DOI: 10.66069/ojspub.27451032

Advances in Medical Imaging for the Diagnosis and Treatment of Osteoarthritis

Xinghao Li[1,2], Jiayu Hu[1], Tianqi Chen[1], Yanrong Long[1], Yeqian Ran[1], Rui Zhang[1,*]

[1]College of Medical Technology, Guiyang Kangyang University, Guiyang 550081, Guizhou, China
[2]School of Basic Medical Sciences, Guizhou University of Traditional Chinese Medicine, Guiyang 550025, Guizhou, China
Correspondence Author

Abstract: ***Osteoarthritis (OA) is a leading cause of joint pain and functional impairment in middle-aged and elderly populations. Because its pathology involves whole-joint structures—including cartilage, subchondral bone, synovium, menisci, and ligaments—a single imaging modality is insufficient for a comprehensive evaluation. Focusing on knee OA, this review summarizes the applications of radiography (X-ray), multi-slice spiral computed tomography (MSCT), ultrasound, magnetic resonance imaging (MRI), and nuclear medicine imaging in OA diagnosis, clinical decision-making, interventional guidance, and therapeutic efficacy evaluation. Radiography serves as the cornerstone for Kellgren-Lawrence (K-L) grading, joint space width measurement, and lower limb alignment assessment. MSCT clearly delineates subchondral bone sclerosis, osteophytes, and subchondral cysts while enabling three-dimensional measurements. Ultrasound is well-suited for assessing joint effusion and synovial hypertrophy, as well as guiding arthrocentesis and intra-articular injections. MRI provides a comprehensive visualization of cartilage, bone marrow lesions (BMLs), menisci, and ligaments, serving as a vital tool for early diagnosis and treatment monitoring. Nuclear medicine imaging reflects bone metabolism and inflammatory activity. Two single-center studies have demonstrated that combining MSCT with MRI yields higher diagnostic accuracy for knee OA than either modality alone. Currently, available evidence is primarily derived from small-sample retrospective studies, and evaluation criteria remain unstandardized. Multimodal fusion, quantitative imaging, and artificial intelligence represent key directions for future development.***

Keywords: Osteoarthritis, Medical imaging, Ultrasound, Diagnosis, Treatment.

1. Introduction

Osteoarthritis (OA) is a chronic, progressive joint disease characterized mainly by degeneration of articular cartilage, remodeling of subchondral bone, and osteophyte formation at the joint margins, and its development is closely associated with disrupted homeostasis among multiple intra-articular tissues [1]. Both the prevalence and incidence of OA increase markedly with age [2], and OA has become a major cause of chronic pain and restricted mobility in middle-aged and elderly people [1,3]. Both the Guideline for Diagnosis and Treatment of Osteoarthritis (2018 Edition) [2] and the Chinese Guideline for Diagnosis and Treatment of Osteoarthritis (2021 Edition) [1] emphasize that OA treatment should follow individualized and stepwise principles, and accurate assessment and grading of disease severity are prerequisites for implementing stepwise treatment.

The knee is the joint most frequently affected by OA. Its soft tissues—including cartilage, menisci, ligaments, and synovium—cannot be directly visualized on plain radiographs, and early OA often presents as "pathological changes already present while radiographs remain normal." With advances in computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, and functional imaging, the role of imaging in OA has gradually expanded from simply displaying bone structures and establishing a diagnosis to covering the entire diagnostic and therapeutic process, including identification of early lesions, severity grading, selection of treatment strategies, interventional guidance, and evaluation of therapeutic efficacy [1,3,4].

Because existing imaging studies have focused mainly on knee OA, this review centers on knee OA. Drawing on Chinese and international guidelines, consensus statements, and clinical studies, we systematically summarize the value and limitations of various imaging techniques in the diagnosis and treatment of OA, with the aim of providing a reference for the rational selection of imaging examinations and the standardization of image-guided treatment in clinical practice.

2. Pathological Basis of OA and Requirements for Imaging Assessment

The current view holds that OA is not merely "wear and tear" of cartilage but a stage-wise progressive disease involving whole-joint structures, including cartilage, subchondral bone, synovium, menisci, and ligaments [4,5]. Its main pathological changes, and hence the targets of imaging, therefore involve the entire joint. In the early stage, articular cartilage shows loss of glycosaminoglycan (GAG) from the matrix, altered water content, and disruption of the collagen network; at this point, the cartilage surface is still intact and radiographs are normal. As the disease progresses, the cartilage gradually thins, and fissures, ulceration, and even full-thickness defects appear, accompanied by corresponding narrowing of the joint space [4,6]. Subchondral bone undergoes "biphasic" changes: in the early stage, bone remodeling accelerates and trabeculae become sparse, possibly accompanied by microfractures and bone marrow edema-like lesions (bone marrow lesions, BMLs); in the late stage, bone density increases, with subchondral sclerosis and cyst formation [4]. Subchondral bone is thus an important target for early intervention and efficacy evaluation. Synovitis, joint effusion, and popliteal cysts are important causes of joint pain and swelling and are also areas in which ultrasound and MRI excel [7]. Meniscal degeneration and tears and ligament injuries can lead to joint instability and are closely related to OA progression [8]. The patellofemoral joint is one of the predilection sites of knee OA; MRI can evaluate patellar position and the status of the patellofemoral cartilage, providing supplementary diagnostic value in early-stage patients with negative radiographs.

These pathological features determine the core requirements of imaging assessment in OA: (1) identifying early changes in the cartilage matrix and microstructure to capture the optimal window for intervention; (2) accurately evaluating the extent and severity of osseous and soft-tissue lesions to inform treatment selection; and (3) reflecting changes before and after treatment in a reproducible and quantitative manner for efficacy evaluation. Because each imaging technique has its own strengths, multimodal complementarity has become the basic strategy for imaging assessment of OA.

3. Common Imaging Techniques and Their Assessment Systems

3.1 Radiography: The Basis for Screening, Grading, and Follow-up

Plain radiography is simple to perform, inexpensive, and widely available, making it the first-choice modality for OA screening and follow-up [3,9]. Typical findings include joint space narrowing (JSN), osteophyte formation, subchondral sclerosis and cysts, irregular articular surfaces, and joint deformity [10]. It should be noted that radiography reveals decreased bone density only when bone loss is substantial; the diagnosis of osteoporosis should be based on dual-energy X-ray absorptiometry (DXA).

The Kellgren-Lawrence (K-L) grading system, proposed by Kellgren and Lawrence in 1957 [11], is currently the most widely used radiographic grading standard for OA and comprises grades 0 to IV. For the measurement of joint space width (JSW), minimum JSW shows better reproducibility and sensitivity than mean JSW [10].

The limitations of radiography mainly include the following: it cannot directly visualize cartilage, menisci, ligaments, synovium, or effusion, making early cartilage damage difficult to detect; overlapping osseous structures and variations in projection position may affect the assessment of JSN; and it involves ionizing radiation, so frequent repeat examinations within a short period are not advisable [10,12].

3.2 Ultrasound: A Radiation-free Tool for Soft-tissue Assessment and Interventional Guidance

High-frequency ultrasound (8–12 MHz) involves no ionizing radiation and allows real-time, dynamic, bedside examination [7]. It can display joint effusion, synovial thickening, popliteal cysts, osteophytes, and the thickness and surface smoothness of part of the articular cartilage (e.g., the femoral trochlear cartilage), and power Doppler can further evaluate the activity of synovitis [7,13].

Regarding diagnostic criteria, Zhang [9] defined effusion as an anechoic area in the suprapatellar bursa with a depth >1 mm and synovial thickening as a synovial thickness >2 mm, and regarded an irregular cartilage surface, increased echogenicity, or reduced thickness as indicating cartilage damage; however, the thresholds vary across studies, and uniform criteria are still lacking. In terms of treatment, the main advantage of ultrasound is its ability to guide joint aspiration and injection in real time [14]; its limitations lie in its operator dependence and its limited ability to visualize deep structures and intraosseous lesions [7,13].

3.3 CT and Multi-slice Spiral CT: Detailed Visualization of Osseous Structures

Multi-slice spiral CT (MSCT) offers fast scanning without the need for patient repositioning, and with multiplanar reformation (MPR) and volume rendering (VR), it can display articular surfaces, subchondral bone, and intra-articular structures from multiple orientations. Gu et al. [12] reported that the MSCT findings of knee OA include asymmetric joint space narrowing, joint subluxation, eburnation (ivory-like sclerosis) of the articular surface, lip-like osteophytes at the joint margins, synovial ossification, and pseudocysts with sclerotic margins (shown on MPR to communicate with the joint cavity).

Compared with radiography, MSCT avoids the superimposition of osseous structures, is more sensitive in detecting bony lesions, and can be used for three-dimensional (3D) measurement of lower-limb alignment and preoperative planning [15,16]; however, its inadequate visualization of periarticular soft-tissue swelling and early cartilage damage is the main cause of misdiagnosis and missed diagnosis [12]. In recent years, dual-energy CT (DECT), which can identify urate crystals and display bone marrow edema-like lesions, has shown some value in differentiating OA from gouty arthropathy and in assessing bone marrow lesions [4].

3.4 MRI: Comprehensive Assessment of Whole-joint Structures

With high soft-tissue contrast and multisequence, multiplanar imaging capability, MRI is currently the most comprehensive noninvasive imaging method for evaluating cartilage, bone marrow, menisci, ligaments, synovium, and effusion [10,13,17]. Typical MRI findings of knee OA include [12] osteophytes and subchondral cysts (the cysts appear hyperintense on fat-suppressed T2-weighted sequences); cartilage thinning, discontinuity, or delamination, most commonly in the medial tibia; intra-articular loose bodies (small ones are easily missed); thickening and degeneration of the synovium and ligaments; meniscal degeneration and tears; and joint effusion. As for the scanning protocol, Gu et al. [12] used 3.0 T MRI with sequences including sagittal turbo spin echo (TSE) dual-echo, fat-suppressed (FS) TSE dual-echo, and coronal and axial FS-TSE proton density-weighted imaging (PDWI). The PDWI sequence provides good soft-tissue contrast and has high diagnostic sensitivity and specificity for meniscal injuries [10].

Limitations of MRI include long examination time, relatively high cost, restricted use in patients with metallic implants or claustrophobia, and limited ability to identify small loose bodies and their origin [12].

3.5 Nuclear Medicine and Functional Imaging

Nuclear medicine imaging mainly reflects bone metabolism and inflammatory activity rather than anatomical structure alone. Bone scintigraphy (99mTc-MDP) can detect increased osteoblastic activity in subchondral bone, manifested as focal radiotracer accumulation, which correlates with pain and

BMLs and may precede radiographic changes; single-photon emission computed tomography (SPECT)/CT combines functional and anatomical information and can improve the accuracy of lesion localization [18]. 18F-fluorodeoxyglucose (18F-FDG) positron emission tomography (PET)/CT can assess synovial inflammation and metabolic activity, helping to determine the degree of inflammatory activity and to evaluate treatment response; however, owing to its cost and radiation dose, it is currently used mainly for research purposes [19]. Overall, nuclear medicine imaging can complement structural imaging at the metabolic and inflammatory levels and is of value in assessing early and active lesions.

3.6 Semi-quantitative, Quantitative, and Artificial Intelligence-based Assessment

To overcome the predominantly qualitative nature of conventional imaging, semi-quantitative, quantitative, and intelligent assessment systems have gradually been developed for the imaging evaluation of OA. Semi-quantitative scoring systems, including the Whole-Organ Magnetic Resonance Imaging Score (WORMS) [5], the Boston Leeds Osteoarthritis Knee Score (BLOKS), and the MRI Osteoarthritis Knee Score (MOAKS) [20], grade structures such as cartilage, BMLs, menisci, and synovium by subregion and are widely used in cohort studies and clinical trials; semi-quantitative and quantitative assessments are complementary, and their combined use helps improve the detection of structural progression [21,22]. Quantitative MRI techniques—including T2 mapping, T1ρ, delayed gadolinium-enhanced MRI of cartilage (dGEMRIC), sodium imaging, glycosaminoglycan chemical exchange saturation transfer (gagCEST), and ultrashort echo time (UTE) imaging—can reflect changes in the cartilage collagen network and proteoglycan content and hold promise for detecting biochemical changes in cartilage at the radiographically negative stage [6,23]. Among these, T2 mapping is relatively mature and has been used to evaluate the cartilage matrix and repair tissue [6,23].

Artificial intelligence (AI)-based assessment, including deep learning-based automatic K-L grading [24] and prediction of OA progression and joint replacement risk, has become a research hotspot. However, a systematic review found that only 7% of the included studies performed external validation and that nearly half used data from the same public cohort [25]; the clinical translation of these models therefore still needs to be confirmed by prospective multicenter studies.

4. Applications of Imaging Techniques in OA Diagnosis

4.1 Ability of Different Imaging Techniques to Detect Various Pathological Changes

Different imaging techniques differ in their ability to detect the various pathological changes of OA. Zhang [9] performed radiography, ultrasound, and MRI in the same group of patients with knee OA and compared the detection rates of the various pathological changes among the three modalities; Xiong and Gu [26] reached similar conclusions in a study of 52 patients with knee OA. For osseous changes such as osteophytes and JSN, radiography had the highest detection rate, whereas the detection rates of sesamoid bones were similar across the three methods. For non-osseous lesions such as joint effusion, synovial hyperplasia, cartilage degeneration, meniscal injury, and popliteal cysts, the detection rates of ultrasound and MRI were significantly higher than that of radiography [26]; MRI had a higher detection rate than ultrasound for meniscal injury, whereas the two were similar for the other items. Ultrasound and conventional MRI are not used to assess bone mass; although radiography can suggest decreased bone mass, a definitive diagnosis of osteoporosis still relies on DXA.

A study by Jiang [27] comparing radiography with MRI likewise showed that MRI had significantly higher detection rates than radiography for subchondral bone damage (88.23% vs 27.45%), meniscal injury (85.00% vs 0), cartilage damage (92.72% vs 0), suprapatellar bursa effusion (85.71% vs 0), and synovial hyperplasia (86.79% vs 0) (all $P < 0.01$), whereas radiography was superior to MRI in suggesting osteoporosis. The three modalities have their respective advantages and are complementary [13,28]. MRI clearly displays cartilage, menisci, loose bodies, ligaments, and effusion and therefore has high diagnostic value for knee OA [8].

4.2 Quantitative Comparison of Diagnostic Performance

With regard to diagnostic performance, two single-center studies compared MSCT and MRI, alone and in combination, for the diagnosis of knee OA and found that combined MSCT and MRI outperformed either examination alone [12,29]. Jiang's analysis of 83 patients [27] showed no statistically significant difference in sensitivity between radiography and MRI (89.06% vs 92.54%, $P > 0.05$), but the specificity (81.25% vs 47.37%) and accuracy (90.36% vs 79.52%) of MRI were significantly higher than those of radiography ($P < 0.05$). This suggests that radiography relies mainly on osseous changes for diagnosis, which makes it prone to false-positive results and leads to relatively low specificity.

The conclusions of the two studies are largely consistent. It should be noted, however, that these studies were mostly single-center retrospective studies with sample sizes of 50–100 cases. In the study by Wang et al. [29], non-OA control cases were few, limiting the precision of the specificity estimate. Moreover, scanning parameters and reference standards were not uniform across studies, and the performance indices of the same examination method varied between studies (e.g., the area under the curve [AUC] of MSCT was 0.712 and 0.788, respectively). Therefore, these results should be regarded as suggestive and require further validation in large-sample, multicenter prospective studies.

4.3 A Tiered, Stepwise Imaging Diagnostic Pathway

Based on the available evidence, imaging diagnosis of OA can follow a "tiered, stepwise, and combined-as-needed" approach. As shown in Figure 1, weight-bearing anteroposterior and lateral radiographs of the knee are the first choice at the initial visit and for screening, to identify typical imaging findings and assign a K-L grade; when necessary, weight-bearing full-length lower-limb radiographs are added

to assess alignment [1,2,11]. For patients with early-stage disease, or those with prominent symptoms but negative radiographs, ultrasound (to evaluate soft tissues such as effusion and synovium) and/or MRI (to evaluate cartilage, BMLs, menisci, and ligaments) should be preferred [4,26,28].

MSCT is added for patients who require clarification of osseous details, localization of loose bodies, or preoperative 3D planning [12,15,16]. For complex cases or patients requiring comprehensive preoperative assessment, combined MSCT and MRI can be used, as its diagnostic performance is superior to that of either single examination [12,29].

In addition, a meta-analysis showed that varus alignment of the lower limb is a prognostic factor with strong evidence for radiographic progression of knee OA [30], suggesting that alignment assessment at the initial visit is useful for identifying patients who require close follow-up. Once the extent and severity of the lesions have been clarified through this pathway, they can further guide the choice of treatment.

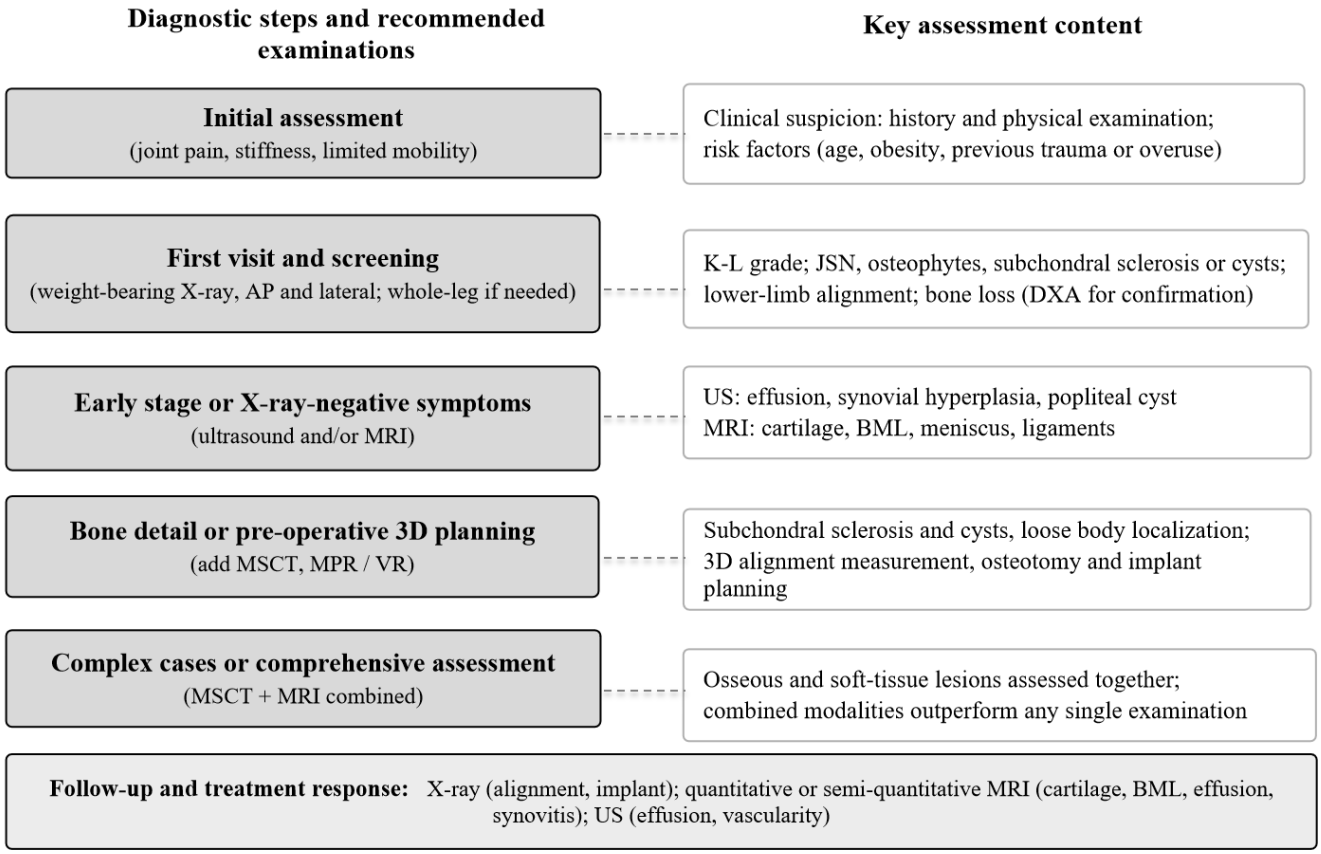


Figure 1: Tiered, stepwise imaging diagnostic pathway for knee OA

5. Applications of Imaging Techniques in OA Treatment

5.1 Imaging Assessment and Treatment Decision-making

The extent and severity of lesions determined by imaging assessment are important bases for formulating OA treatment plans. In general, patients with K-L grades 0–II are managed primarily with basic and conservative treatments such as health education, exercise therapy, weight management, and pharmacotherapy; for patients with grade III disease accompanied by lower-limb malalignment and lesions confined to a single compartment, joint-preserving procedures such as high tibial osteotomy (HTO) may be considered; end-stage unicompartmental disease may be treated with unicompartmental knee arthroplasty, whereas multicompartmental involvement or severe deformity usually requires total knee arthroplasty [1,3]. It should be emphasized that imaging severity does not fully correspond to clinical symptoms; surgical decisions should be made comprehensively in light of pain severity, functional impairment, age, and patient preference, and imaging grade should not serve as the sole indication for surgery [1]. Preoperative alignment measurement and evaluation of intra-articular lesions are described in Section 5.3.

5.2 Guidance of Interventional Therapy

Ultrasound-guided joint aspiration and injection is the most widely used image-guided interventional technique. Real-time ultrasound allows direct visualization of the needle tip and drug dispersion, improves the success rate of puncture, reduces injury to surrounding tissues, and avoids inadvertent injection into the synovium or fat pad. A randomized controlled trial showed that, compared with conventional anatomical landmark guidance, ultrasound-guided knee arthrocentesis and corticosteroid injection reduced procedural pain, increased the success rate of aspiration and the volume of aspirated fluid, and improved clinical outcomes [14]. Commonly used intra-articular agents include corticosteroids, sodium hyaluronate, and platelet-rich plasma (PRP). The Osteoarthritis Research Society International (OARSI) guidelines conditionally recommend intra-articular corticosteroids and hyaluronic acid (sodium hyaluronate) for knee OA, whereas PRP is not recommended [31]; in contrast, the 2024 Chinese guideline includes PRP among the optional early reparative treatments [3].

For deep joints such as the hip, or for lesions requiring precise localization, aspiration and biopsy can be performed under fluoroscopic or CT guidance [32]. SPECT/CT can show areas of abnormal radiotracer accumulation in subchondral bone, providing a basis for localization in the targeted management of subchondral bone lesions (e.g., core decompression) [18].

5.3 Preoperative Planning and Intraoperative Assistance

The surgical treatment of OA has now formed a stepwise model of "corrective osteotomy–unicompartmental arthroplasty–total knee arthroplasty," and the choice of procedure and surgical planning depend largely on imaging assessment [1,3]. For alignment assessment, parameters such as the mechanical axis of the lower limb and the anterior bowing angle of the distal femur are measured on weight-bearing full-length lower-limb radiographs or 3D CT reconstructions, providing a basis for designing the correction angle and osteotomy plane in HTO [15,16]. For the assessment of intra-articular lesions, MRI can determine the location, area, and depth of cartilage damage, as well as the extent of meniscal injury and BMLs, and is an important basis for evaluating the indications for joint-preserving surgery (HTO, unicompartmental arthroplasty, and cartilage repair) [8,17]. 3D data derived from CT/MRI can be used for preoperative prediction of implant size, design of patient-specific osteotomy guides, and 3D printing, which helps improve implant fit and the accuracy of alignment restoration [16]. Regarding intraoperative assistance, intraoperative C-arm fluoroscopy can confirm the osteotomy angle, implant position, and internal fixation, and computer navigation and robot-assisted systems are mostly planned on the basis of preoperative CT or radiographic data [33].

5.4 Efficacy Evaluation and Follow-up

Imaging is one of the few in vivo, noninvasive, and reproducible objective methods for evaluating treatment efficacy in OA. In pharmacological and intra-articular injection therapies, MRI can monitor changes in cartilage thickness and signal, BML extent, effusion, and synovitis to evaluate responses to treatments such as nonsteroidal anti-inflammatory drugs (NSAIDs), glucosamine, sodium hyaluronate, corticosteroids, and PRP [8]. The annual change in JSW measured on radiographs may be smaller than the measurement error, so radiography should not be used alone for short-term efficacy evaluation, and ultrasound measurement of cartilage thickness is influenced by the operator and the acoustic window [9,28]. Therefore, quantitative or semi-quantitative MRI methods should be preferred for efficacy evaluation [21,22]. During postoperative follow-up, radiography and CT can evaluate implant position, lower-limb alignment, periprosthetic osteolysis, wear, and loosening; MRI with metal artifact suppression sequences can evaluate the periprosthetic soft tissue and bone, and regular imaging follow-up helps detect surgical failure early [34].

Studies of complementary therapies such as traditional Chinese medicine (TCM) have relied mostly on molecular markers or invasive pathological examinations to evaluate efficacy [35], which can hardly reflect changes in the cartilage matrix and synovial inflammation dynamically in vivo. Quantitative MRI (T2 mapping, T1ρ, and dGEMRIC), ultrasound, and radiomics can provide noninvasive and reproducible evaluation indices [4] and are expected to become objective imaging markers for evaluating the efficacy of such therapies.

5.5 Imaging Biomarkers and the Shift in OA Treatment Concepts

Advances in imaging technology have not only optimized existing treatments but also driven a shift in treatment concepts. Radionuclide bone scintigraphy studies suggest that some patients with OA who have not yet developed full-thickness cartilage defects already show abnormal subchondral bone metabolism, indicating that structural imaging changes often lag behind pathological changes and providing a rationale for early intervention [18]. MRI studies have found that BMLs are closely associated with knee pain and structural progression [36,37], and the Multicenter Osteoarthritis Study (MOST) also showed that MRI-detected effusion and synovitis increase the risk of cartilage loss in knees without OA [38]. These findings have shifted the goal of OA treatment from mere "symptom relief" toward "delaying structural progression," and imaging biomarkers have become important outcome measures in clinical trials of disease-modifying OA drugs (DMOADs) [22].

6. Current Challenges and Future Perspectives

In summary, the roles of the various imaging techniques in OA are now relatively well defined: radiography is used mainly to assess osseous changes and alignment; ultrasound focuses on the evaluation of effusion and synovial lesions and on interventional guidance; CT excels at displaying osseous details and 3D measurement; MRI enables comprehensive evaluation of cartilage, bone marrow, and intra-articular soft tissues; and nuclear medicine reflects bone metabolism and inflammatory activity. In diagnosis, multimodal combination improves diagnostic performance (AUC of 0.913–0.932 for combined MSCT and MRI) [12,29]; in treatment, imaging now spans the entire process of preoperative planning, intraoperative guidance, interventional therapy, and postoperative follow-up, and is expected to provide an objective basis for evaluating the efficacy of therapies such as TCM.

Several challenges remain. Existing studies are mostly single-center, small-sample retrospective studies with a low level of evidence, and their scanning parameters, diagnostic criteria, and reference standards are inconsistent. Quantitative MRI is time-consuming and demanding in terms of equipment, has low availability in primary hospitals, and lacks unified acquisition and analysis standards. Ultrasound depends on operator experience, and its reproducibility needs to be improved. AI models are mostly built on data from a single cohort and lack external validation [24,25]. Future directions include: (1) multimodal fusion—integrating radiographic, CT, MRI, and ultrasound images with clinical, biochemical, and omics data to construct individualized assessment models; (2) quantification and standardization—unifying the acquisition protocols and diagnostic thresholds of quantitative techniques such as T2 mapping, T1ρ, and dGEMRIC; (3) intelligence — developing interpretable AI grading and prediction models

with multicenter external validation; and (4) whole-process integration—incorporating imaging assessment into the entire course of OA screening, diagnosis, treatment, and follow-up, thereby promoting the transformation of imaging from "morphological diagnosis" to "decision support for precision diagnosis and treatment."

7. Conclusion

Medical imaging plays an irreplaceable role in the diagnosis and treatment of OA. In clinical practice, imaging examinations should be selected rationally according to the specific clinical question: radiography for screening and grading; ultrasound and MRI for identifying early soft-tissue and cartilage lesions; MSCT to supplement osseous details and 3D information; and multimodal combinations when necessary, with imaging assessment integrated throughout treatment decision-making, interventional guidance, and efficacy follow-up. With the development and standardization of quantitative imaging, multimodal fusion, and AI technologies, imaging is expected to play an even greater role in the early diagnosis, precise stratified treatment, and efficacy evaluation of OA.

Fund Project

This work was supported by the Basic Research Project of Traditional Chinese Medicine and Ethnic Medicine of the Guizhou Provincial Administration of Traditional Chinese Medicine (No. QZYY-2026-202), and the Scientific Research Team Fund Project of Guiyang Kangyang University (No. Guikangda-TD2025-003).

References

[1] Joint Surgery Group of the Chinese Orthopaedic Association; Subspecialty Group of Osteoarthritis, Chinese Association of Orthopaedic Surgeons; National Clinical Research Center for Geriatric Disorders (Xiangya Hospital); et al. Chinese guideline for diagnosis and treatment of osteoarthritis (2021 edition). Chinese Journal of Orthopaedics. 2021;41(18):1291-1314.

[2] Joint Surgery Group of the Chinese Orthopaedic Association. Guideline for diagnosis and treatment of osteoarthritis (2018 edition). Chinese Journal of Orthopaedics. 2018;38(12):705-715.

[3] Expert Group of Chinese Guidelines for Diagnosis and Treatment of Osteoarthritis; Pain Disease Branch of the Chinese Aging Well Association. Chinese guidelines for diagnosis and treatment of osteoarthritis (2024 edition). Chinese Journal of Painology. 2024;20(3):323-338.

[4] Si LP, Yao WW. Advances in new MRI and CT techniques for quantitative imaging of knee cartilage and subchondral bone in early osteoarthritis. Journal of Diagnostics Concepts and Practice. 2018;17(4):477-481.

[5] Peterfy CG, Guermazi A, Zaim S, et al. Whole-Organ Magnetic Resonance Imaging Score (WORMS) of the knee in osteoarthritis. Osteoarthritis Cartilage. 2004; 12(3): 177-190.

[6] Chen C, Yang FJ, Fan YQ, et al. MR T2-mapping imaging quantitative analysis the value of early diagnosis of knee joint osteoarthritis. Chinese Journal of CT and MRI. 2016;14(12):114-117.

[7] Yang B, Xue LF, Zhang XR, et al. Value of high-frequency ultrasound and X-ray in diagnosing knee osteoarthritis: a comparative study. China Medicine. 2015;10(8):1177-1180.

[8] Sun H, Xue YJ, Jiang DW, et al. Application and imaging characteristics of magnetic resonance imaging in knee osteoarthritis. World Journal of Complex Medicine. 2019;5(11):136-138.

[9] Zhang ZQ. Comparison of the clinical value of X-ray, ultrasound and MRI in the diagnosis of knee osteoarthritis. Journal of Taishan Medical College. 2018; 39(1):90-91.

[10] Braun HJ, Gold GE. Diagnosis of osteoarthritis: imaging. Bone. 2012;51(2):278-288.

[11] Kellgren JH, Lawrence JS. Radiological assessment of osteo-arthrosis. Annals of the Rheumatic Diseases. 1957; 16(4):494-502.

[12] Gu YM, Guo J, Tian B, et al. Imaging features of MSCT and MRI in degenerative knee osteoarthritis and diagnostic value of combined application. China Journal of Modern Medicine. 2021;31(23):6-10.

[13] Wang HY. Application value of high-frequency ultrasound and MRI in the diagnosis of knee osteoarthritis. Medical Equipment. 2020;33(15):24-26.

[14] Sibbitt WL Jr, Kettwich LG, Band PA, et al. Does ultrasound guidance improve the outcomes of arthrocentesis and corticosteroid injection of the knee? Scand J Rheumatol. 2012;41(1):66-72.

[15] Ke S, Wang M, Xu Y, et al. A preliminary study of DFSAA in the knee osteoarthritis patients based on CT-three dimensional reconstruction-measurement. Journal of Practical Orthopaedics. 2019;25(6):523-527.

[16] Zeng DH, Wang J, Liang YQ. Analysis on imaging features of osteoarthritis in 64 row MSCT and its clinical application value. Chinese Journal of CT and MRI. 2020;18(11):153-155.

[17] Li X, Zhao L, Wang SL, et al. Arthroscopy and magnetic resonance imaging for the classification of knee articular cartilage injury in patients with osteoarthritis. Orthopedic Journal of China. 2017;25(1):29-32.

[18] Huang ZB, Zhu H, Peng XC, et al. Research progress in imaging diagnosis of knee osteoarthritis. The Journal of Traditional Chinese Orthopedics and Traumatology. 2014;26(6):43-45.

[19] Lee K, Niku S, Koo SJ, et al. Molecular imaging for evaluation of synovitis associated with osteoarthritis: a narrative review. Arthritis Research Therapy. 2024; 26:25.

[20] Hunter DJ, Guermazi A, Lo GH, et al. Evolution of semi-quantitative whole joint assessment of knee OA: MOAKS (MRI Osteoarthritis Knee Score). Osteoarthritis Cartilage. 2011;19(8):990-1002.

[21] Roemer FW, Eckstein F, Guermazi A. Magnetic resonance imaging-based semiquantitative and quantitative assessment in osteoarthritis. Rheumatic Disease Clinics of North America. 2009;35(3):521-555.

[22] Guermazi A, Roemer FW, Haugen IK, et al. MRI-based semiquantitative scoring of joint pathology in osteoarthritis. Nature Reviews Rheumatology. 2013; 9(4):236-251.

[23] Dunn TC, Lu Y, Jin H, et al. T2 relaxation time of cartilage at MR imaging: comparison with severity of knee osteoarthritis. Radiology. 2004;232(2):592-598.
[24] Tiulpin A, Thevenot J, Rahtu E, et al. Automatic knee osteoarthritis diagnosis from plain radiographs: a deep learning-based approach. Scientific Reports. 2018; 8(1):1727.
[25] Binvignat M, Pedoia V, Butte AJ, et al. Use of machine learning in osteoarthritis research: a systematic literature review. RMD Open. 2022;8(1):e001998.
[26] Xiong Y, Gu WB. Value of X-ray, ultrasound and MRI in diagnosis of knee osteoarthritis. Journal of Imaging Research and Medical Applications. 2019;3(6):30-32.
[27] Jiang B. Diagnostic value of X-ray and MRI in knee osteoarthritis. Journal of Aerospace Medicine. 2020; 31(11): 1338-1339.
[28] Xiao LK, Li JW. Diagnostic value of X-ray and MRI in early knee osteoarthritis. Rheumatism and Arthritis. 2019;8(9):43-45.
[29] Wang Y, Li QL, Liu Y, et al. Imaging diagnostic value of MSCT and MRI in degenerative knee osteoarthritis. Henan Medical Research. 2021;30(15):2847-2849.
[30] Bastick AN, Belo JN, Runhaar J, et al. What are the prognostic factors for radiographic progression of knee osteoarthritis? A meta-analysis. Clinical Orthopaedics and Related Research. 2015;473(9):2969-2989.
[31] Bannuru RR, Osani MC, Vaysbrot EE, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. Osteoarthritis Cartilage. 2019;27(11):1578-1589.
[32] Puri A, Shingade VU, Agarwal MG, et al. CT-guided percutaneous core needle biopsy in deep seated musculoskeletal lesions: a prospective study of 128 cases. Skeletal Radiology. 2006;35(3):138-143.
[33] Mancino F, Fontalis A, Kayani B, et al. The current role of CT in total knee arthroplasty. The Bone and Joint Journal. 2024;106-B(9):892-897.
[34] Ries MD, Link TM. Monitoring and risk of progression of osteolysis after total hip arthroplasty. The Journal of Bone and Joint Surgery. 2012;94(22):2097-2105.
[35] Zhang JP, Zhou MW, Wang XP, et al. Research progress in the mechanism of saponins in preventing and treating knee osteoarthritis. Chinese Journal of Library and Information Science for Traditional Chinese Medicine. 2025;49(4):222-226.
[36] Lu C, Liu HX, Zhang GQ, et al. Correlation between Subchondral Bone Marrow Edema and Pain in Knee Osteoarthritis. Chinese Journal of Surgery of Integrated Traditional and Western Medicine. 2015;21(3):242-245.
[37] Felson DT, McLaughlin S, Goggins J, et al. Bone marrow edema and its relation to progression of knee osteoarthritis. Annals of Internal Medicine. 2003;139(5 Pt 1):330-336.
[38] Roemer FW, Guermazi A, Felson DT, et al. Presence of MRI-detected joint effusion and synovitis increases the risk of cartilage loss in knees without osteoarthritis at 30-month follow-up: the MOST study. Annals of the Rheumatic Diseases. 2011;70(10):1804-1809.