease too advanced for radiotherapy, as previously mentioned. This combined approach is referred to as 'hybrid therapy'[7]. It merges both modalities, negating the need for aggressive resection and enabling the use of adjuvant radiotherapy.

Decompressive and Stabilization Surgery

Decompression, achieved via laminectomy, is indicated for rapid cord decompression and resolution of any neurological deficit[13]. Depending on tumour location, numerous different approaches can be adopted; (i) anterior (ii) strictly posterior (iii) posterolateral and, (iv) combined anteroposterior. All approaches are associated with an increase in ambulation (60% vs.98%) between pre-operative and post-operative measurements, in addition to significant pain relief reported in 95% of patients[14]. Posterior approaches represent the most commonly employed method as posterior laminectomies can enable multi-level vertebral decompression resulting in a more effective decompression and relief of symptoms[13]. For involvement of the cervical spine, an anterior approach is more frequently engaged. Controversy exists regarding the number of levels for fixation necessary to achieve adequate stability[14,15]. It is generally accepted that at least two levels of fixation above and two levels below the affected vertebrae is required in metastatic disease of the spine.

En Bloc Resection

En bloc resection, described by Tomita is the standard management of solitary spinal metastases confined within the vertebral body. The premise of the procedure is to ensure negative histologic margins[15]. However, multitudes of patients with spinal metastases often present late with multiple metastases, pathologic fractures, and/or cord compression. These patients are no longer candidates for en bloc resection. Thus, there has been a shifting paradigm away from such invasive surgeries as they no longer serve a primary form of treatment for the majority of patients with spinal malignancies[10,12]. Although the benefits of this surgery include better local control and superior functional outcome, it should be reserved for curative therapy as opposed to palliative[15].

Conclusion

Management of primary and secondary spinal malignancies remain a strategic challenge. No pan-applicable treatment approach exists for such pathological states. Surgery is indicated to optimise quality of life and is employed in scenarios of cord compression, vertebral instability and refractory pain. Methods include simple resection, decompressive surgery, radiosurgery, vertebroplasty and kyphoplasty, and radical en bloc resection. Such surgical strategies are incorporated into multi-modal approaches with systemic chemotherapy and targeted radiation to augment effect and ultimately reduce morbidity and mortality rates associated with spinal malignancies.

Declaration of Conflicts of Interest:
None declared.

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