Evaluation of focal lesions of the supraspinatus tendon with elastosonography: comparison with B-mode ultrasound and magnetic resonance imaging: our experience

Valutazione delle lesioni focali del tendine del sovraspinato con elastosonografia: confronto con ecografia B-mode e risonanza magnetica: esperienza personale

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SUMMARY

Aim: The aim of the study was to assess the elasticity of the tendon of the supraspinatus in the symptomatic shoulder of patients with clinical suspicion of unilateral focal lesion of the supraspinatus tendon, and to compare the findings with those observed in conventional B-mode ultrasonography (US) and magnetic resonance imaging (MRI).

Methods: Between January and December 2009 both shoulders of 58 patients (mean age 46 years, range 32-58 years) were evaluated by a radiologist. Both shoulders were analyzed with real-time elastosonography and also with US using the same ultrasound machine (EUB - Hitachi 7500) with a high frequency (13 MHz) linear probe. The elasticity of the supraspinatus tendon fibers was evaluated by a semiquantitative score of different colors representing hard tissue (blue) and progressively more elastic tissue (green, yellow, red). Elastosonographic and US findings were evaluated separately by a second radiologist, and those of the affected shoulder compared with those seen after an MRI performed in a period between 2 and 4 weeks after the ultrasound examination. The MRI was evaluated by a third radiologist blinded to the result of elastosonographic and US findings.

Results: Using MRI as the gold standard, the elastosonography correctly diagnosed in seven patients a partial-thickness tear detected by US as simple tendinosis, probably due to the presence of intrasional granulation tissue with echostucture similar to that of the surrounding tendon. Moreover, three cases of intrasubstance partial-thickness tear reported by US proved to be, both with elastosonography and MRI, a full-thickness tear. In all cases (58/58) MRI findings confirmed those of elastosonography, although in some cases the extent of injury appeared greater in MRI, presumably due to the additional high signal given by perilesional edema.

Conclusion: Elastosonography is a sensitive method for diagnosis of focal lesions of the supraspinatus tendon, in particular degenerative partial and full thickness tears.

KEY WORDS: Magnetic resonance imaging - Shoulder - Ultrasound.
RIASSUNTO
Obiettivo. Scopo dello studio era valutare l’elasticità del tendine del sovraspinato nella spalla sintomatica di pazienti con sospetto clinico di rottura unilaterale della cuffia dei rotatori, e comparare i reperti riscontrati con quelli dell’ecografia convenzionale (ultrasound, US) e della risonanza magnetica (RM).
Metodi. Nel periodo compreso tra gennaio e dicembre 2009 sono state esaminate da un radiologo entrambe le spalle di 58 pazienti (età media: 46 anni; range 32-58 anni) sia con modulo elastosonografico in real-time che in B-mode tramite uno stesso ecografo (EUB - Hitachi 7500), usando una sonda lineare a elevata frequenza (13 MHz). L’elasticità delle fibre tendinee del sovraspinato è stata valutata mediante uno score semiquantitativo di colori differenti rappresentanti tessuto rigido (blu) e tessuto via via più elastico (verde, giallo, rosso). I reperti riscontrati con elastosonografia ed ecografia convenzionale sono stati valutati separatamente da un secondo radiologo e quelli della spalla affetta comparati successivamente con quelli riscontrati a un esame RM eseguito in un arco temporale compreso tra 2 e 4 settimane dopo l’esame ecografico. L’esame RM è stato valutato da un terzo radiologo in cieco sul risultato dell’esame ecografico precedentemente eseguito.
Risultati. Usando come gold-standard l’esame RM, l’elastosonografia ha correttamente diagnosticato in sette pazienti una lesione parziale rilevata come semplice tendinosi dall’esame B-mode verosimilmente a causa della presenza di tessuto di granulazione intraligamentare ad ecocarattere simile a quello tendineo circostante. Inoltre, tre casi di lesione intratendinea riscontrati con l’US sono risultati essere, sia all’elastosonografia che all’US, una lesione a tutto spessore. In tutti i casi (58/58) i reperti dell’esame RM hanno confermato quelli dell’elastosonografia, anche se in alcuni casi l’ampiezza della lesione appariva maggiore in RM, presumibilmente a causa dell’elevato segnale aggiuntivo dato dall’edema perilesionale.
Conclusioni. L’esame elastosonografico è un metodo sensibile per la diagnosi di lesioni del tendine del sovraspinato, in particolare di quelle parziali e a tutto spessore su base degenerativa.
Parole chiave: Risonanza magnetica - Spalla - Ecografia.

Elastosonography is a recent ultrasound technique that can evaluate tissue elasticity ¹ thanks to the principle that tissue compression produces a stress within the tissue that is less in rigid tissue and greater in elastic tissue. Elastosonography can demonstrate different degrees of tissue stress by comparing pairs of images before and after the compression is applied to the tissue.² ³ Furthermore, the tissue stress is calculated in real-time by the ultrasound technician, who thus shows different degrees of elasticity on a conventional ultrasound image. Recent technological developments of this technique, such as the calculation of the lateral and axial stress of the tissue structure under compression, have allowed improved spatial resolution, a reduction of artifacts, and improved accuracy during routine examinations.⁴ It is known that in certain cases, conventional ultrasound is completely unable to distinguish or has difficulty distinguishing pathological tissue when it has the same echogenicity as the surrounding healthy tissue, and it is also known that inflammatory and cancer processes cause a variation of tissue elasticity.⁵ De Zordo et al.⁶ have demonstrated that elastosonography applied to patients with lateral epicondylitis of the elbow can distinguish tendinous and peritendinous alterations, with a good correlation with the findings of conventional and clinical ultrasound.

L’elastosonografia rappresenta una recente tecnica ecografica capace di valutare l’elasticità tessutale grazie al principio che la compressione tessutale produce una sollecitazione all’interno del tessuto, che è minore in quello rigido e maggiore in quello elastico. L’elastosonografia può dimostrare diversi gradi di sollecitazione tessutale comparando coppie di immagini prima e dopo che la compressione venga applicata sul tessuto.² ³ Inoltre, la sollecitazione tessutale viene calcolata in tempo reale dall’ecografo che mostra così diversi gradi di elasticità su un’immagine ecografica convenzionale. Recenti sviluppi tecnologici di questa tecnica, come il calcolo della sollecitazione laterale e assiale della struttura tessutale sotto compressione, hanno permesso una migliore risoluzione spaziale, una riduzione degli artefatti, ed una migliorata accuratezza durante gli esami di routine.⁴ È noto che l’ecografia convenzionale, in certi casi, non riesce del tutto o con difficoltà a distinguere tessuto patologico quando esso presenta la stessa ecogenicità del tessuto sano circostante, così come è noto anche che processi flogistici e tumorali determinano una variazione dell’elasticità tessutale.⁵ De Zordo et al.⁶ hanno dimostrato che l’elastosonografia applicata a pazienti con epicondilità laterale del gomito è capace di distinguere alterazioni tendinee e peritendinee, con buona correlazione coi reperti dell’ecografia convenzionale e quelli clinici.

In letteratura, tuttavia, non esiste a tutt’oggi
In the literature, however, to date there is no work on elastosonography applied to the evaluation of the supraspinatus tendon in patients where there is a clinical suspicion of rupture of the rotator cuff; the aim of our work is, therefore, to evaluate the role of this method in this field of application and its sensitivity and specificity with respect to the magnetic resonance imaging (MRI) examination, which is defined as the gold standard.

**Materials and methods**

During the period between January and December 2010, on a prospective basis, both shoulders (N.=116) of 58 patients, (30 men and 28 women; average age 46 years; range 32-58 years) with a clinical suspicion of unilateral rupture of the rotator cuff were examined. None of the patients who had been informed of the purpose of this study had undergone locoregional minimally invasive therapies, such as shock waves or cortisone infiltrations, but only conservative oral treatment with non-steroidal anti-inflammatory drugs. Furthermore, no patient had a history of tendon rupture or systemic inflammatory disorders such as rheumatoid arthritis. The clinical evaluation was performed through the Jobe test (patient with upper limbs in abduction at 90° and 30° of anterior flexion in internal rotation, asked to exert a force from low to high while the examiner applies resistance; the test is considered negative if the patient resists the force, and vice versa it is considered positive for tendinitis if he shows pain and positive for rupture if he shows muscular insufficiency). The pain reported by the patients was recorded with a visual analog scale (VAS, score from 0 to 10).

**Imaging**

Two radiologists (R.S., A.I.), blinded with regard to the clinical findings, examined both shoulders of each patient by ultrasound, model EUB-7500 HV (Hitachi Medical Systems Europe, Zug, Switzerland), using a multi-frequency linear probe (6-13 MHz), in both B-mode and, simultaneously, with a real-time elastographic module, using a double window on the monitor. In order to evaluate the supraspinatus tendon, the patients were asked to position their forearm posteriorly, placing the palm of their hand on the upper side of the iliac wing, with the elbow flexed and directed posteriorly.

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The probe was positioned both parallel and transversal to the longitudinal axis of the tendon. A visual indicator placed on the screen indicated the optimal compression force in the region of interest, thereby avoiding errors from excessive or insufficient compression. Every elastasonographic scan was repeated multiple times (at least three cycles of compression-decompression) in order to obtain reproducible results.

The images obtained were sent via Local Area Network (LAN) to our institute's RIS/PACS system (MedRIS Elefante\Impax System, AGFA Healthcare System), and subsequently separated in a random way for blind evaluation by two other radiologists (F.C., M.M).

The elasticity of the tendinous fibers of the supraspinatus was evaluated through a semi-quantitative score of different colors representing rigid tissue (blue) and progressively more elastic tissue (green, yellow, red), which are observed in the region of interest of the screen during a compression-decompression cycle.

Any tendinous lesions, measured with the electronic calipers provided with the PACS software, were classified in both B-mode and with elastasonography in this way:

- “full thickness”: whenever a solution of the tendon continuity is observed that crosses the entire thickness of the tendon, reaching both the bursal side and the joint side;
- “partial-bursal”: whenever the rupture is limited only to the bursal side;
- “partial-joint”: whenever the rupture is limited only to the joint side;
- “partial-intratendinous”: whenever the rupture is limited to within the tendinous thickness, without affecting either the joint side or the bursal side.

In particular, the following grading system of the focal lesions was used in the elastasonography:

0: blue or green (rigid) tendon corresponding to a healthy tendon;
1: tendon with yellow area, corresponding to a tendon with low-medium grade tendinosis;
2: tendon with orange area, corresponding to a tendon with a high degree of tendinosis;
3: tendon with red area, corresponding to a tendon with lesion, whether it is partial or full-thickness.

This grading system was also applied to the findings obtained with B-mode ultrasound, making reference to areas of echostructural inhomogeneity of the tendon's fibrillar architecture.
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Introduction

The findings detected with elastosonography and conventional ultrasound in the affected shoulder were compared with those of the presumed healthy contralateral shoulder and subsequently with those detected during an MRI examination of the affected shoulder performed between 2-4 weeks after the ultrasound examination. The MRI examination was performed with a high-field 1.5 T machine [GE Signa Excite HD, Milwaukee, WI, USA], acquiring sequences DP-pesated (TR/TE 800/26 ms), T2-pesated with suppression of the fat signal (TR/TE 2860/90 ms), STIR (TR/TE/TI 4140/30/80 ms), and GRE (TR/TE 30/15 ms). All of the sequences were characterized, during acquisition, by a number of samplings in the direction of the reading and a number of phase encodings in the direction of the greatest phase encoding of 256; the reconstruction of the image therefore occurred on a matrix of 512 x 512 pixels. The thickness of the layer and the reconstruction interval used were between 4 mm and 0.4 mm in all of the sequences. All of the investigations were carried out without the intravenous administration of a paramagnetic contrast agent containing gadolinium. The images obtained were sent via LAN to our institute's RIS/PACS system for evaluation by two radiologists (R.S., F.C.), blinded with regard to both the conventional and elastosonographic ultrasound findings.

The same tendon alteration classification and grading systems as those already discussed for B-mode ultrasound and elastosonography were used; the electronic calipers provided with the PACS software were used for their measurement.

For the statistical analysis, the values of the dimensions of all of the alterations, quantified in an objective way, were reported as the mean ± the standard deviation. The significance of the results was calculated using the paired t test with P<0.01.

Results

Evaluation of the history and clinical objectivity of the patients

All of the subjects (100%) reported typical symptoms that had begun 12.31±4.98 weeks after an ultrasound examination of the affected shoulder.

The findings detected with elastosonography and conventional ultrasound in the affected shoulder were compared with those of the presumed healthy contralateral shoulder and subsequently with those detected during an MRI examination of the affected shoulder performed between 2-4 weeks after the ultrasound examination. The MRI examination was performed with a high-field 1.5 T machine [GE Signa Excite HD, Milwaukee, WI, USA], acquiring sequences DP-pesated (TR/TE 800/26 ms), T2-pesated with suppression of the fat signal (TR/TE 2860/90 ms), STIR (TR/TE/TI 4140/30/80 ms), and GRE (TR/TE 30/15 ms). All of the sequences were characterized, during acquisition, by a number of samplings in the direction of the reading and a number of phase encodings in the direction of the greatest phase encoding of 256; the reconstruction of the image therefore occurred on a matrix of 512 x 512 pixels. The thickness of the layer and the reconstruction interval used were between 4 mm and 0.4 mm in all of the sequences. All of the investigations were carried out without the intravenous administration of a paramagnetic contrast agent containing gadolinium. The images obtained were sent via LAN to our institute's RIS/PACS system for evaluation by two radiologists (R.S., F.C.), blinded with regard to both the conventional and elastosonographic ultrasound findings.

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Risultati

Valutazione dell’anamnesi e dell’obiettività clinica dei pazienti

Tutti i soggetti (100%), riferivano una sintomatologia tipica, insorta da 12,31±4,98 settimane (range 5-24 settimane), caratterizzata dalla lesione tendinea e dalla limitazione del movimento della spalla.

Riscontro di patologia tendinea e valutazione del grading di lesione

Le Tabelle I, II riassumono i risultati.

Per l’analisi statistica i valori delle dimensioni di tutte le alterazioni quantizzate in modo oggettivo sono stati riportati come la media ± la deviazione standard. La significatività dei risultati è stata calcolata usando il paired t test con P<0.01.
ago (range: 5-24 weeks), characterized by pain located in the anterior-superior region of the shoulder during elevation and abduction movements. The Jobe test was positive for unilateral pathology of the rotor cuff with VAS equal to 7.5±2.1 (range: 5-10). No abnormal finding was clinically found in the asymptomatic contralateral shoulder with the Jobe test.

**Tendon pathology finding and evaluation of the lesion grading**

Tables I and II summarize the results.

The elastosonography showed rigid tendon structures, corresponding to the blue color (Figure 1A, B), in the asymptomatic shoulder in 53/58 (91.4%) of the patients, while the remaining 5/58 (8.6%) cases showed a first degree tendon alteration; in the symptomatic shoulder, however, the elastosonography demonstrated alterations in tendon elasticity of the first degree in 5/58 (8.6%) cases (Figure 2A, B), second degree in 3/58 (5.2%) cases and third degree in 50/58 (86.2%) cases (Figure 3).

B-mode ultrasound demonstrated signs of tendon alterations of the first degree in the symptomatic shoulder of 5/58 (8.6%) patients, second degree in 10/58 (17.2%) patients, and third degree in 43/58 (74.2%) patients, while in the asymptomatic shoulder, it detected a first degree alteration in 3/58 (5.2%) patients and a healthy tendon in the remaining 55/58 (94.8%) patients.

The MRI findings were similar to those of elastosonography.

**Measurement of the tendon lesions**

The average size of the intratendinous partial lesions was equal to 0.4±0.3 cm with ultrasound (N.=9), 0.3±0.2 cm with elastosonography (N.=10), and 0.3±0.2 cm with MRI (N.=10).

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**Table I.**—Findings reported with the various methods object of our study (percentage values in brackets).

<table>
<thead>
<tr>
<th>Findings</th>
<th>Method</th>
<th>B-mode US (N.=58)</th>
<th>Elastosonography (N.=58)</th>
<th>MRI (N.=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tendinosis without tears</td>
<td></td>
<td>15 (25.9)</td>
<td>8 (13.8)</td>
<td>8 (13.8)</td>
</tr>
<tr>
<td>Full-thickness tear</td>
<td></td>
<td>27 (46.5)</td>
<td>30 (51.7)</td>
<td>30 (51.7)</td>
</tr>
<tr>
<td>Intrarubstance partial-thickness tear</td>
<td></td>
<td>9 (15.6)</td>
<td>10 (17.2)</td>
<td>10 (17.2)</td>
</tr>
<tr>
<td>Articular side partial-thickness tear</td>
<td></td>
<td>6 (10.3)</td>
<td>9 (15.6)</td>
<td>9 (15.6)</td>
</tr>
<tr>
<td>Bursal side partial-thickness tear</td>
<td></td>
<td>1 (1.7)</td>
<td>1 (1.7)</td>
<td>1 (1.7)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>58 (100)</td>
<td>58 (100)</td>
<td>58 (100)</td>
</tr>
</tbody>
</table>

**Table II.**—Grading of tendon disorders with the various methods object of our study (percentage values in brackets).

<table>
<thead>
<tr>
<th>Lesion grading Affected shoulder (N.=58)</th>
<th>Healthy shoulder (N.=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-mode ultrasound</td>
<td></td>
</tr>
<tr>
<td>0 (healthy tendon)</td>
<td>0</td>
</tr>
<tr>
<td>1 (low-medium grade tendinosis)</td>
<td>5 (8.6)</td>
</tr>
<tr>
<td>2 (high grade tendinosis)</td>
<td>10 (17.2)</td>
</tr>
<tr>
<td>3 (tear)</td>
<td>43 (74.2)</td>
</tr>
<tr>
<td>Elastosonography</td>
<td></td>
</tr>
<tr>
<td>0 (healthy tendon)</td>
<td>0</td>
</tr>
<tr>
<td>1 (low-medium grade tendinosis)</td>
<td>5 (8.6)</td>
</tr>
<tr>
<td>2 (high grade tendinosis)</td>
<td>3 (5.2)</td>
</tr>
<tr>
<td>3 (tear)</td>
<td>50 (86.2)</td>
</tr>
<tr>
<td>MR</td>
<td></td>
</tr>
<tr>
<td>0 (healthy tendon)</td>
<td>0</td>
</tr>
<tr>
<td>1 (low-medium grade tendinosis)</td>
<td>5 (8.6)</td>
</tr>
<tr>
<td>2 (high grade tendinosis)</td>
<td>3 (5.2)</td>
</tr>
<tr>
<td>3 (tear)</td>
<td>50 (86.2)</td>
</tr>
</tbody>
</table>

1A, B), a carico della spalla asintomatica in 53/58 (91.4%) pazienti, mentre nei restanti 5/58 (8.6%) casi ha evidenziato una alterazione tendinea di I grado; nella spalla sintomatica, invece, l’elastosonografia ha dimostrato alterazioni dell’elasticità tendinea di I grado in 5/58 (8.6%) casi (Figura 2A, B), di II grado in 3/58 (5.2%) casi e di III grado in 50/58 (86.2%) (Figura 3).

L’US B-mode ha dimostrato segni di alterazioni tendinee di I grado nella spalla sintomatica di 5/58 (8.6%) pazienti, di II grado in 10/58 (17.2%), e di III grado in 43/58 (74.2%), mentre nella spalla asintomatica in 3/58 (5.2%) ha riscontrato un’alterazione di I grado e un tendine sano nei rimanenti 55/58 (94.8%).
The size of the partial lesions affecting only the joint side was equal, on average, to 0.7±0.5 cm with ultrasound (N.=6), 0.6±0.4 cm with elastosonography (N.=9) and 0.6±0.4 cm with MRI (N.=10) (Figure 4).

The size of the only partial lesion affecting only the bursal side was equal to 0.4 cm with ultrasound (N.=1), 0.5 cm with elastosonography (N.=1) and 0.5 cm with MRI (N.=1).

The average size of the full-thickness lesions was equal to 1.3±0.9 cm with ultrasound (N.=27), 1.6±0.8 cm with elastosonography (N.=30) and 1.7±0.9 cm with MRI (N.=30) (Figure 5).

Statistical significance of the results obtained

With regard to the measurement of the full-thickness lesions, a statistically significant difference (P<0.01) between ultrasound and elastosonography and between ultrasound and MRI emerged, while a statistically significant difference (P<0.05) did not emerge between elastosonography and MRI.

Statistically significant differences (P<0.01) emerged between ultrasound and elastosonography (and MRI) in the measurement of the in-
tratendinous partial lesions affecting only the joint side.

**Discussion**

The incidence of rupture of the supraspinatus tendon is significantly higher than that of the other tendons of the rotator cuff and, except for a small percentage of cases due to acute trauma, the cause is generally unclear. More often than not, the pathogenesis of the rupture of the supraspinatus tendon is considered to be multifactorial and includes intrinsic degeneration and impingement syndrome, and in any case the subsequent development of the pathology is very similar regardless of its origin, since it is independent. The clinical and radiographic evaluation can suggest the presence of a lesion, and in particular the most important clinical finding is a positive outcome to the impingement test. The X-ray is usually negative in the acute phase and only in the late phases does it show a reduction of the subacromial space and, in the “outlet view” projections, a reduced opacity and size of the supraspinatus muscle as a result of atrophy following rupture. Ultrasound and MRI are, therefore, the methods

Figure 2.—Elastosonographic image (A) shows a tendinosis of the supraspinatus tendon (most green colored with scattered orange-red and blue areas) without lesions; corresponding US image (B) does not show definite signs of tendinosis.

Figura 2. — Immagine elastosonografica (A) che evidenzia una tendinosi del tendine del sovraspinato (colorato per la maggior parte in verde con frammiste aree arancio-rosse e blu) in assenza di lesioni; l’immagine US corrispondente (B) non evidenzia segni definiti di tendinosi.
current used to evaluate the presence or not of a tendon rupture, especially during the acute phase when the radiographic appearance is still negative, so that treatment can be applied as soon as possible. Even though the sensitivity of conventional ultrasound is very high (up to 90% on average, according to the most recent literature data),\(^8\) thanks also to the use of secondary signs such as the irregularity of the osseous cortical profile of the humeral greater tuberosity, the presence of an articular effusion and bursitis associated with the rupture, it is less sensitive and specific for small partial lesions, especially in a situation of tendinous degeneration, and is often operator-dependent.\(^8\)\(^9\)

MRI is also very sensitive and specific (up to 95%) in the diagnosis of rupture of the supraspinatus tendon when compared with the pathology of the space under the acromion and, in the so-called “outlet view”, a reduced opacity and dimension of the supraspinatus muscle due to a tear sequelae.\(^10\) Pertanto, l’US e la RM sono le metodiche attualmente usate per valutare la presenza o meno di una rottura tendinea specie in fase acuta, quando ancora l’aspetto radiografico risulta negativo, in modo da potere applicare una terapia il più precocemente possibile. Anche se la sensibilità dell’US convenzionale risulta molto elevata (fino al 90% in media, secondo i dati della letteratura più recente)\(^8\), grazie anche all’uso di segni secondari come l’irregolarità del profilo corticale osseo e la riduzione dello spessore del tendine, l’immagine coronale RM SE-T2 pesata (C) conferma la lesione parziale non a tutto spessore del versante articolare del tendine del sovraspinato.
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logical findings, however, in many centers it is preferred to use ultrasound as the first level investigation due to the simple fact that it is more economical and available, effectively delegating the MRI examination to cases in which there is discordance between the ultrasound finding and the clinical examination.\(^8,9\)

The presence of tendon tissue affected by degeneration is very difficult or impossible to evaluate with conventional ultrasound, since the degenerated tissue often has the same echostructure as the surrounding healthy tissue.\(^5\) However, it is known that inflammation can cause a variation in tissue elasticity and some studies have demonstrated that real-time elastosonography can be used to differenti-

Anche la RM risulta molto sensibile e specifica (fino al 95%) nella diagnosi di rotura del tendine del sovraspinato se comparata ai reperti patologici, tuttavia in molti centri si preferisce usare l’US come indagine di primo livello per il semplice fatto che quest’ultima risulta più economica e disponibile, delegando l’esame RM di fatto ai casi in cui vi sia discordanza tra reperto ecografico ed esame clinico.\(^8,9\)

La presenza di tessuto tendineo affetto da degenerazione risulta molto difficile o impossibile da valutare con l’US convenzionale, dal momento che il tessuto degenerato spesso ha la stessa ecostruttura del tessuto sano circostante.\(^5\) Tuttavia, è risaputo che una flogosi può determinare una variazione nell’elasticità tessutale ed alcuni
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Our study has confirmed that the tendinous structure of a presumably healthy tendon appears rigid (blue) upon elastosonography, as seen in 55/58 cases, with signs of initial tendinous degeneration (according to the grading system for both elastosonography and B-mode ultrasound as explained in the methods) in the supraspinatus tendon.

Figure 5.—Elastosonographic image (A) shows a full-thickness tear (red areas - arrows) that appears larger than in US image (B) (open arrows); coronal and axial SE-T2w MR images (C, D) correlates better with elastosonography, confirming a large full-thickness lesion of the supraspinatus tendon.

Il nostro studio ha confermato che la struttura tendinea di un tendine presunto sano appare rigida (blu) all’elastosonografia, come visto in 55/58 casi, con segni di iniziale degenerazione tendinosas (secondo il sistema di grading sia elastosono-
remaining three cases, even if they were asymptomatic upon clinical examination.

With conventional ultrasound, the presence of tendinous degeneration results in an area of hypoechochogenicity that corresponds to areas of collagen degeneration and broken fibrils that can be replaced by reparative granulation tissue, which can often assume an echostructure similar to that of the adjacent healthy tendon. This can explain the fact that in the study of the asymptomatic shoulders of the 58 patients, conventional ultrasound showed only three cases of low-medium grade tendinosis with respect to 5 with elastasonography and MRI in the symptomatic shoulders.

Even a partial tendinous rupture can often be filled with scar-forming granulation tissue that assumes an echostructure similar to that of the adjacent tendon, making evaluation with ultrasound difficult; this is reflected in our results since the elastasonography demonstrated that three presumed cases of high degree tendinosis with B-mode ultrasound were in reality partial lesions, one of which affected only the joint side and the other only the bursal side.

Furthermore, four cases of partial lesion detected with B-mode ultrasound were instead, with both elastasonography and MRI, full-thickness lesions.

The findings detected with elastasonography were comparable to those with MRI with regard to the classification and grading of the tendinous alterations detected, even though a difference in the measurement of the lesions between the two methods emerged, especially of the full-thickness ones, which were slightly larger with MRI, probably due to the time elapsed between the two examinations (ca. 2-4 weeks) and the high signal intensity of the perilesional edema that summed with that of the lesion itself.

A possible limitation of this study regards the lack of comparison of the ultrasound and MRI findings with arthroscopy, considered the “gold standard” method with regard to full-thickness and partial tendinous lesions; however, since magnetic resonance is also considered by many authors to be a very sensitive and specific method for these lesions, this limitation is in any case marginal for the purpose of our study, which is to compare elastasonography with standard B-mode ultrasound and not to evaluate the sensitivity of magnetic resonance. Furthermore, arthroscopy is not recommended with regard to the treatment of tendinosis in the absence of lesions, as these pathologies should not be mistaken for a degenerative process in the absence of clinical symptoms. The presence of a degeneration tendineae in US conventionale risulta in un’area di ipoecogenicità che corrisponde a zone di degenerazione collagena e di fibrille rotte che possono essere sostituite da tessuto di granulazione riparativo, che spesso può assumere un’ecostruttura simile a quella del tendine sano adiacente. Questo può spiegare il fatto che nello studio delle spalle asintomatiche dei 58 pazienti, l’US convenzionale abbia dimostrato solo 3 casi di tendinosi di basso-mezzo grado rispetto ai 5 dell’elastosonografia e della RM nelle spalle sintomatiche.

Anche una rottura tendinea parziale può essere spesso riempita da tessuto di granulazione cicatriziale che assume un’ecostruttura simile a quella del tendine adiacente, rendendo difficile la valutazione all’US, e ciò si riflette nei nostri risultati dal momento che l’elastosonografia ha dimostrato che tre presunti casi di tendinosi di alto grado in ecografia B-mode erano in realtà lesioni parziali, di cui una interessante il solo versante articolare e l’altra il solo versante bursale.

Inoltre, quattro casi di lesione parziale riscontrati con l’US B-mode sono risultati essere invece, sia all’elastosonografia che alla RM, lesioni a tutto spessore. I reperti riscontrati all’elastosonografia sono risultati sorrapponibili a quelli della RM per quanto riguarda la classificazione ed il grading delle alterazioni tendinee riscontrate, seppure sia emersa una differenza nella misurazione delle lesioni tra le due metodiche, specie di quelle a tutto spessore, che sono risultati lievemente più ampie alla RM, verosimilmente a causa del tempo intercorso tra i due esami (circa 2-4 settimane) e dell’intensità di segnale elevata dell’edema perilesionale che si andava a sommare a quella della lesione di per sé.

Una possibile limitazione di questo studio riguarda la mancanza del confronto dei reperti ecografici ed RM con l’artroscopia, ritenuta metodica “gold standard” per quanto riguarda le lesioni tendinee a tutto spessore e parziali, ma, dal momento che anche la RM è ritenuta da molti autori metodica molto sensibile e specifica per tali lesioni, tale limitazione risulta comunque marginale per lo scopo del nostro studio, che resta quello di confrontare l’elastosonografia rispetto all’ecografia standard in B-mode e non quello di valutare la sensibilità della Risonanza Magnetica; inoltre, l’artroscopia non è consigliata per quanto riguarda la terapia delle tendinosi in assenza di lesioni, in quanto tali patologie...
be treated with physical and rehabilitative medicine, so it was therefore not applicable to all of our study’s cases.

**Conclusions**

We believe that elastosonography, thanks to its excellent correlation with clinical data and the MRI examination, is a powerful diagnostic tool that can be used in addition to ultrasound examination in B-mode to differentiate the presence of a lesion or a tendinous degeneration of the supraspinatus that is masked by granulation tissue, making their evaluation by ultrasound difficult. From the therapeutic point of view, the possibility of avoiding this ultrasound pitfall in the diagnosis of lesions of the supraspinatus tendon, in particular of those that are partial and full-thickness on a degenerative basis, plays an important role.

It would, therefore, be a good idea, wherever software for elastosonographic evaluation is available, to repeat the ultrasound examination of the shoulder tendons with the elastosonographic module, especially if there are doubts regarding the presence of granulation tissue in a partial lesion or of tendinosis that is more serious than that which standard ultrasound can show.

References/Bibliografia