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骨腫瘤診斷與治療新視界：深耕人工智慧驅動的精準分類、影像辨識與微創

Slogan： 整合分類 × 精準診斷 × 微創治療

(Integration of Classification, Precision Diagnosis, and Minimally Invasive Therapy)

時　　間：115 年 6 月 27 日(星期六) 08:30~12:00
地　　點：臺北榮民總醫院 三門診 9 樓 創新沙龍

08:30-08:40	***開幕致詞*** ***Opening Remarks***	吳宏達主任 Hung-Ta Wu
	座長：游治維 助理教授(Chih-Wei Yu)	
08:40-09:10	骨腫瘤影像診斷的系統化判讀模式 Systematic Imaging Approach to Bone Tumors	吳宏達助理教授 Hung-Ta Wu
09:10-09:40	骨腫瘤病理診斷基因標記最新趨勢 Molecular Markers in Bone Tumor Pathology	陳志學助理教授 Chih-Hsueh Chen
09:40-10:10	利用先進電腦模擬困難骨盆腫瘤手術 Application of Advanced Computer Simulation in Complicated Pelvis Tumor Resection	陳昭銘助理教授 Chao-Ming Chen
10:10-10:25	***Coffee Break***	
	座長：林彥懷 科主任(Yen-Huai Lin)	
10:25-10:55	骨腫瘤相關最新影像量化型研究發展 Quantitative Imaging & Radiomics in Bone Tumors	林重榮教授 Chung-Jung Lin
10:55-11:25	骨腫瘤影像導引消融治療實際經驗 Image-Guided Ablation Therapy for Bone Tumors: Practical Experience	洪嘉安醫師 Jia-An Hong
11:25-12:00	專家對談和問題討論 Panel Discussion and Q&A	全體講者

Systematic imaging approach to bone tumors

骨腫瘤影像診斷的系統化判讀模式

Hong-Da Wu

吳宏達

Division of Musculoskeletal Radiology, Department of Radiology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

臺北榮民總醫院 影像診療部 骨骼肌肉診療科

The systematic interpretation of bone tumor imaging requires a disciplined analytical framework that integrates clinical context, lesion morphology, and multimodality imaging characteristics. A haphazard or intuition-driven approach leads to diagnostic errors, missed lesions, and inappropriate management. A structured method, by contrast, transforms complex imaging findings into actionable diagnostic conclusions.

This presentation introduces a step-by-step protocol for bone tumor image interpretation applicable across radiography, CT, and MRI. The framework covers six core domains: (1) lesion location — epiphyseal, metaphyseal, or diaphyseal; cortical, medullary, or periosteal; (2) lesion margin and zone of transition — indicating biologic aggressiveness; (3) matrix characterization — osteoid, chondroid, fibrous, or mixed; (4) periosteal reaction patterns — Codman triangle, sunburst, onion skin; (5) soft tissue extension and neurovascular involvement; and (6) multiplicity and systemic context including skeletal survey and whole-body MRI or PET findings.

The presentation emphasizes age-stratified differential diagnosis: in pediatric patients, osteosarcoma and Ewing sarcoma dominate the malignant spectrum; in adults, metastases and myeloma must be excluded before entertaining primary bone tumors. Key imaging mimics and diagnostic pitfalls are illustrated with case examples. Integration of MRI signal characteristics — particularly T1 marrow signal, T2 heterogeneity, and contrast enhancement patterns — is discussed in relation to histological correlation.

In conclusion, a systematic imaging approach to bone tumors reduces diagnostic uncertainty and facilitates timely multidisciplinary tumor board decision-making. Standardized reporting templates aligned with this framework are presented as a tool for improving consistency across radiologists and institutions.

Molecular markers in bone tumor pathology

骨腫瘤病理診斷基因標記最新趨勢

Chih-Hsueh Chen

陳志學

Department of Pathology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

臺北榮民總醫院 病理部

The landscape of bone tumor pathology has been fundamentally reshaped by advances in molecular diagnostics. The fifth edition of the WHO Classification of Tumours of Soft Tissue and Bone (2020) reflects a paradigm shift from purely morphology-based diagnosis to an integrated approach that incorporates immunohistochemistry, fluorescence in situ hybridization (FISH), and next-generation sequencing (NGS). Molecular markers now play a central role in diagnosis, prognostication, and therapeutic targeting.

This presentation reviews the most clinically impactful molecular alterations across the major bone tumor subtypes. For osteosarcoma, complex genomic instability and TP53 alterations remain hallmarks, with emerging interest in CDK4 and MDM2 amplification distinguishing low-grade central osteosarcoma from dedifferentiated variants. Ewing sarcoma is defined by EWSR1-FLI1 and related fusions detectable by FISH or RNA sequencing, critical for diagnosis in morphologically ambiguous cases. Chondrosarcomas are stratified by IDH1/IDH2 mutations in conventional subtypes, while mesenchymal chondrosarcoma harbors the HEY1-NCOA2 fusion. Giant cell tumor of bone is characterized by H3F3A p.G34W mutation, detectable by immunohistochemistry.

The role of SMARCB1 loss in epithelioid sarcoma, STAT6 nuclear expression in solitary fibrous tumor, and MDM2 amplification in atypical lipomatous tumors/well-differentiated liposarcomas are discussed as paradigmatic examples of marker-driven reclassification. The application of liquid biopsy and circulating tumor DNA in monitoring treatment response and detecting relapse represents an emerging frontier.

In conclusion, molecular pathology has become indispensable in the diagnosis and classification of bone tumors. Pathologists, radiologists, and oncologists must collaborate within a molecular tumor board framework to ensure accurate diagnosis and enable access to targeted therapy in eligible patients.

Application of advanced computer simulation in complicated pelvis tumor resection

利用先進電腦模擬困難骨盆腫瘤手術

Chao-Ming Chen

陳昭銘

Division of Joint Reconstruction, Department of Orthopedic Surgery, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

臺北榮民總醫院 骨科部 關節重建科

Pelvic bone tumor resection remains one of the most technically demanding procedures in orthopedic oncology. The complex three-dimensional anatomy of the pelvis, proximity to major neurovascular structures, and the need to achieve wide oncologic margins while preserving functional limb and pelvic ring integrity create formidable surgical challenges. Conventional preoperative planning based on two-dimensional imaging is often insufficient for anticipating intraoperative complexity.

This presentation describes the application of advanced computer simulation and three-dimensional (3D) surgical planning technologies to facilitate pelvic tumor resection. Preoperative workflows include CT- and MRI-based 3D reconstruction of tumor extent and its relationship to the iliac vessels, sciatic nerve, sacroiliac joint, and acetabulum. Virtual osteotomy planning allows the surgeon to define resection planes, simulate margin adequacy, and assess reconstruction options — including custom 3D-printed implants, modular hemipelvic prostheses, and structural allograft composites — prior to the index procedure.

Case examples are presented illustrating Enneking zone I–III pelvic resections where computer simulation altered the operative strategy, reduced intraoperative blood loss, and enabled safer nerve-sparing approaches. Integration of intraoperative navigation systems and patient-specific cutting guides — fabricated from preoperative 3D plans — is discussed in the context of improving resection accuracy and reproducibility.

In conclusion, advanced computer simulation represents a transformative tool in the surgical management of complex pelvic bone tumors. The combination of virtual planning, custom implants, and intraoperative navigation defines a new standard of care that improves oncologic outcomes while reducing surgical morbidity.

Quantitative imaging & radiomics in bone tumors

骨腫瘤相關最新影像量化型研究發展

Chung-Jung Lin

林重榮

Division of Musculoskeletal Radiology, Department of Radiology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan, ROC

臺北榮民總醫院 影像診療部 骨骼肌肉放射線科

國立陽明交通大學 醫學院

The integration of quantitative imaging and radiomics into the evaluation of bone tumors has fundamentally transformed the landscape of musculoskeletal oncologic radiology. Conventional morphological assessment, while foundational, is inherently limited by interobserver variability and the inability to capture the full spectrum of tissue heterogeneity. Radiomics — the high-throughput extraction of quantitative features from medical images — offers a pathway to objectify and standardize imaging-based tumor characterization.

This presentation reviews the current state of quantitative imaging research in bone tumors, encompassing primary malignancies (osteosarcoma, chondrosarcoma, Ewing sarcoma) as well as bone metastases. Key topics include: (1) MRI-based radiomic feature extraction for tumor grading and histological subtype differentiation; (2) CT-derived texture analysis for predicting treatment response to neoadjuvant chemotherapy; (3) the role of photon-counting CT (PCCT) in enhancing spectral data quality and enabling new quantitative metrics; (4) PET/CT radiomics for metabolic phenotyping and prognostic stratification; and (5) the application of machine learning and deep learning algorithms to automate feature selection and build robust predictive models.

Emerging evidence supports the utility of radiomics in differentiating benign from malignant lesions, identifying pathological fracture risk, and monitoring disease progression. Standardization of image acquisition protocols, reproducibility of feature extraction pipelines, and prospective validation remain critical challenges. The IBSI (Image Biomarker Standardisation Initiative) framework is discussed in the context of harmonizing multi-institutional datasets.

In conclusion, quantitative imaging and radiomics represent a paradigm shift in bone tumor imaging, bridging the gap between radiology and precision oncology. As artificial intelligence tools become increasingly integrated into clinical workflows, radiologists are positioned to deliver not only diagnostic but also prognostic and predictive information, elevating the value of imaging in multidisciplinary tumor management.

Image-guided ablation therapy for bone tumors: Practical experience

骨腫瘤影像導引消融治療實際經驗

Jia-An Hong

洪嘉安

Division of Interventional Radiology, Department of Radiology, Taipei Veterans General Hospital, Taipei, Taiwan, ROC

臺北榮民總醫院 影像診療部 血管介入影像診療科

Image-guided ablation therapy has emerged as a safe, effective, and minimally invasive treatment option for a spectrum of bone tumors, ranging from benign lesions such as osteoid osteoma to malignant entities including bone metastases and primary sarcomas selected for palliative or adjunctive treatment. With real-time imaging guidance — primarily CT fluoroscopy — ablation offers precision targeting while minimizing collateral damage to adjacent neurovascular structures.

This presentation shares our institutional experience with radiofrequency ablation (RFA), microwave ablation (MWA), and cryoablation for bone tumors. Osteoid osteoma remains the gold-standard indication for RFA, with technical success rates exceeding 90% and a low complication profile. For bone metastases causing intractable pain, cryoablation provides durable pain palliation and local tumor control, particularly in lesions refractory to radiotherapy or in patients with limited radiation tolerance. Specific procedural considerations are addressed, including thermal protection of adjacent cortex, spinal cord, and peripheral nerves, as well as cement augmentation to reduce post-ablation fracture risk in weight-bearing bones.

Practical insights from case series are presented: patient selection criteria, pre-procedural imaging review, needle trajectory planning, ablation zone monitoring with thermometry, and post-procedural follow-up protocols using MRI and CT. Complications encountered — including skin burns, incomplete ablation, and transient neuropraxia — and their management are discussed candidly.

In conclusion, image-guided ablation for bone tumors is a well-established and expanding minimally invasive modality. Institutional experience, rigorous technique, and close multidisciplinary collaboration are essential for achieving reproducible oncologic and symptomatic outcomes.