Comparison of sonography and magnetic resonance imaging for the diagnosis of partial tears of finger extensor tendons in rheumatoid arthritis

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Abstract

Objective. Finger extensor tenosynovitis in rheumatoid arthritis (RA) may lead to partial and eventually to complete tendon tears. The aim of this study was to investigate the diagnostic value of sonography (SG) and/or magnetic resonance imaging (MRI) to visualize partial tendon tears.

Methods. Twenty-one RA patients with finger extensor tenosynovitis for more than 12 months underwent SG, MRI and surgical inspection, the latter being the gold standard.

Results. For partial tears, sensitivity and specificity were 0.27 and 0.83 for MRI, and 0.33 and 0.89 for SG, respectively. Positive and negative predictive values were 0.35 and 0.78 for MRI, and 0.50 and 0.80 for SG, respectively. Accuracy was 0.69 for MRI and 0.75 for SG.

Conclusion. For visualization of partial finger extensor tendon tears in RA patients, SG performs slightly better than MRI, but both techniques are at present not sensitive enough to be used in daily practice.

KEY WORDS: Sonography, MRI, Partial tears, Finger extensor tendon, Rheumatoid arthritis, Diagnosis, Imaging.

Tenosynovitis of finger flexor and extensor tendons in rheumatoid arthritis (RA) occurs in up to 64% of all RA patients, more often in extensor than in flexor tendons [1–3]. A diffuse swelling on the dorsal aspect of the wrist is the most common clinical feature of finger extensor tenosynovitis [4]. A serious complication of persistent tenosynovitis is complete rupture of the tendon with loss of finger function [4]. The exact frequency of rupture of finger extensor tendons is unknown. According to a survey using a small questionnaire, which reflects the personal experience of 90 Dutch rheumatologists, who were attending a national meeting of the Dutch Society for Rheumatology, the incidence of rupture of a finger extensor tendon in a general rheumatology practice in The Netherlands is estimated to be one rupture in 100 RA patients. This would mean that an estimated 340 RA patients suffer from finger extensor tendon rupture in The Netherlands each year. It may be caused by chafing of the tendon against bone, as in the case of a dorsally subluxated ulna or Lister's tubercle [4]. Rupture may also be caused by invasion of pannus into the tendon or by pannus due to compression, both causing oedema, ischaemia and necrosis [4, 5]. In RA, the most common ruptures of tendons of the hand involve the extensor pollicis longus and the extensor tendons of the little finger [5, 6]. If the extensor pollicis longus tendon ruptures, this will cause more functional loss than the rupture of any other finger extensor tendon rupture [5, 6]. The propensity for rupture is considered to be independent of the extent of the tenosynovitis [6]. There seems to be a strong positive correlation between aggressive disease in RA and the incidence of tendon rupture [6]. Rupture of the extensor tendon is often insidious and painless [6].

It is assumed that partial tears in finger extensor tendons eventually progress to complete ruptures because the causative factors, the tenosynovitis and/or
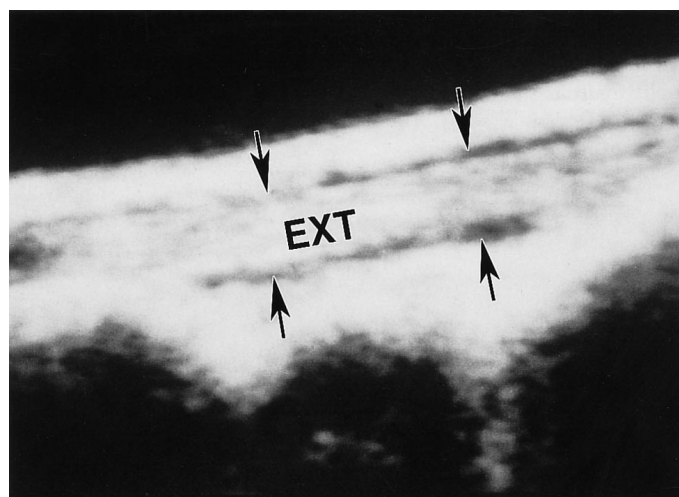
Fig. 1. Finger extensor tendon (EXT), visualized with an SG transducer in the longitudinal position. Arrows indicate a normal tendon sheath.

the bony spurs, usually persist [5, 6]. Diagnosis by physical examination of a rupture of an extensor tendon can sometimes be difficult because poor extension may also be due to arthritis or subluxation of metacarpal joints, or lateral deviation of extensor tendons. In general, however, functional tests are thought to be sufficient to diagnose a complete tendon rupture [7]. However, partial tears of the extensor tendons cannot be detected by physical examination. Tenosynovitis, defined as synovial proliferation and/or effusion, in RA patients can be visualized clearly by means of magnetic resonance imaging (MRI) and sonography (SG) [8–11]. In order to detect partial rupture of tendons, these same techniques, i.e. MRI and SG, might be helpful. If these techniques for the diagnosis of partial tears in finger extensor tendons could be validated, prediction of complete ruptures might be possible.

The aim of this study was to compare the diagnostic values of MRI and SG for the detection of partial ruptures of the finger extensor tendons in patients with RA and tenosynovitis.

Patients and methods

From March 1994 to January 1997, 21 consecutive RA patients (18 women and three men), visiting the rheumatology out-patient clinic and suffering for more than 12 months from finger extensor tenosynovitis, were advised to have surgery and asked to participate in the study. Approval was given for this study by the Ethical Committee of our hospital and informed consent was obtained from all patients. Inclusion was performed by the rheumatologist (WAAS) 6 weeks before surgery. In the case of involvement of both hands, the most severely affected hand was operated upon. Sonography and MRI of the 12 finger extensor tendons of the most severely affected hand were performed within 6 weeks before surgery, as were the laboratory studies. During surgical synovectomy, all tendons were inspected by one orthopaedic surgeon (PCGH). All patients had RA involvement of the hand and fulfilled the classification criteria for the diagnosis of RA [12]. Mean age was 61 yr (range 37–76) and mean disease duration was 8.7 yr (range 2–36 yr). All patients had been and/or were being treated with disease-modifying anti-rheumatic drugs. Each hand has 12 extensor tendons that are covered by the dorsal retinaculum which sends vertical septa from its deep surface to the radius and ulna. Thus, tendons pass, either alone or in groups, through six separate compartments. The third compartment, ulnar to Lister's tubercle, contains the extensor pollicis longus (tendon 5), which is prone to rupture. The latter has major functional consequences [5, 6]. Data on this tendon were therefore analysed separately.

Sonography

SG was performed by a rheumatologist (WAAS) experienced in this technique. The sonographer was blinded for the MRI findings. A 10 MHz linear array transducer was used (Diasonics, Prisma, Santa Clara, USA). Longitudinal (Figs 1 and 2) and transverse images were made. A partial tear (Fig. 3) was defined as damage of tendon integrity on one or both sides of an extensor tendon. A tear was scored complete if separated torn ends were visible. Partial and complete tears were scored as present or absent. The relevant part of the images extended from the wrist joint up to 5 cm in the distal direction.

MRI

MRI was performed with a 1.0 Tesla system (Impact, Siemens, Erlangen, Germany) with a dedicated wrist surface coil as receiver. All patients were placed prone in the magnet with the wrist above the head in the centre of the table. After a T1 (TR/TE 400/20 ms) weighted localizing sequence, a standard T2 axial spin-echo (SE) sequence (repetition time ms/echo time [TE] ms = 2.000/20,80) followed by a fat-suppressed
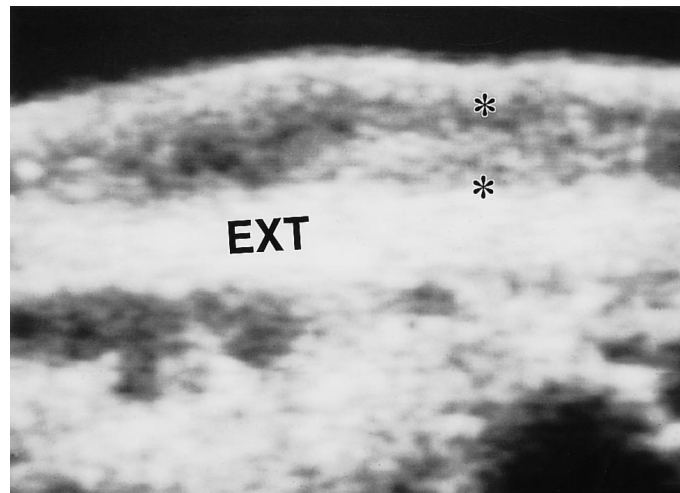
FIG. 2. Finger extensor tendon (EXT) tenosynovitis (between the two asterisks), visualized with an SG transducer in the longitudinal position.
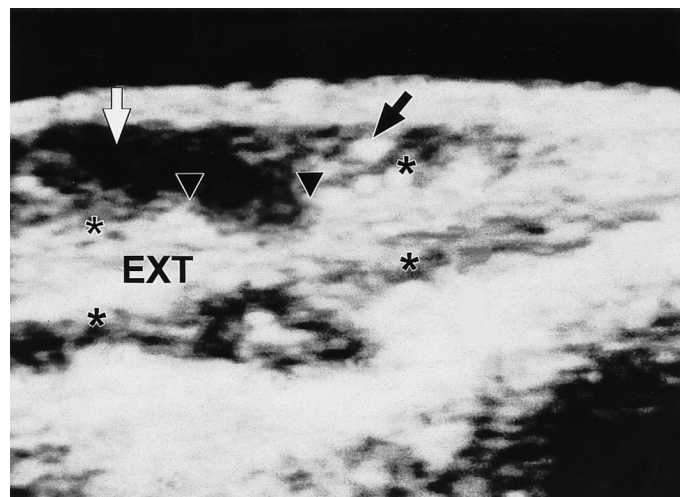

FIG. 3. Finger extensor tendon (EXT) (between the two asterisks) tenosynovitis, visualized with an SG transducer in the longitudinal position. Note the irregular borders and a partial tear (between the arrowheads) of the extensor tendon caused by tenosynovitis. Black arrow indicates pannus; white arrow points at effusion.

sequence was performed. Only transverse images (Figs 4 and 5) were available for scoring. The following parameters were used: section thickness 3 mm, with a 1 mm gap; matrix 128 × 256; field of view 8–10 cm; and one or two excitations. The relevant part of the images, as for SG, extended from the wrist joint up to 5 cm in the distal direction. Imaging time ranged from 4 to 8 min per sequence, with a total examination time of 45 min. MRI scoring parameters and imaging locations were the same as those described for SG. The images were evaluated independently by one experienced radiologist (PRA) who was not aware of the SG findings.

Surgical procedure

In the present study, surgery was applied in all patients. Surgery was performed by one orthopaedic surgeon (PCGH) within 6 weeks after inclusion. Scoring parameters at surgery were the same as those described for

SG. A lengthwise incision was made under tourniquet pressure along the midline across the dorsum of the wrist; as a result it was possible to inspect all 12 finger extensor tendons. The relevant part of the tendons, as for SG and MRI, extended from the wrist joint up to 5 cm in the distal direction.

Immediate registration was performed during surgery on a score sheet.

Statistics

For the 21 patients, the 12 tendons of the more severely affected hand were investigated. In total, 252 finger extensor tendons were analysed. Surgery was used as the gold standard. The sensitivity, specificity, positive and negative predictive values, and accuracy of MRI and SG for the presence of partial tears and total ruptures were calculated. Sensitivity is defined as the number of true-positive (TP) cases divided by the sum
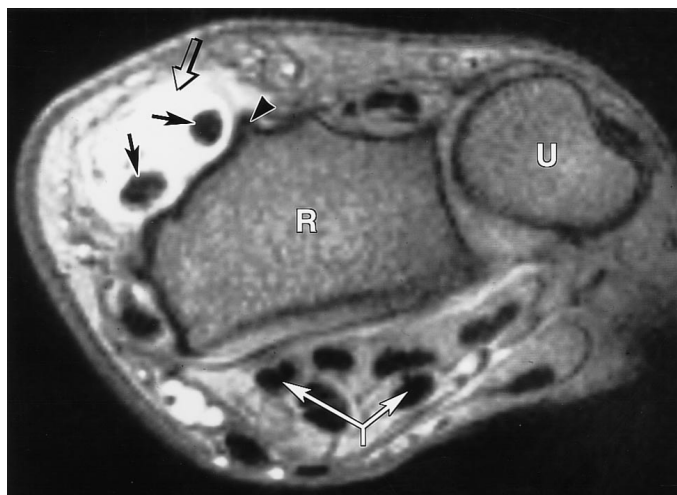
FIG. 4. Transverse MRI (T2-weighted) image at proximal wrist level with ulnar bone (U) and radial bone (R). The black arrowhead indicates Lister's tubercle on top of the radial bone. The tailed black arrows represent the extensor carpi radialis longus and brevis surrounded by effusion due to synovitis (open arrow). The two white arrows indicate the superficial and deep flexor tendon loges.
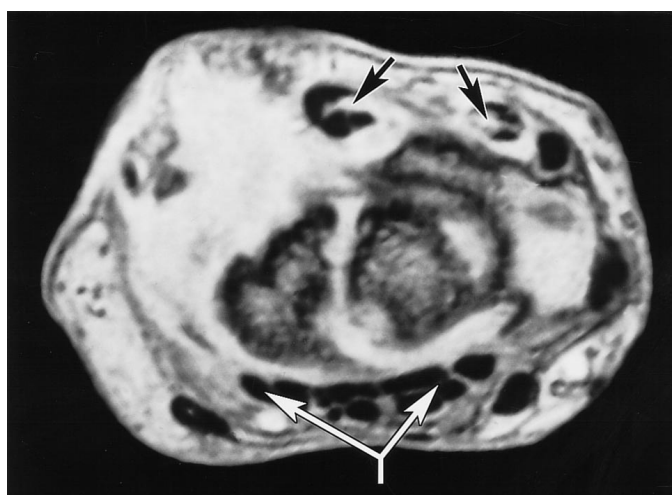

FIG. 5. Transverse MRI (T2-weighted) image at distal wrist level with partial tears (black arrows) due to damage of two finger extensor tendons. The flexor compartment is indicated by two white arrows.

of TP and false-negative (FN) cases. Specificity is defined as the number of true-negative (TN) cases divided by the sum of true-negative and false positive (FP) cases. The positive predictive value is defined as the number of TP cases divided by the sum of TP and FP cases. The negative predictive value is defined as the number of TN cases divided by the sum of TN and FN cases. Accuracy is defined as the sum of TP and TN cases divided by the sum of TP, FP, FN and TN cases. To compare the results of partial tears demonstrated by SG and surgery *vs* MRI and surgery, McNemar's tests were applied. Statistical analyses were performed using the 'Number Cruncher Statistical System' Version 97.

Results

All patients had RA involvement of the hand and fulfilled the classification criteria for diagnosis of RA [12]. Mean age was 61 yr (range 37–76) and mean disease duration 8.7 yr (range 2–36 yr). All patients had been and/or were being treated with disease-modifying anti-rheumatic drugs. Data on the 21 patients are shown in Table 1. Findings at tendon level at surgery are shown in Table 2.

SG, MRI and surgery

Partial tears. At surgery, 64 partial tears were found. The sensitivity and specificity of SG were 0.33 and 0.89, while MRI scored 0.27 and 0.83, respectively. The positive predictive values (PPV) of SG and MRI were 0.50 and 0.35, respectively. The negative predictive values (NPV) were 0.80 and 0.77 for SG and MRI, respectively. The accuracy of SG and MRI was 0.75 and 0.69, respectively (Table 3). With regard to tendon 5, surgery revealed partial tears in seven cases. The sensitivity, specificity and accuracy of SG were 0.57,

TABLE 1. Data on the 21 patients with rheumatoid arthritis and finger extensor tenosynovitis

	Patient number																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Age (yr)	37	41	58	62	55	55	41	56	53	51	70	76	71	73	51	76	69	67	70	71	72
Gender[a]	f	f	m	f	f	f	f	f	f	f	m	f	f	f	f	f	f	f	m	f	f
Disease duration (yr)	4	2	2	7	14	12	45	4	6	14	7	35	6	7	17	7	4	4	7	15	36
DMARDs[b]	1	5	3	2	1	4	2	6	2	4	2	2	3	2	4	1	1	1	2	2	4
Steroids[c]	–	+	+	–	–	–	–	+	+	+	–	+	–	–	+	–	–	–	–	+	+
ESR (mm/h)	12	35	74	6	23	23	11	40	37	84	79	64	35	31	6	45	22	15	65	43	12
Rheumatoid factor[d]	256	4096	1024	128	64	512	2084	1024	128	512	1024	128	256	128	32	512	2048	16	4096	1024	32
Steinbrocker[e]	2	2	3	2	2	2	1	3	2	3	2	2	2	2	3	3	2	2	2	2	2
Erosions[f]	+	–	+	+	+	+	–	+	+	+	+	+	+	+	+	–	+	–	+	+	+
Dorsal subluxation of ulna	–	–	–	–	+	–	–	+	–	+	–	–	+	–	+	–	–	–	+	+	–
Spontaneous tendon rupture (in past)[f]	–	–	–	–	+	–	–	+	–	+	–	–	–	–	–	+	–	–	–	–	+
Partial rupture[g]	3	5	7	2	0	2	2	9	6	3	2	2	5	5	3	0	2	0	2	4	0
Total rupture[h]	–	–	+	–	–	–	+	–	–	–	–	–	–	–	–	–	–	+	–	+	–

[a] f = female; m = male.
[b] Number of DMARDs used at the time of surgery.
[c] Using oral corticosteroids at the time of surgery (– = no, + = yes).
[d] Waaler–Rose (dilution).
[e] Functional classification (24).
[f] – = absent, + = present.
[g] Number of partial ruptures in 12 tendons.
[h] Assessed during surgery; patient 3 showed ruptures in tendon 10 and 11; patient 7 in tendon 5; patient 18 in tendon 5; patient 20 in tendons 9 and 10.

TABLE 2. Findings at tendon level at surgery[a]

Tendon number	1	2	3	4	5	6	7	8	9	10	11	12
Normal	13	15	4	7	1	9	13	9	9	8	14	13
Partial tear	4	1	12	7	14	4	3	5	4	3	2	5
Complete tear	0	0	0	0	2	0	0	0	1	2	1	0

[a]All tendons are scored for items such as normal, partial tear and complete rupture.
Tendons: 1. abductor pollicis longus; 2. extensor pollicis brevis; 3. extensor carpi radialis longus; 4. extensor carpi radialis brevis; 5. extensor pollicis longus; 6. extensor indicis proprius; 7–10. extensor digitorum; 11. extensor digiti minimi; 12. extensor carpi ulnaris.

0.36 and 0.43, while MRI scored 0.86, 0.29 and 0.48, respectively.

Total ruptures. At surgery, six total ruptures were found. The sensitivity and specificity for SG were 0.67 and 1.0, and MRI scored 0.17 and 0.99, respectively. The PPV and NPV for SG were 1.0 and 0.99 and for MRI, 0.33 and 0.98, respectively. The accuracy of SG and MRI was 0.99 and 0.97, respectively (Table 3B).

Discussion

Options for treatment of finger extensor tenosynovitis in RA patients are systemic drug therapy and local steroid injections [4, 13]. If refractory to drug treatment, prophylactic tenosynovectomy might be considered to preserve the tendon. Tendon rupture and recurrent tenosynovitis rarely occur after prophylactic tenosynovectomy [14–16]. Opinions differ with respect to the timing and value in general of prophylactic synovectomy. A review of 125 patients who had undergone 173 tenosynovectomies showed that in 50% of the cases, the tendons had already been invaded by pannus when prophylactic synovectomy was performed 6 months from the first signs of tenosynovitis [17]. For this reason, orthopaedic surgeons advise prophylactic synovectomy 6 months after initial signs, in accordance with rheumatological literature [4, 6, 13, 17]. The lack of reliable clinical criteria for partial tears in extensor tendons may lead to unnecessary surgery in some cases and tendon rupture in others [5]. If SG and/or MRI were to become reliable imaging techniques for partial tears, new objective criteria for the prediction of total tears might be found.

MRI and sonography vs surgery

For partial tears, the sensitivity and PPV of SG were low, while the specificity, NPV and accuracy were better. The same applies for MRI, except that SG scored slightly better in all respects (Table 3A). For clinical practice, these results are disappointing. A high NPV was found. This means that if SG or MRI was negative for a partial tear, the chance that a partial tendon tear would be present at surgery is very small.

We also focused on the extensor pollicus longus (EPL, tendon 5) because, of all the extensor tendons, it ruptures very frequently and causes significant functional disability of the hand [5, 6]. However, for this tendon (EPL) too, the findings on partial tears detected by SG and MRI were comparable with those at surgery. With

TABLE 3A. Binary decision matrix for sonography and MRI vs surgery results concerning partial tears of finger extensor tendons

	Surgery findings	
	+	−
Sonography/MRI results +	**21**/17	**21**/32
−	**43**/47	**167**/156

+ = present, − = absent.
For SG, this yields a sensitivity of 0.33; specificity of 0.89; PPV of 0.50; NPV of 0.80 and accuracy of 0.75.
For MRI, this yields a sensitivity of 0.27; specificity of 0.83; PPV of 0.35; NPV of 0.77 and accuracy of 0.69.

TABLE 3B. Binary decision matrix for sonography and MRI vs surgery results concerning total ruptures of finger extensor tendons

	Surgery findings	
	+	−
Sonography/MRI results +	**4**/1	**0**/2
−	**2**/5	**246**/244

+ = present, − = absent.
For SG, this yields a sensitivity of 0.67; specificity of 1.0; PPV of 1.0; NPV of 0.99 and accuracy of 0.99.
For MRI, this yields a sensitivity of 0.17; specificity of 0.99; PPV of 0.33; NPV of 0.98 and accuracy of 0.97.

regard to the total rupture of tendons, the results of SG were better than those of MRI (Table 3B).

In this study, SG and MRI were each interpreted by one different observer. For practical reasons, inter- and intra-observer reproducibility tests were not performed; this is a drawback of our study. However, in the literature, no data were found on this subject; it remains to be studied.

Sonography

Literature on SG and tendon pathology suggests that synovial proliferation and effusion, both aspects of synovitis, are easy to detect by means of SG [10, 11]. There is abundant literature reporting on tendinitis and complete tears [18–20]. Little is known about partial tears in finger extensor tendons in RA patients and examination by SG. To our knowledge, a longitudinal study to validate SG *vs* MRI for imaging partial tears in extensor tendons in RA patients, using surgery as the gold standard, has not yet been performed.

Grassi *et al.* [10] used a 13 MHz SG transducer to

examine flexor and extensor tendons in the hands of 20 RA patients and compared these findings with SG of 20 gender- and age-matched normal subjects. In this study, 50% of the flexor tendons and 30% of the extensor tendons showed partial tears. They concluded that high frequency SG is helpful in assessing even minor finger tendon abnormalities in RA patients. However, in this study, surgery was not used as the gold standard.

With 5.0 and 7.5 MHz SG transducers, Fornage [20] examined 16 patients, 11 of whom underwent surgery. Both the dorsal and volar tendons of the wrist and hand were inspected. He diagnosed partial and complete flexor tendon tears correctly by means of SG in three patients pre-operatively. No data were presented on false negative and false positive results. Extensor tendon tears were not mentioned at all.

In the present study, it was found that SG is not sensitive enough as a screening method to detect partial tears in finger extensor tendons in RA patients. Although we used a 10 MHz linear array transducer, our results did not confirm our hypothesis that SG would be a good imaging screening technique for partial extensor tendon tears in the fingers. In the near future, when transducers with even higher frequencies will be available for general purpose, it might be possible to visualize partial tendon tears properly. In any case, SG will be dependent on the experience of the sonographer, no matter what the frequency of the transducer. For example, the sound beam should be perpendicular to the structure being examined at all times. Beam obliquity will result in artificially decreased echogenicity, called 'anisotropy', a well known pitfall in SG.

MRI

This technique is able to visualize synovial proliferation as hyperaemia by using T1-weighted images before and after gadolinium injection. Effusion, like proliferation a sign of tenosynovitis, can be visualized on a T2-weighted image [8, 9, 21]. Rubin et al. [22] distinguished different degrees of finger flexor tendon tears in four cadaver models by means of MRI. With a scalpel, lesions were made and studied by means of MRI, dissection being the gold standard.

Comparison of our results with those of Rubin et al. is not valid because there are clear differences between the two studies. First, inflammation as a source of irregular tendon damage was not included in their study. Second, Rubin et al.'s study was an in vitro investigation. Third, they looked at flexor tendons while we concentrated on extensor tendons and, fourth, the localization of the injury was known beforehand, in contrast to our study.

Rubens et al. [21] demonstrated the use of MRI to assess involvement of the dorsal tendon sheath and dorsal tendons in RA patients. Of the 23 hands in this study, only six hands (bias?) were operated upon, which is too small a number for statistical analysis. Also, Rubens et al. did not state whether all 12 tendons of each affected hand were evaluated at surgery, as in our study. They also found that clinical assessment of the enlarged dorsal tendon sheath correlated poorly with findings on the MRI images.

The comparison of MRI and partial tears in finger extensor tendons in our study was disappointing. Future developments of MRI, such as three-dimensional acquisition techniques and a higher Tesla rate, might better define the course and integrity of tendons, allowing images in the longitudinal and oblique planes.

Patients at risk

The hallmarks of an aggressive and severe form of RA with a poor prognosis are high titres of rheumatoid factor and bone erosions in an early stage of the disease [4, 13]. There seems to be a strong correlation between aggressive disease and the tendency for tendon rupture [6].

According to the literature [6, 17], extensor tendon rupture in the past, and marked dorsal subluxation of the ulna, are also risk factors for further ruptures.

Our study was too small to show a correlation between tendon ruptures found at surgery and dorsal subluxation of the ulna, earlier spontaneous finger tendon ruptures, high titres of rheumatoid factors, or the presence of early bone erosions. In the present study, 21 RA patients had tenosynovitis of their finger extensor tendons. Partial tears in one or more tendons were confirmed by surgery in 17 (81%) cases (Table 1). In a general Dutch rheumatology practice, at least 250 different RA patients are seen [23]. The prevalence of finger extensor tenosynovitis in RA patients is estimated to be about 40%. This would yield an estimated 81 patients (250 patients $\times$ 0.40 $\times$ 17/21) with tenosynovitis and partial tears. If the hypothesis that partial tears will become total ruptures is true, there should be many more patients with a total rupture than the 2.4 patients seen by each Dutch rheumatologist per year (Dutch survey). Therefore, the hypothesis that all partial tears will become total ruptures is questionable. This is an interesting point of view with respect to the question of whether and when prophylactic tenosynovectomy should be performed. Perhaps prophylactic tenosynovectomy should be recommended only for a subgroup of patients with a high risk profile.

Conclusion

Sonography and MRI are, at present, not reliable enough for proper screening for partial tears. In RA patients with persistent tenosynovitis of finger extensor tendons, prophylactic tenosynovectomy should probably be performed only on patients at risk.

Acknowledgements

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