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Original article

Ultrasonography for the diagnosis of tendinitis and electromyography for the diagnosis of peripheral neuropathy and upper limb radiculopathy - rheumatologists' perspectives☆

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ABSTRACT

Objective: To ascertain the value ascribed by Brazilian rheumatologists to ultrasonography (US) for diagnosing tendinitis and to electromyography (EMG) for diagnosing peripheral neuropathy and upper limb radiculopathy.
Material and methods: In total, 165 rheumatologists answered an anonymous survey (sent via the internet) concerning the two exams, with respect to the following characteristics: reliability, diagnostic accuracy, the importance and necessity of these tests for diagnostic confirmation, and the credibility and training of the professionals who perform the tests.
Results: The study revealed that most of the rheumatologists recognised that these exams are operator-dependent, that clinicians do not rely entirely on the results, that these exams are not mandatory for the diagnoses listed, and that professionals who perform these exams should be better trained to provide reliable results.
Conclusions: The Brazilian rheumatologists believe the following: the results of these exams should be interpreted with caution and are not definitive for diagnosis; musculoskeletal US and EMG should be performed by trained professionals; and there must be better preparation of the professionals who perform these exams.

☆ Study conducted by the Commission of Occupational Rheumatology of the Brazilian Society of Rheumatology, São Paulo, SP, Brazil.

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Ultrassonografia no diagnóstico da tendinite e eletroneuromiografia no diagnóstico da neuropatia periférica e da radiculopatia do membro superior – visão do reumatologista

RESUMO

Objetivo: Averiguar o valor que os reumatologistas brasileiros conferem ao exame de ultrassonografia para o diagnóstico de tendinite e ao exame de eletroneuromiografia para o diagnóstico da neuropatia periférica e da radiculopatia dos membros superiores.
Material e métodos: No total, 165 reumatologistas responderam a uma pesquisa de opinião anônima (enviada pela internet), sobre diversas situações relativas aos dois exames, no que diz respeito aos seguintes questionamentos: confiabilidade, precisão no diagnóstico, importância e necessidade desses exames para confirmação diagnóstica e credibilidade e treinamento dos profissionais que executam os exames.
Resultados: O estudo revelou que a maioria dos reumatologistas reconhece que esses exames são operador-dependentes, que não confia integralmente nos resultados observados, que tais exames não são imperativos para os diagnósticos elencados, e que os profissionais que executam esses exames deveriam ser mais bem treinados para fornecer resultados mais confiantes.
Conclusão: Para os reumatologistas brasileiros, os resultados desses exames devem ser interpretados com cautela e não são definitivos para o diagnóstico; a ultrassonografia musculoesquelética e a eletroneuromiografia devem ser realizadas por profissionais capacitados; deve haver melhor preparo dos executores desses exames em nosso meio.

Palavras-chave:
Ultrassonografia
Eletroneuromiografia
Tendinite
Neuropatia
Radiculopatia

Introduction

Ultrasonography (US) and electromyography (EMG) are complementary exams with several applications in daily medical practice. In the context of litigation, these exams are among the tests most frequently observed in labour disputes to prove the alleged diseases (mostly in the upper limbs), particularly within the context of repetitive strain injury (RSI) or work-related musculoskeletal disorders (WMSDs).

These two methods have markedly different clinical indications but share the fact that they are fully operator-dependent. Healthcare personnel who perform these exams should be medical doctors and should have knowledge of musculoskeletal anatomy, neuroanatomy, electrophysiology, and locomotor system pathology, as well as an understanding of the relevant principles and techniques.[1]

US consists of an imaging test that dispenses radiation and is based on recording the image obtained from the reflection of high frequency sound waves emitted by a device called an echograph.[2] Transducers are used to convert electrical pulses into mechanical signals, and vice versa. The frequency bands commonly used to evaluate the tendons range between 5 and 10 MHz. The transducer format is important because tendons are mostly elongated and have an internal fibrillar architecture that reflects the ultrasonic beam with different intensities and directions, thereby requiring a linear transducer geometry.[3,4]

The term "tendinitis" suggests an inflammatory process in the tendon. When the inflammation is restricted to the sheath surrounding certain tendons, the process is called "tenosynovitis". However, there is no evidence of an inflammatory process in most histopathological, biochemical, or molecular studies that use the term tendinitis.[5-8] Therefore, several authors have suggested that the best term to be used is "tendinosis", which means a degenerative process of the tendon.[9,10]

The precise nature of the degenerative process is still a matter of debate. There are several factors that contribute to tendinosis, including glycosaminoglycan accumulation, calcification, and lipid accumulation. These factors are also found in asymptomatic tendons and do not necessarily suggest the presence of disease.[11-14]

The term "tendinopathy" has been used by radiologists to describe various situations affecting the tendons, including tendon rupture, chronic pain, degenerative changes, and other sequelae. This term does not assume the pathophysiological knowledge of a possible underlying disease.

Because US is an operator-dependent exam, a false-positive result is a variable that cannot be neglected when considering the diagnosis of tendinitis.[15,16]

Contributing factors for false-positive results are: improper technical handling, the short duration of the exam, and the operator's lack of anatomical knowledge. Furthermore, improper placement of the US image transducer can create a false image suggestive of tendinitis. This phenomenon is called anisotropy. The tendon is an anisotropic structure, that is, its reflection varies with the angle of incidence of the sound wave by the US transducer. If the sound wave beam is oblique to the tendon, then the reflection will be smaller, resulting in areas of artifactual hypoechogenicity, which can be mistaken for tendinitis. This anisotropic phenomenon was described in 1958 by Dussik.[17]

Anisotropy has been a frequent occurrence and is one of the responsible factors for the false-positive results of ten-

dinitis and tenosynovitis.[18,19] It is also well established that wide inter- and intra-operator variations exist among musculoskeletal US results.[20-24]

For these and other reasons, any changes found on US should be interpreted with caution and should not be overvalued in explaining clinical symptoms, as these changes may not be related to the physical findings.[25]

EMG is a technique for monitoring bioelectric phenomena occurring in the cell membranes of skeletal muscle fibres. The depolarisation produces electrical activity that manifests as motor unit action potential, which is graphically recorded as an electromyogram. The EMG records the electrical activity present during muscle contraction, which is caused by neuromuscular activation under normal conditions.[26,27]

The EMG signal is the algebraic sum of all detected signals in a given area and may be affected by muscular, anatomic, and physiologic properties, as well as by peripheral nervous system control and the instrumentation used to acquire the signals. The EMG record allows for observing the electrophysiological behaviour of muscles under different physiological and pathological conditions. The exam includes the insertion of needle-shaped electrodes into the skeletal muscles or the use of surface electrodes that send electrical signals to the EMG device, corresponding to the ion exchange occurring at the cellular level and recording the activity of isolated motor units at rest or during exercise. The signals obtained are amplified and displayed on a computer screen.[28,29]

The factors responsible for false-positive results from an upper limb EMG include (but are not limited to) the following: electric grid interference from the environment in which the test is performed; cold hands; the patient's emotional state (stress, worry, anxiety); the carpal dimensions and weight (particularly for median neuropathy or carpal tunnel syndrome); and technical failures.

Although the systematisation of the clinical history and of the semiology has intrinsic values that are technically uncontested, the emergence of increasingly sophisticated complementary diagnostic methods might give the layperson a false notion that these procedures determine the final diagnosis.

Specifically regarding tendinitis and the neuropathies, which are common subjects of labour disputes (in which the physician may inadvertently be considered an arbitrator), the supremacy of the clinical history and the physical examination is evident. Strict observation of the symptoms, utilisation of physical examinations with specific semiotic manoeuvres, verification of the eventual association between the muscle-tendon units used in work-related activities and the muscle-tendon unit that is injured, questions about the work organisation and the work environment, and the possible association between systemic diseases and congenital variations are imperative aspects. These factors are just a few of the parameters that should not be ignored, under the penalty of incurring a medical misdiagnosis that could translate into a pension burden, among other consequences.

To assess the perception of experts regarding these two complementary exams that are employed to evaluate tendinitis, compressive neuropathies, and upper limb radiculopathy, an opinion survey was conducted using a questionnaire constructed with assertions about these methods.

Materials and methods

The study was conducted through a questionnaire prepared by the Commission for Occupational Rheumatology of the Sociedade Brasileira de Reumatologia (Brazilian Society of Rheumatology, SBR); the survey was sent to rheumatologists via an e-mail from the SBR through the "SBR - NEWSLETTER".

The inclusion criteria for the rheumatologists who received the questionnaire were to be a member of the SBR, to have his/her current address updated with the institution, and to work as a rheumatologist in both private and public sectors. The exclusion criteria were based on non-observance of the inclusion criteria, which was the safest way to ensure data quality.

The questionnaire consisted of 11 items, with two types of response: "agree" and "disagree". The present study addressed different aspects of situations involving the two exams (US and EMG), such as the reliability, variability of the findings, necessity of performing these tests to diagnose the diseases (tendinitis, peripheral neuropathy, and radiculopathy), competency of the professional performing these exams, and training needs of the professional.

All of the responses were answered through the website www.surveymonkey.com, with a link available in the e-mail sent by the SBR (NEWSLETTER), which was accessible only by the rheumatologists. The completed questionnaire was sent to the SBR Rheumatology Occupational Commission for analysis. The data collection period occurred from June, 2011 to September, 2011. All of the collected information was deposited in a database.

The number of study participants was calculated by Student's *t* test to obtain the number necessary for a homogeneous and significantly representative sample. Based on the 1,448 rheumatologists who were active members in the SBR (data provided by the SBR), a sampling error of 5% (expected standard), a confidence level of 95%, and a minimum percentage of 10%, it was determined that the sample should contain more than 147 respondents to be considered representative.

The statistical analysis was descriptive and inferential. The percentages in each response option was marked for each question and performed in isolation for each assertion.

Results

The questions and answers are listed in Table 1. In total, 165 rheumatologists participated in the study. Therefore, the sample of 165 respondents has a confidence level of 95% in terms of statistical significance and, consequently, represents the opinions of Brazilian rheumatologists.

A strong concordance of opinion was observed. Four questions were virtually unanimous in their answers. Almost all the participants agreed that US and EMG are operator-dependent exams (98% and 84%, respectively), which provide results that are variable and dependent on the quality of learning of each professional performing the exam.

Approximately one-half of the respondents (44%) did not trust the US results for the diagnosis of tendinitis, and the vast majority (87%) did not consider this exam indispensable

Table 1 – Survey questions and answers.

Question	Answer	Result
1. Musculoskeletal ultrasound is an operator-dependent examination and therefore can yield great variability in the conclusions from this type of imaging exam.	Agree Disagree	161 (98%) 4 (2%)
2. I trust the result of ultrasound examination for the diagnosis of tendinitis.	Agree Disagree	92 (56%) 73 (44%)
3. The ultrasound is an essential exam to confirm or exclude the diagnosis of tendinitis in the upper limb.	Agree Disagree	22 (13%) 143 (87%)
4. Electromyography is an operator-dependent exam and therefore can show wide variability in the diagnostic reports.	Agree Não concordo	139 (84%) 26 (16%)
5. I trust the electromyography results for the diagnosis of radiculopathy or peripheral neuropathy of the upper limb.	Agree Disagree	110 (67%) 55 (33%)
6. Electromyography is an indispensable exam for confirming or excluding the diagnosis of radiculopathy or peripheral neuropathy of the upper limb.	Agree Disagree	55 (33%) 110 (67%)
7. I consider ultrasound and electromyography results crucial to my diagnostic conclusions.	Agree Disagree	44 (27%) 121 (73%)
8. I need to technically recognise the work of the professional conducting the electromyography and ultrasound exams, to accept the results as accurate.	Agree Disagree	148 (90%) 17 (10%)
9. I consider trustworthy and fully accept all of the musculoskeletal electromyography and ultrasound exam results that I receive.	Agree Disagree	3 (2%) 162 (98%)
10. The sonographer should receive better training to obtain reliable results for the diagnosis of tendinitis.	Agree Disagree	161 (98%) 4 (2%)
11. The electromyographer should receive better training to obtain reliable results for the diagnosis of radiculopathy or peripheral neuropathy.	Agree Disagree	161 (98%) 4 (2%)

for the diagnosis. Exactly one-third of the rheumatologists did not trust the EMG results for the diagnosis of radiculopathy or peripheral neuropathy of the upper limb, and exactly two-thirds avoid these complementary exams to make their diagnoses. Nearly three-quarters (73%) of the respondents indicated that these two exams are not crucial for the diagnosis.

The vast majority (90%) required information regarding the technical capacity of the professional performing these exams, to consider the medical reports credible. This observation most likely justifies the answers to questions 2 and 5, which are related to the confidence in the results of these tests (Table 1).

The most decisive answers, provided by 98% of the study participants, indicate that the rheumatologists do not consider reliable and do not fully accept the results of musculoskeletal EMG and US; furthermore, there should be better training of the sonographer and electromyographer to obtain more reliable results with these complementary exams.

Discussion

Some physicians and especially patients rely on the results of complementary tests. In the case of tendinitis, peripheral neuropathies, and radiculopathy, the most requested diagnostic exams are US and EMG.

Such exams now have greater weight in the decision of judges in disputes related to occupational diseases. Among the complementary exams attached to the case files or requested by the court experts, US and EMG are the most prevalent and the most cited as diagnostic confirmation in their conclusions. Often, these exams correspond to the only documentary "evidence". Other times, these exam results drive and influence the clinical propaedeutic, even when no symptoms have been reported in the previous medical history.

The overestimation of these exams has been a matter of debate and confrontation in litigious disputes and when justifying an absence from work to the social security institution. Many lay people believe that the US and EMG results are definitive for the diagnosis of tendon and nerve diseases. During a labour dispute, it is critical that the medical expert knows, despite the importance of an expert diagnosis, how to clarify the diagnostic state of the art and the possible confounders.

For example, US of the shoulder tendons has a sensitivity of 50%, specificity of 87%, and efficiency of 56%. Echogenicity variations can be found in normal tendons. The echogenicity increases when the ultrasound beam falls perpendicular to the tendon and decreases when the ultrasound beam is received obliquely; moreover, some hypoechoic areas located in tendon insertion regions may be artefacts caused by the obliquity of the tendon in this region.[30]

False-positive sonographic findings of the rotator cuff can be caused by the technique (anisotropy, transducer positioning, or shadowing caused by the deltoid septum), the anatomy (rotator cuff interval, supraspinatus/infraspinatus interface, musculotendinous junction, or fibrocartilaginous insertion), or by other factors (criteria for the diagnosis of rotator cuff lesions, tendon heterogeneity, shadowing caused by scar tissue or calcification, or thinning of the rotator cuff).[31]

By contrast, a careful medical history and an adequate semiology can contribute to 90% of the correct diagnosis of shoulder tendinitis, with a sensitivity of 91.3% and specificity of 88.9%, which may be confirmed by surgery, without the aid of any complementary examination.[32] A good clinical propaedeutic, therefore, surpasses the imaging exam in this situation.[33]

The same conclusion applies to false-positive sonographic results for tendinitis in the elbow and wrist. US of the common extensor tendon has a high sensitivity but a low specificity in detecting lateral epicondylitis,[34] and the hypoechoic appearance of anisotropy can be mistaken for wrist tenosynovitis by less capable professionals.[35]

A study conducted in Brazil, which evaluated the correlation of clinical findings with the reports of complementary exams, revealed that US yielded high rates of false-positives

(71%) and false-negatives (4%) compared with the detailed clinical examinations performed during the same period. The most common false-positive results were tenosynovitis diagnosed in the medial and/or lateral epicondyle of the humerus, where there is no synovial tissue, and in the proximal third of the forearm (at the level of the flexor muscle), where neither tendons nor synovia exist.[36]

Such findings do not diminish the importance of US as a complementary diagnostic method but constitute evidence against its inadequate use as a method that by itself can provide a diagnosis.

The same can be stated regarding EMG. In the same Brazilian study cited earlier, this exam yielded a significant rate of false-positives for carpal tunnel syndrome in patients with complaints of nonspecific and generalised paraesthesias in their upper limbs.[36]

How such exams can facilitate the complete characterisation of peripheral neuropathies, including the principles of electrodiagnostics and how to detect and interpret the results, has been widely discussed.[37] The assessment of nerve conduction represents the diagnostic component of peripheral neuropathy or radiculopathy. However, this assessment requires great attention to detail because the equipment and the professional performing the exam can make mistakes that affect the correct interpretation of the nerve conduction data and the nature of a nerve disease.[38]

Optimising the use of this exam requires a basic understanding of how it works, of when and how to request it, and about its inherent limitations.[39]

With regard to painful musculoskeletal conditions such as tendon and nerve disorders, for which the aim is to make the subjective experience of pain more objective and concrete, we must admit that the attempt to summarise, group, quantify, label, and especially visualise this phenomenon is perfectly understandable. However, because pain is subjective, the attempt to define this symptom topographically within the context of a clinical history and physical examination has not been surpassed by any complementary diagnostic method, which has been irrefutably demonstrated by the scientific literature and by daily medical practice.

This fact is extremely relevant to the scenario of RSI and WMSDs, in which physicians often encounter the subjectivity of self-declared painful conditions, which in most cases do not correlate with the topography of tendinitis, compressive peripheral neuropathy, or radiculopathy and which have discrepantly received such diagnostic labels based solely on the US and EMG results.

Conclusions

Brazilian rheumatologists, aware of the above-discussed facts, agree that US and EMG exams are operator-dependent; moreover, these rheumatologists do not overestimate the results when such tests are performed by professionals whom they do not know or do not trust. In such situations, the rheumatologists do not value many of the reports from these complementary exams for reaching the diagnostic conclusion. These physicians also stated that it is necessary to better prepare some of the professionals who perform these exams.

The results of the present research are in agreement with the literature and provide an alert about certain reports from these complementary exams. The present findings also highlight the fact that, as the description implies, these exams serve only to complement the clinical reasoning. Thus, the art of listening and examining the patient must prevail.[40-42] The semiology should not be set aside and the diagnostic responsibility transferred to an exam that is fully operator-dependent and subject to high inter- and intra-operator variability. Therefore, the old aphorism remains: "Medical propaedeutic is superior to any complementary examination."

Finally, we emphasise the value of these two complementary exams and their favourable use to assist the diagnostic investigation of certain cases, if these tests are performed by technically competent individuals.

Conflicts of Interest

The authors declare no conflicts of interest.

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