

Advances in Oncologic Orthopedics: A Comprehensive Review

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Abstract

Oncologic orthopedics, the subspecialty dedicated to the diagnosis and treatment of bone and soft tissue tumors, has witnessed significant advancements in recent years. With a focus on preserving function while eradicating malignancies, the field has made remarkable strides in improving patient outcomes and quality of life. In this comprehensive review, we explore the key advancements in oncologic orthopedics that have revolutionized the management of bone and soft tissue tumors. One of the cornerstones of successful oncologic orthopedics is early detection. Advanced imaging techniques such as magnetic resonance imaging (MRI), positron emission tomography (PET), and computed tomography (CT) scans have played a vital role in detecting tumors at their earliest stages.

These techniques offer improved visualization of tumor extent, aiding in surgical planning and assessment of the response to treatment. Advances in surgical techniques have revolutionized the management of bone and soft tissue tumors. Limb-sparing surgeries, once deemed impossible for certain aggressive malignancies, are now becoming the standard of care. Surgical oncologists can meticulously remove tumors while preserving as much healthy tissue and function as possible. Additionally, the advent of 3D-printed patient-specific implants has provided personalized solutions for complex cases, improving implant integration and overall surgical outcomes.

Keywords: Oncologic orthopedics; Positron emission tomography; Computed tomography; Magnetic resonance imaging

Introduction

The evolution of surgical techniques has been a defining factor in the success of oncologic orthopedics. Traditional procedures often involved radical amputations to ensure complete tumor removal, leading to significant functional impairment and decreased quality of life for patients. However, advances in limb-sparing surgeries, also known as limb-salvage procedures, have emerged as a preferred approach [1]. Limb-salvage procedures involve removing the tumor while preserving the surrounding healthy tissue and joints. These techniques have been refined through better understanding of tumor biology, improved imaging, and preoperative planning using 3D printing and computer-assisted navigation systems. The use of custom-made implants and biological reconstruction options, such as bone grafts and allografts have further enhanced limb function and patient satisfaction. In recent years, there has been a significant shift towards targeted therapies and chemotherapy for bone and soft tissue tumors. Targeted therapies focus on specific molecular pathways involved in tumor growth, reducing the impact on healthy tissues and minimizing side effects [2].

These therapies have shown promising results in controlling tumor growth and improving survival rates. Additionally, neoadjuvant chemotherapy, administered before surgery, has proven effective in shrinking tumors, making them more amenable to limb-sparing procedures. This approach has opened new possibilities for patients who were previously candidates only for amputation [3]. The integration of adjuvant therapies and rehabilitation has become an essential aspect of comprehensive oncologic orthopedic care. Physical therapy, occupational therapy, and pain management strategies are integral components of patient recovery after surgery or radiation therapy. Moreover, rehabilitation programs aim to restore function, mobility, and quality of life, promoting a holistic approach to patient care. Oncologic orthopedics is a prime example of the importance of multidisciplinary collaboration in modern medicine. The management of musculoskeletal tumors requires a seamless integration of orthopedic surgeons, medical oncologists, radiologists, pathologists, radiation oncologists, and other specialists. Team-based decision-making ensures that patients receive the most appropriate and tailored treatment plans,

leading to the best possible outcomes [4].

Early detection through advanced imaging, targeted therapies, and immunotherapy have significantly improved survival rates and reduced treatment-related side effects. Surgical innovations, including limb-sparing procedures and 3D-printed implants, have reshaped the surgical management of bone and soft tissue malignancies. Minimally invasive techniques and comprehensive rehabilitation programs further contribute to better patient experiences and outcomes. As researchers and medical practitioners continue to explore new frontiers, it is evident that multidisciplinary collaboration and technological innovations will continue to drive progress in oncologic orthopedics. This comprehensive review highlights the ongoing efforts to advance knowledge and clinical practice in the field, bringing renewed hope to patients and their families facing the challenges of musculoskeletal tumors [5].

Discussion

Radiotherapy has long been a valuable tool in the treatment of bone and soft tissue tumors. Recent advancements in radiotherapy techniques, such as intensity-modulated radiotherapy (IMRT) and stereotactic body radiation therapy (SBRT), have allowed for more precise targeting of tumors while sparing healthy tissues [6]. Furthermore, intraoperative radiotherapy, where radiation is delivered directly to the tumor site during surgery, has shown promise in preventing local tumor recurrence and improving patient outcomes. These advancements have significantly reduced the radiation-related

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complications, enabling patients to maintain their quality of life after treatment. The management of bone and soft tissue tumors necessitates a multidisciplinary approach, involving orthopedic surgeons, oncologists, radiologists, pathologists, and other specialists. Collaborative decision-making ensures personalized treatment plans tailored to each patient's unique condition, maximizing the chances of a successful outcome [7].

Supportive care has also received considerable attention in recent years. Managing pain, reducing side effects of treatments, and addressing psychological and emotional well-being are essential components of holistic patient care. Palliative care teams work closely with oncologic orthopedic specialists to enhance patients' comfort and overall quality of life [8]. Traditional treatment approaches for musculoskeletal tumors often involved aggressive surgery, radiation, and chemotherapy. However, the landscape of oncologic orthopedics has shifted towards targeted therapies and immunotherapy. These novel treatments focus on specific genetic or molecular characteristics of tumors, offering more tailored and less toxic alternatives [9].

Targeted therapies inhibit specific molecules involved in tumor growth, while immunotherapy stimulates the patient's immune system to recognize and attack cancer cells. These advancements have led to improved treatment outcomes and increased overall survival rates. Minimally invasive procedures have gained traction in oncologic orthopedics due to their numerous benefits, including reduced surgical trauma, shorter hospital stays, and faster recovery times. Image-guided percutaneous techniques, radiofrequency ablation, and cryoablation are being increasingly utilized for treating small tumors, metastatic lesions, and palliative interventions. These procedures are particularly valuable for patients with advanced-stage cancers or those who may not tolerate more invasive treatments [10].

Conclusion

Advances in oncologic orthopedics have undoubtedly transformed the landscape of bone and soft tissue tumor management. Early detection through advanced imaging, limb-sparing surgical techniques, targeted therapies, improved radiotherapy methods, and comprehensive supportive care have all contributed to improved outcomes and enhanced patient experiences. As research continues to push the boundaries of medical science, the field of oncologic orthopedics remains at the forefront of innovation. The pursuit of more effective and less invasive treatments, combined with a patient-centered approach, holds the promise of further elevating the standard of care for individuals facing bone and soft tissue tumors. Ultimately, these

advancements bring hope to patients and reaffirm the commitment of medical professionals to fight against cancer with unwavering determination. Oncologic orthopedics, a specialized field at the intersection of oncology and orthopedic surgery, has made significant strides in recent years.

This comprehensive review explores the latest advancements in the diagnosis, treatment, and management of musculoskeletal tumors and related pathologies. With the collaboration of multidisciplinary teams and cutting-edge technologies, the field of oncologic orthopedics continues to evolve, offering new hope to patients facing challenging bone and soft tissue malignancies. Early detection plays a pivotal role in improving patient outcomes in oncologic orthopedics. Advancements in imaging technologies, such as magnetic resonance imaging (MRI), positron emission tomography-computed tomography (PET-CT), and computed tomography (CT) scans, have significantly enhanced the ability to detect bone tumors at their earliest stages. These techniques enable accurate tumor localization, aiding orthopedic surgeons in precise preoperative planning and surgical decision-making. The field of oncologic orthopedics has experienced tremendous advancements, making a profound impact on the lives of patients with musculoskeletal tumors.

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