

The Emerging Era of Interventional Imaging in Rheumatology: An Overview During the Coronavirus Disease-2019 (COVID-19) Pandemic

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Abstract: Imaging has long been taking its place in the diagnosis, monitor, and prognosis of rheumatic diseases. It plays a vital role in the appraisal of treatment. Key progress in the clinical practice of rheumatology is the innovation of advanced imaging modalities; such as musculoskeletal ultrasound (MSUS), computerized tomography (CT) and magnetic resonance imaging (MRI). These modalities introduced a promising noninvasive method for visualizing bone and soft tissues to enable an improved diagnosis. The use of MSUS in rheumatology is considered a landmark in the evolution of the specialty and its ease of use and many applications in rheumatic diseases make it a forerunner instrument in the practice. The use of MSUS among rheumatologists must parallel the development rate of the excellence revealed in the specialty. Moreover, innovative interventional imaging in rheumatology (III-R) is gaining fame and key roles in the near future for a comprehensive management of rheumatic diseases with precision. This review article throws light on the emergence of these robust innovations that may reshape the guidelines and practice in rheumatology, in particular, efforts to enhance best practice during the coronavirus disease 2019 (COVID-19) pandemic are endorsed.

Keywords: interventional imaging, musculoskeletal ultrasound, rheumatology, COVID-19 pandemic

Current Imaging Modalities in Rheumatology

Imaging is playing a fundamental role in the diagnosis, monitor and prognosis of rheumatic diseases. Foremost progress in the clinical practice of rheumatology is fuelled by hi-tech innovations. Although conventional radiography exists as the primary widely used imaging modality by rheumatologists, musculoskeletal ultrasound (MSUS), computerized tomography (CT) and magnetic resonance imaging (MRI) provided a non-invasive modalities with a promising interventional role.¹ Every imaging modality has its pros and cons.² *Conventional radiography* is a primary imaging modality; however,

the limited visualisation significantly limits its utility.³ In the precedent years, the use of US are considered landmarks in the evolution of the specialty. Its accessibility and numerous applications in rheumatic diseases make it a forerunner modality in clinical practice and many rheumatologists consider it the optimum “extension” of medical assessment.⁴ *MSUS* imaging allows detecting inflammation of the joint cavity, tendons and bursae, as well as activity assessment.⁵ This is now apparent by numerous inclusions in European League Against Rheumatism (EULAR) and American College of Rheumatology (ACR) classification criteria for rheumatoid arthritis (RA), crystal-induced arthritis, spondyloarthritis (SpA), or polymyalgia rheumatic (PMR).⁶ *Computed tomography* can ultimately evaluate cartilage degeneration by three dimensions visualization of joint space narrowing as direct observation is possible by the invasive injection of a contrast material. *Dual-energy CT* helps in the identification of crystals thus refining the differential diagnosis of undifferentiated arthritis.⁷ *MRI* permits timely classification of axial SpA (axSpA) ahead of structural damage. MRI has served in expanding the knowledge regarding the pathophysiology, untimely diagnosis, prognosis, therapeutic effectiveness of enthesitis.⁸ In daily clinical practice, MRI is the leading non-invasive imaging modality to evaluate early structural variations in the cartilage volume or thickness,⁹ and surrounding tissues.³ Whole-body MRI is gaining more value in the diagnosis, prognosis and therapeutic response assessment in the pediatric rheumatic diseases.¹⁰ However, MSUS is not regularly considered as the primary imaging technique in the estimation of suspicious axSpA.¹¹ The rising *hybrid imaging*, PET/MRI and *single photon emission CT* (SPECT)/CT, paves way for a potentially enhanced ability to concurrently assess the joint's structural change and functional activity in osteoarthritis (OA) research.³ Provided the central contribution of imaging in the appraisal of therapy, in certain situations, more than one modality may be required.¹² Alongside with *CT*, *MRI* allows differentiation of doubtful sacroiliitis and degeneration of the spine, and *positron emission tomography* (PET) was chiefly requested to settle a diagnosis of large-vessels vasculitis.¹³

Diagnostic Potential of Imaging Modalities in Rheumatology Inflammatory Arthritis

In spite being well-established imaging tools, US and MRI have been lately integrated into essential Rheumatology practice. Both surpass conventional radiography in the detection of bone erosions as they are ever more being utilized for the detection of subclinical inflammation in patients with arthritis. On performing sequential evaluation of synovitis, US or MRI imaging may be considered as a lively biomarker that could monitor the evolution of the disease and the therapeutic implications.¹ Both can enable predicting the progress of undifferentiated arthritis to erosive RA.¹⁴ MSUS plays a vital role in the detecting subclinical synovitis especially for those in clinical remission. Moreover, the significance of US in the diagnosis and monitoring of peripheral SpA is gaining popularity.⁵ Power Doppler (PD) signal of the synovial membrane has prognostic value for RA.⁷ The use of US with PD helps differentiate between active and inactive inflammation within joints and periarticular soft tissues thus allowing more accurate and objective assessment.¹⁵ Together the rheumatologist and radiologist should make the most of these developments in view of the recent recommendations from EULAR that offer helpful guidance.¹⁶

Enthesitis and Dactylitis

Clinical and US *enthesitis* scores were reported to be comparable in AxSpA.¹⁷ Creating a sonographic enthesitis scoring system is an imperative step in enhancing a brisk diagnosis and in promoting early interventions that may broadly improve enduring outcomes.¹⁸ In addition, imaging also helps in sorting out the primary pathogenesis pathways that may lead to the chronicity of *dactylitis* in PsA patients.¹⁹ DACTylitis gLObal Sonographic (DACTOS) score is a consistent measure to understand the US characteristics of dactylitis and supports clinical diagnosis and management in PsA patients with dactylitis.²⁰

Vasculitis

Ultrasound more commonly determines large-vessel vasculitis compared to contrast-enhanced MRA. This has supported the recommendation that US is a leading step in the appraisal of giant cell arteritis (GCA).²¹ In the latest PMR criteria, an US scan of the shoulder and pelvis regions was a reliable substitute to clinical assessment.²²

Sjögren's Syndrome

Salivary gland US (SGUS) has lately been re-discovered as a promising measure to evaluate salivary gland involvement in primary Sjögren's syndrome (SS) with added value in disease stratification and monitoring patient response to therapy.²³ With confidence, SGUS as a noninvasive modality provides a high diagnostic yield for both primary and secondary SS.²⁴

Myositis

There is an emerging useful role of US in the evaluation of myositis.^{25,26} Sonoelastography is currently applied in the diagnosis of myositis and become a regular handy additional technique.²⁷ Patients with inclusion body myositis (IBM) have a noticeable increase in echogenic intensity of the muscles due to fatty substitution. Most prominently, US revealed a notable precision in contrast to MRI.²⁸ As there are no unambiguous guidelines for using of diagnostic US for the assessment of idiopathic inflammatory myositis (IIM), it was reported that edema and PD are firmly associated with early myositis and the degree of activity as inflamed muscles appear swollen, thickened and with PD signals. The aforementioned provides a window of hope for a novel potential role of US in the diagnosis and monitoring of IIM.²⁹ Certainly, US may be regarded as a promising tool and outcome measure in autoimmune myositis (AIM).³⁰

Systemic Sclerosis

There is a rising handy role of US in the estimation of scleroderma.²⁵ In juvenile systemic sclerosis (SSc), US provides real-time lively high-resolution images and with the aid of advanced transducers, it allows notable cutaneous and articular imaging. B-mode or PD may show thickening and hypervascularization of the skin and subcutaneous tissue, synovitis, tenosynovitis, and small calcific deposits. MRI provides added value in the assessment of cutaneous inflammation and atrophy as well as the deeper structures such as the fascia, muscles and joints that could be difficult to see on US. However, in children MRI may necessitate sedation in addition to being costly and time-consuming. Conventional radiography may show soft-tissue calcification, acroosteolysis, contractures, and subluxations. As CT warrants a high-dose of radiation, it is usually avoided in children.³¹ Using US to identify skin ulcers in scleroderma patients has been validated and showed a promising result to characterize the morphology and detect underlying pathology of skin ulcers.³² ACR/EULAR classification criteria allow for the US features for the hand to replace capillaroscopy with a comparable performance in their diagnostic potential in SSc.³³

Pediatric Rheumatism

There is emerging proof in favor of using MSUS in the estimation and management of children with rheumatic diseases with special focus on juvenile idiopathic arthritis (JIA). MSUS improves the diagnosis of inflammatory joint disease involving synovitis, enthesitis and tenosynovitis as well as the likely discovery of subclinical synovitis.²⁵

Sport Injuries

Interestingly, signal intensity and echogenicity of the knee ligaments on MRI and US were comparable to the histological findings.³⁴ US plays a vital role in the evaluation of sports injuries.³⁵

Peripheral Nerve Disorders

Neuromuscular US (NMUS) is frequently applied to evaluate the peripheral nerves of the lower limbs due to its superiority over MRI in showing the soft-tissue details at a reduced price besides avoiding magnetic artifacts and being user friendly with greater sensitivity. Further reimbursements are the ability of real-time dynamic imaging, and the prompt capacity to visualize the upper and lower limbs on both sides. It may also guide diagnosis and management strategies.³⁶ Using combined US parameters in association with nerve conduction studies (NCS) and nerve histopathology are highly suggested to further look into systemic lupus erythematosus (SLE) neuropathy.³⁷

Interventional Imaging in Rheumatology (III-R)

The spectrum of utilizing interventional imaging in Rheumatology is presented in Figure 1 and the various regions approached in Figure 2. The Egyptian Rheumatologists experience with interventional imaging using MSUS in various articular regions is presented in Figure 3.

Articular-Ultrasound-Guided (USG) Injection

Ultrasound-guided *temporo-mandibular joint* (TMJ) injections are performed with high proficiency compared to the conventional blind technique, in particular on targeting the lower joint space.³⁸ Intra-articular injection of the *zygo-apophyseal (facet) joint* is a recognized diagnostic approach of the cervical spine and US-guided technique adds to its accuracy.³⁹

US-guided injection of the *shoulder* proved effective regardless the procedure for injection (anterior, posterior, or lateral) and was effective for post-injection evaluation.⁴⁰ US-guided injection of the shoulder via the rotator interval technique is used for arthrograms, and intra-articular shoulder joint injections.⁴¹ US-guided steroid injection procedure provides a dramatic improvement. When hyaluronic acid (HA) is considered, a more targeted site should be well-thought out to enhance the efficacy and prevent side effects.⁴²

Currently, US imaging is a key modality used to promptly improve the diagnosis of *Elbow* pain and guide interventions in its management.⁴³ US-guided injection of the elbow joint; radio-ulnar and radio-humeral with corticosteroid eliminated any enduring pain and remarkably optimized the range of motion.

Intra-articular HA is generally required in the management of symptomatic OA of the thumb *carpometacarpal joint* and US-guided injection was found to be effective and safe.⁴⁴ US may be used to accurately perform intra-articular *trapeziometacarpal* (TMC) joint injections. Moreover, US is a feasible substitute of fluoroscopy when a targeted injection is needed.⁴⁵ Amazingly, US-guided intra-articular injection of anti-tumor necrosis factor alpha (anti TNF- α) in small joints with arthritis involving the wrists, and finger joints gave no noticeable adverse events.⁴⁶ Furthermore, US-guided dry needling secured a significant advance of shoulder and hand movements in cases of complex regional pain syndrome (CRPS).⁴⁷

Intra-articular injection is commonly acquired for *hip* joint diseases and provides a valuable therapeutic option.⁴⁸ US-guided intra-articular injection has become a basic choice in the diagnosis and treatment of a variety of hip disorders. US provides sizeable therapeutic importance particularly when considered in combination with a sufficient physical therapy program.⁴⁹ US-guided intra-articular injection of HA was found effective and safe in the treatment of symptomatic hip OA.⁵⁰

Besides the famous treatment options for *knee* OA such as HA, corticosteroids and oxygen-ozone therapy, many other promising products have been employed in the last decades such as polydeoxy-ribonucleotide, platelet-rich plasma (PRP) and mesenchymal stem cells (MSCs). Also, US-guided intra-meniscal injection has been launched into clinical practice.

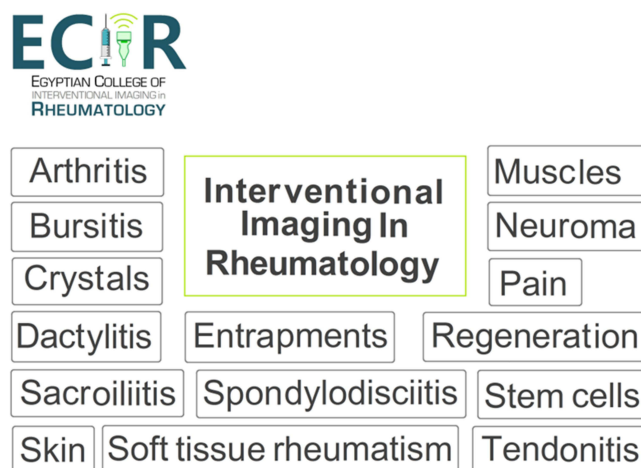


Figure 1 Spectrum of the role of interventional imaging in rheumatology.

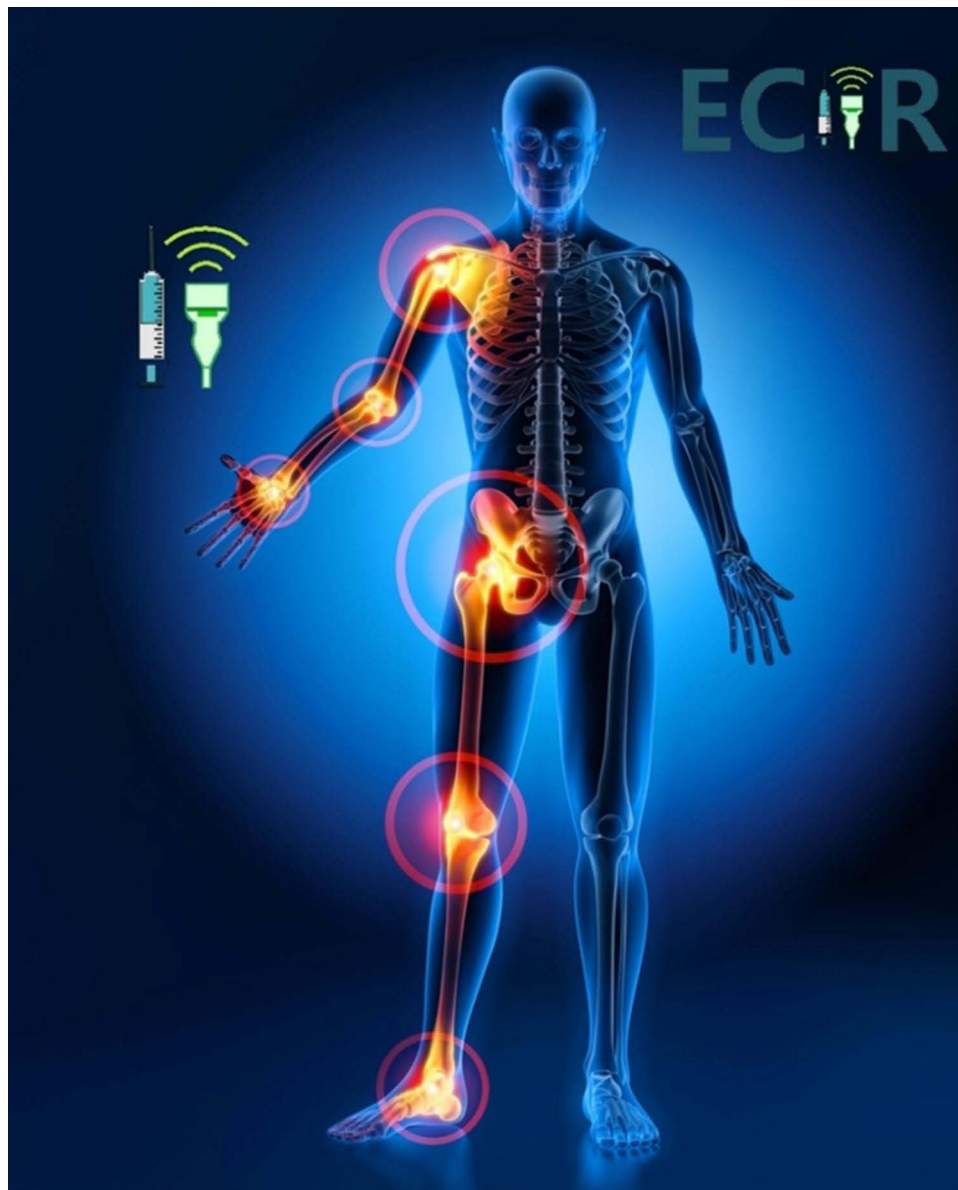


Figure 2 Musculoskeletal regions considered in ultrasound-guided interventional injections.

The use of biologic therapy and monoclonal antibodies involving nano-molecular technology are presently evolving with the aim of establishing personalized medicine and mounting the therapeutic armamentarium against knee OA.⁵¹ As knee structures are mostly superficial and the ease of access, an outstanding visualization could be facilitated with a high-frequency linear array transducer. In most cases, an in-plane way is simply attained. US-guided knee approaches have constantly shown superior correctness, especially for patients with a high body mass index and allows a more specific diagnosis and accurate targeting of the lesions with satisfactory safety.⁵²

US-guided injection of the *foot and ankle* helps in the alleviation of pain due to disorders related to the joints, bursae, tendons, and nerves at an improved accuracy to provide a solid diagnosis with reasonable safety particularly when done close to neurovascular structures.⁵³ Interestingly, among patients with *ankle* OA, USG intra-articular PRP injection was akin USG placebo injection as regards pain and disability.⁵⁴ US guided injection of the *talonavicular joint* is better compared to a LMB method.⁵⁵ US guided posterior *subtalar joint* injections allow easy and precise needle insertion while reducing the risk of damaging nearby vital soft-tissues structures un-noticed by other procedures such as fluoroscopy or CT.⁵⁶ However, LMB approach is as effective as US-guidance for intra-articular injection in patients with hallux rigidus.⁵⁷

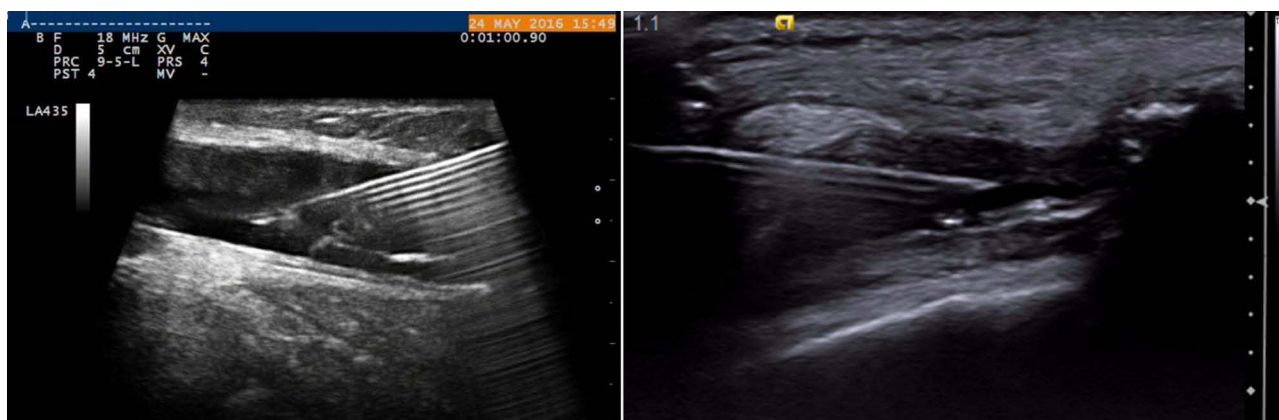


Figure 3 Musculoskeletal ultrasound (MSUS) interventional imaging of the suprapatellar space (transverse and longitudinal views B mode) with in-plane ultrasound guided needle.

Articular-Ultrasound-Guided (USG) Aspiration

USG arthrocentesis is adding great compensation over a blind landmark-based (LMB) approach. USG arthrocentesis offers direct visualization of the effusion and is performed with high precision and limited attempts. It can also determine mild effusions that would not be evaluated using a LMB approach.⁵⁸ In patients with knee pain due to OA and meniscal tear, US-guided micro-fragmented fat tissue injected into a torn meniscus was reported to be a secure and likely successful preference.⁵⁹ Knee OA treated with USG intra-articular injection of bone marrow concentrate lead to a considerable improvement in symptoms and functional status with minimal complications.⁶⁰

Articular-Ultrasound-Guided (USG) Biopsy

US-guided knee intra-articular *core needle biopsy* in patients with possible soft-tissue tumours is a highly effective and safe technique.⁶¹ In addition to being efficient, secure and nonradioactive, US allows easy guidance for radiofrequency (RF) in symptomatic relief and functional upgrading in knee OA patients.⁶² Moreover, US-guided genicular nerve cooled RF ablation provides a finer efficacy in the management of non-surgically indicated patients with advanced knee OA.⁶³ Amusingly, USG knee procedures were related to more patient satisfaction, immediately and after 4–6 weeks compared to LMB approach.⁶⁴

Soft Tissue and Regional Rheumatism–USG Injection Tendinopathy

Percutaneous tenotomy is a needle is repeatedly inserted into the abnormal tendon with the aim of switching a chronic degenerative process to an acute inflammatory condition that may proceed towards tendon healing. US guidance for this procedure is indispensable to make sure that the damaged part of the tendon is precisely targeted.⁶⁵ Moreover, progress in stem-cell technology offers a novel opportunity in regenerative rheumatology.¹

Dactylitis

The effectiveness of US-guided steroid injection for dactylitis has been well-known with the remarkable remission and improvement in extra-articular inflammation with special reference to tenosynovitis and soft tissue oedema.⁶⁶

Subcutaneous Lesions

The calcific deposits in SSc can lead to functional restrictions, cutaneous ulcers and cosmetic deformities. Management of *calcific deposits* can be difficult and refractory to surgical and non-surgical treatment options. *US-guided aspiration* was reported to be useful in treatment of such conditions.⁶⁷

Muscle Injury

PRP is a compelling mini-invasive treatment for *muscle injuries*, and to maximize its efficacy US guidance accurately localizes the lesion and leads the needle enabling full muscle recovery.⁶⁸ US-guided intramuscular injection can be carried out with excellent accuracy in the *sternocleidomastoid muscle* in patients with *cervical dystonia*, as US can be used to evaluate the muscle thickness and cross-sectional area.⁶⁹

Shoulder Region

Ultrasound is effectual in localizing the needle insertion into the *subacromial bursa* in patients with chronic subacromial bursitis.⁷⁰

Elbow Region

US-guided injection is of value in treating *olecranon bursitis*.⁷¹ In cases of *chronic elbow tendonopathies*, US-guided PRP injection was within the tendon in all cases.⁷²

Wrist Region

US-guided one injection of PRP, can improve the clinical symptoms of patients with a mild to moderate *carpal tunnel syndrome* (CTS).⁷³

Hand Region

US-guided injection of steroid and HA could be a reasonable and easy mode for the treatment of *trigger finger*;⁷⁴ however, it has been reported that it may be time consuming with more effort and similar clinical benefits compared to the blinded LMB technique.⁷⁵ US-guided Dupuytren's contracture injection tended to be superior than standard injections.⁷⁶

Lower Back

Interventional *lower back facet joint* management with US-guided oxygen/ozone therapy was considered safe and effective.⁷⁷

Pelvis, hip and thigh region: US-guided technique allows accurate guidance for the injection of botulinum toxin in the management of *iliopsoas spasticity*⁷⁸ and *greater trochanteric* pain was effectively managed by US-guided injection.⁷⁹ US-guidance is relatively more expensive and anatomic LMB injection continues to be the method of choice for *trochanteric bursitis* and US-guided approach is reserved for extreme obesity or injection failure.⁸⁰ However, treatment of *meralgia paresthetica* with US-guided injection was comparable to surgery.⁸¹

Knee Region

US-guided *pes anserinus bursa* injection is more precise and efficient than blind LMB injection.⁸² The contemporaneous administration of PRP and high volume US-guided injections of saline influences *tendon repair* by means of various mechanisms and grant a superior enhancement for patellar tendinopathy.⁸³ Interestingly, *intraalipolysis* is an effective method for decreasing fat deposits on the inner side of the knees. Ultrasonography is confirmed to be a valuable method to check the proper administration of the medication and to assess outcomes.⁸⁴

Foot Region

The need for interventional US-guidance is a well-known procedure and aids in the guidance for vascular and visceral structures. MSUS for the foot and ankle provides focused insertion of the needle tip and consequent injection. US-guided injection is considered an effective procedure for diagnostic aspiration of the joint, tendon, and bursae.⁸⁵ Both US-guided botulinum toxin and steroid injection were effective in the treatment of *plantar fasciitis*.⁸⁶ Injection of *Morton neuroma* under US guidance provides a significant improvement compared to blind injection.⁸⁷

Guidelines for Best Practice During the Coronavirus Disease-2019 (COVID-19) Pandemic

The current coronavirus disease-2019 pandemic has strained medical resources, generating a dilemma for physicians responsible to limit spread of the infection and to treat the patients they are entrusted to care for.⁸⁸ The challenges of the

COVID-19 pandemic exposed many limitations to treatment access and medication adherence in rheumatic diseases patients and accelerated changes in the way we convey health-care.⁸⁹ Intra-articular injections are allowed when there is no practical therapeutic options, and provided that safety measures to protect the patient and the rheumatologist from viral contamination are followed and suitable information is provided to the patient.⁹⁰ The global mass production of vaccines against COVID-19 is highly encouraged by the Rheumatology university staff members for the rheumatic diseases patients once available.⁹¹ Fortunately, the rheumatic diseases patients reported side effects were typical of those reported in the general population and the relatively reduced frequency of rheumatic disease flare necessitating medications was reassuring.⁹²

In acknowledgment, many rheumatic diseases patients demanding an interventional imaging maneuver during the COVID-19 pandemic are higher risk groups. Telemedicine may provide an effective platform for new and established patients' appointments. Post-intervention follow-up would also be more suitable and convenient if teleMedicine is applied. Nonetheless, provided their very low risks, the lack of appropriate substitutes, and the other benefits afforded by physical and psychological therapies in times of crisis, it is recommended that telehealth be used whenever feasible if indicated.

The COVID-19 pandemic has encouraged everyone to update the standard medical procedures and adapt them to this new era that may involve using wireless probes for US-guided procedures; as they are easier to carry and clean.⁹³ Best practice guidelines for III-R should consider the following:

General Measures for COVID-19 Infection Risk Alleviation

General infection control precautions form the basis of interventional-imaging (injections) practices. In harmony with the Centers for Disease Control and Prevention (CDC) infection control recommendations for preventing transmission, the recommendations that are most applicable to interventional-imaging rheumatologists and their patients include those presented in Table 1.

Table 1 General Measures for Corona Virus Disease 2019 (COVID-19) Infection Risk Alleviation During Interventional-Imaging in Rheumatology

General Measures for COVID-19 Infection Risk Alleviation	
1	Placing signs to educate patients on proper hand and respiratory hygiene as well as cough etiquette.
2	Providing sufficient supplies in noticeable and reachable places.
3	Triage patients with fever and or respiratory symptoms and enforce the use of a facemask
4	Limit unnecessary patient escorts.
5	Adequately separating patients ideally 2 meters (6.5 feet) apart in waiting rooms, locations and queues.
6	Patients should be met in hygienic and satisfactorily disinfected rooms, with no previous exposure to COVID-19 patients.
7	Hand hygiene with 60–95% alcohol-based hand rub for 15 seconds or with soap/water for 20 seconds before and between all patient care episodes.
8	Robustly ensure using face masks and wearing gloves during any patient interaction and care.
9	In areas with community spread, use scrubs before seeing patients.
10	Avoid touching the patients face.
11	During procedures, sterile disposable sheets should be used for each patient.
12	Sterilize and disinfect all surfaces in the patient's care surroundings including the tables, beds, chairs, door handles and equipments between each patient visit.
13	Ensure sufficient sleep and hydration.
14	Optimize health and boost the immune system via behavioral changes such as quitting smoking, improvements in diet and exercise.

Specific Interventional-Imaging Measures for COVID-19 Infection Risk Alleviation

For procedures or consultations that need to be performed in high risk patients or those known to be infectious, the extra measures presented in Table 2 should be considered.

Even though the aforementioned guidelines provides a framework for interventional-imaging management services for rheumatic diseases patients, the clinical status of the patient must be well thought-out in view of the regional health settings, government and hospital directives, resource accessibility, as well as the wellbeing of health-care providers.

Special Emphasis

Interventional Rheumatology: Crosstalk with Other Specialties

The past decade has brought a fresh raft of high-tech progress that has encouraged physicians to cross-examine and manage rheumatic diseases with rising complexity.¹ Well organized and focused US protocols for basic clinical queries have been constructed and put into practice of the following medical fields: anesthesia, cardiovascular, critical-care, dermatology, emergency, neonatal care, gynecological, rheumatology and more in the queue. Point of Care (POC) US is user dependent and needs quality assurance, proper education and sensible training. POC US has the capability to become the physician's innovative special global examination procedure.

US-guided injections in pain Medicine are accepted procedure for pain interventions.⁹⁴ Experience of *anesthesiologists* with USG intra-articular knee injection demonstrated that knee flexion provides another approach that may improve the scan of the suprapatellar bursa when compared to knee extension.⁹⁵ Furthermore, anesthesiologists consider that US is useful for procedures of the ankle joint and adjacent structures.⁹⁴

Radiosynoviorthesis using the intra-articular intervention of β -particle emitting radiocolloids has for years been used for the confined management of inflammatory joint diseases. The European Association of *Nuclear Medicine* (EANM) in close association with an international team of clinical experts, including rheumatologists, provided guidelines.⁹⁶ The European Society of *Musculoskeletal Radiology* (ESSR) primed recommendations about the role of US in diagnosing musculoskeletal

Table 2 Specific Measures for Corona Virus Disease 2019 (COVID-19) Infection Risk Alleviation During Interventional-Imaging in Rheumatology

	Specific Measure for COVID-19 Infection Risk Alleviation
1	Face mask and better if N95 should be used to protect against droplet transmission.
2	Wear cleanable face shields over the mask (when possible).
3	Appropriate use of personal protective equipment (PPE)
4	Wash hands/use gloves before doffing and donning equipments.
5	Properly store, sterilize and disinfect equipments between uses.
6	Minimize the exposure time, limit and sterilize the body regions exposed.
7	Similar to open surgical procedures, the patients may be requested to shower before receiving injections in high-risk circumstances.
8	Procedures should be performed with the minimal number of personnel to avoid or diminish "unnecessary" exposure of hospital staff to patients and identify specific roles that can be carried out remotely. Only those fundamental to the physician-patient interaction should be permitted to enter the hospital and patient care sites.
9	Follow-up cases do not typically require a complete physical examination.
10	Visually inspect body fluids or damage.
11	Except in demanding circumstances, deep sedation that may necessitate airway support should be avoided.

diseases. US was considered the method of choice in imaging peripheral synovitis.⁵ Furthermore, US-imaging is gaining fame thanks to the last classification criteria for RA issued by the ACR and EULAR in 2010.⁹⁷

Interventional Rheumatologists: Crosstalk with Other Specialists

The reported frequency of rheumatologists performing US was widely varied across member countries of the EULAR, ranging from >80% in 6% of countries to <10% in 15% of countries. Most experts mention that their national rheumatology societies arrange MSUS workshops, while courses in MRI or CT were less commonly reported.⁹⁸

Egyptian society of musculoskeletal and neuromuscular sonography (ESMNS)⁹⁹ based in Minia governorate has been developed and enforced in 2019. In collaboration with the Arab league of musculoskeletal, neuromuscular and spine ultrasound (ALMNSU), and as a promising step, the 1st hybrid international conference was held in Cairo, Egypt (1st–2nd Dec. 2021) on musculoskeletal, neuromuscular and spine ultrasound in rheumatology in close collaboration with colleagues in the fields of radiodiagnosis, anesthesia and pain management as well as orthopedic surgery. The conference included many hands-on workshops in order to affirm the ongoing continuous educational role, as well as the illustrated lectures on the emerging importance of interventional imaging in rheumatology (III-R). Among the ESMNS objectives was the development of a consensus-based comprehensive and practical framework on standardized procedures for MSUS imaging in rheumatology in Egypt in agreement with the EULAR standardized protocols for US imaging.⁶ Moreover, the conference call was compelling to determine the need for interventional-imaging management guidelines for the rheumatic diseases patients during the coronavirus disease-2019 (COVID-19) pandemic. Currently in Egypt there are around 100 trained rheumatologist ultrasonographers with various grades of skills and 50 of them with an international base and around 10 are EULAR certified MSUS trainers.

The New Portable US

Current and future progress in medical ultrasound have made the tool extensively pertinent and the new cart-based and pocket size devices have allowed for applicable POC US examinations in various medical specialties. It is promptly executed as a real-time measure helping the physician in diagnosis and needle guidance for percutaneous procedures. The procedure can be performed bedside or at any location that the patient may be present.¹⁰⁰

On comparing POC to the conventional cart-based US machine, a musculoskeletal diagnosis using portable hand-held US was equivalent in spite the limitations. Improvement in the equipment and technology may allow widespread consideration in the near future.¹⁰¹

Conclusion

In conclusion, imaging modalities, in particular, MSUS provided their expanding role in rheumatology. The application of interventional imaging in the daily clinical practice of rheumatology seems inevitable and a closely reachable goal. The proposed overview aimed to help interventional rheumatologists perform the best and safest practice during these hard times. The current manuscript is intended to serve as a foundation for continued dialogue on best practices. Such task may be considered in collaboration with the Egyptian College of Rheumatology (ECR) that has been working on presenting the national spectrum of rheumatic diseases since 2017 and calls for the emergence of the “Egyptian College of Interventional Imaging in Rheumatology” in order to narrow the gap among rheumatologists in easy dealing with imaging tools and in making US a crucial component of daily routine practice.

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