

Assessment of synovial vascularization by power Doppler ultrasonography in TMJ internal derangements treated arthroscopically

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Abstract

Our aim was to evaluate the effect of arthroscopic lysis and lavage of the temporomandibular joint (TMJ) on synovial microvascularisation by comparing preoperative and postoperative grades measured by power Doppler ultrasonography (US). We studied 22 patients with hypomobility, clicking, and pain in the TMJ. Power Doppler US were obtained preoperatively to assess the presence of synovial microvascularisation, and arthroscopic lysis and lavage were done after conservative treatment had proved unsuccessful. The severity of synovitis was assessed arthroscopically. The postoperative power Doppler US scans were obtained 2 months later. Other arthroscopic variables were roofing, adhesions, chondromalacia, clicking, and pain.

Arthroscopic synovitis with varying degrees of synovial vascularisation was detected in all patients. Pain scores decreased considerably during the postoperative period.

We conclude that power Doppler US is a good technique for the assessment of synovial changes by microvascularisation. Arthroscopy of the TMJ reduces synovial vascularisation.

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Introduction

Arthroscopic surgery offers treatment of conditions of the temporomandibular joint (TMJ) including derangements of the disc, adhesions, biopsy of the synovium and fibrocartilage, arthroses, and hypermobility. Arthroscopy has evolved from simple lavage to advanced techniques including laser discoplasty and abrasive shaver systems.^{1,2-4}

Osteoarthritis of the TMJ is often accompanied by synovitis,³ which is an inflammatory disorder of the synovium that is characterised by hyperaemia, angiogenesis, oedema, and capillary proliferation.⁵⁻⁷ It includes acute

or chronic inflammatory changes in the synovium, which encourages hyperplasia of the cell linings in the synovial membrane and initiates the growth of new small blood vessels.^{2,7}

Previous studies reported a correlation between arthroscopic synovitis and histological findings.^{2,5,7,21} Murakami's and Gynther's synovitic scorings were established for the quantitative evaluation of synovitis. These scoring scales are primarily related to the histological angiogenesis and arthroscopic visualisation of the inflamed synovial tissues, which reflect the hyperaemic changes and increasing vascularity.³

Power Doppler US is a useful method for detecting pannus in inflamed fingers with rheumatoid arthritis (RA), and assessing the activity of disease or monitoring therapeutic responses.⁸⁻¹² Power Doppler US not only has the ability to detect vascularisation, but also to depict the flow patterns in the inflamed joints of patients with RA with spec-

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tral analysis.¹¹ US was used to assess the position of displaced intervertebral discs in the mid 1990s.¹³ First US reports of derangements of the TMJ were attributed to the positions of discs and condyles.¹³

The aim of this study was to assess the affect of arthroscopic lysis and lavage on synovial microvascularisation by comparing preoperative and postoperative grades of microvascularisation measured by power Doppler US in patients with synovitis of the TMJ.

Patients and methods

Twenty-two patients (2 men and 20 women) with internal derangements of the TMJ, hypomobility, clicking, and pain were included. Their ages ranged from 17 to 61 years (mean 33). None had a systemic disease that contraindicated general anaesthesia. One of the patients had had a failed arthrotomy in another clinic before arthroscopy.

All patients were examined by manual palpation for tender points in the masticatory muscles. Clicking and crepitation were examined by stethoscope. Dental occlusion was assessed for missing teeth, bruxism, and premature contacts in lateral and protrusive mandibular movements.

Magnetic resonance imaging (MRI) was done with T1 and T2-weighted images (General Electric (G&E) Sigma LX 1.5T MRI System), and showed anterior disc displacement without reduction in 16 patients, with reduction in 3 and a normal position in 3.

Fifteen patients had hypomobility; 1 had chronic subluxation, and 6 had a normal range of mandibular movements. T2-weighted MRI sequences of 17 patients showed changes in synovial density that resembled synovitis, and subchondral oedema in 5 patients with anterior disc displacement with reduction.

Conservative treatment comprised physiotherapy, anti-inflammatory agents, muscle relaxants, sedatives, and occlusal splints for at least 3 months. Before the splints were applied pain-killers were given for two weeks to reduce the discomfort.

Before arthroscopy, power Doppler US scans were obtained to assess the presence of synovial microvascularisation. The severity of the synovitis was scored arthroscopically using Murakami's synovitis scale (Table 2). The scan was taken with a Logiq 500 (GE Medical Systems, Osaka, Japan) scanner using a 6–13 MHz multi-frequency matrix array linear transducer. Patients also had scans after conservative treatment had failed. All scans were done by the same radiologist who was unaware of the patients' clinical symptoms.

Postoperative scans were obtained two months after arthroscopy to see if any changes had taken place in the synovial microcirculation. Roofing, adhesions, chondromalacia, lucency, clicking, and pain were the other variables studied.

Arthroscopic lysis and lavage were done after nasotracheal intubation. One patient was intubated orally because

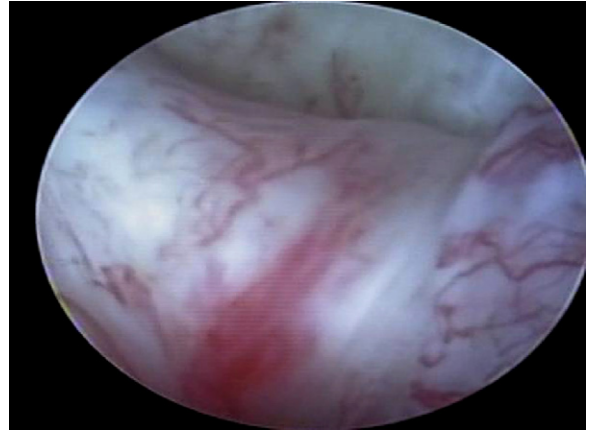


Fig. 1. Grade 2 vascularisation.

of limited mouth opening. TMJs were also examined under general anaesthesia.

Arthroscopic markings were made according to McCain's recommendations.² The joints were insufflated with 1/1 diluted 2% prilocaine hydrochloride (Citanest®, AstraZeneca, UK) - Ringer's lactate solution 2–3 ml until the rebound effect of the syringe was obtained. We used adrenaline-free anaesthetics to minimise the effects of vasoconstriction on the vascularity of the synovial membrane and to establish the accurate diagnosis of synovial abnormality without changing its pathophysiology by vasoconstriction.

The Stryker Speed-Lock 1.9 mm and Hopkins II KarlStorz 2.4 mm small joint arthroscopes and cannulas, blunt-sharp trocars, and small joint arthroscopic instruments (probes, punch forceps, and scissors) were used. First, the internal joint structures were examined with a diagnostic arthroscope (Fig. 1). Next, the procedure was changed to the double puncture technique (Fig. 2).² Extravasation of irrigating fluid in subcutaneous planes was drained by manual pressure at the end of the procedure, and puncture sites were sutured with 6/0 nylon sutures. A cold pack was applied over the

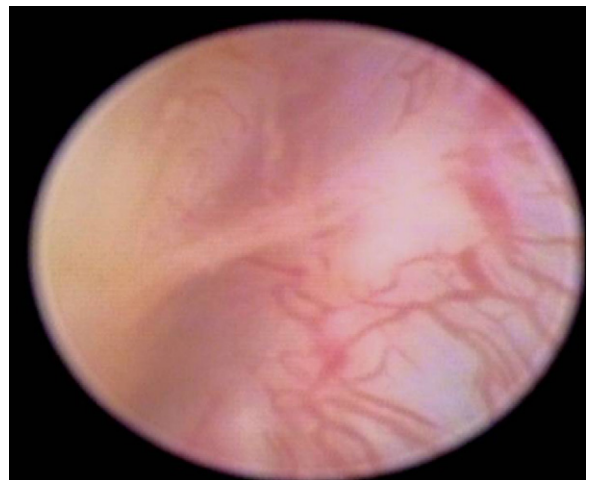


Fig. 2. Grade 3 vascularisation.

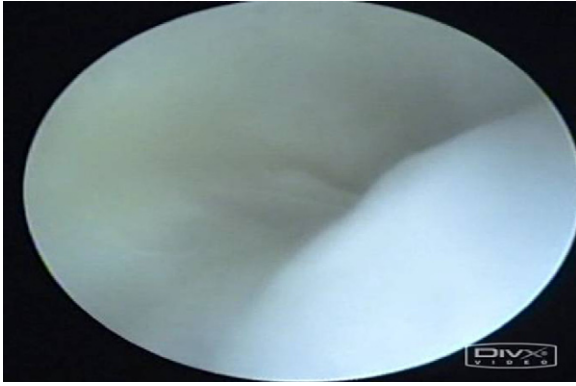


Fig. 3. Normal pale, translucent synovial lining (grade 0).

preauricular joint as soon as the patient returned to the recovery room. Systemic antibiotic and anti-inflammatory agents were prescribed for a week postoperatively. They were followed up at three days, one week, one month, two months, and six months.

We used the Statistical Package for the Social Sciences (SPSS) for Windows, release 11.5 (Chicago, IL, USA). Differences between groups were compared with the Mann–Whitney *U*-test. Correlations were analysed with Pearson's correlation coefficient. Probabilities of less than 0.05 were accepted as significant.

Results

During the preoperative period, six patients had mouth opening within the normal range. Fifteen patients had hypomobility, and one had subluxation during the preoperative period. Measured preoperative and postoperative mean interincisal distances were 26 (3) mm before, and 37 (4) mm after, arthroscopy.

Twenty-one patients had pain preoperatively while one was free of pain. Pain disappeared postoperatively in 13 patients and remained in 5. It returned in 4 patients after 3–6 months, but was less intense after arthroscopy of the TMJ.

Various patterns of vascularisation were seen (Figs. 3–5). Vascularised structures included creeping synovitis, patches or isolated synovial vessels dispersed throughout the synovial membrane, and total vascular invasion (rheumatoid arthritis) (Figs. 1, 2). One patient had advanced, eleven had intermediate, nine had minimal, and one had moderate vascular infiltration. Vascularised synovial structures of varying thicknesses were found, spanning from the articular eminence to the discal surface. These formations were cleared up by arthroscopy (Fig. 6).

Preoperative power Doppler US measurements were detected as grade 1 vascularisation in 10 patients (Fig. 7), grade 2 in 11 (Fig. 8), and grade 3 in one. Postoperative power Doppler US showed normal vascularisation in 9 patients, grade 1 in 12 patients, and grade 2 in one patient. Synovitis was seen in all patients. Arthroscopic vascularisation correlated 100% with power Doppler US scans.

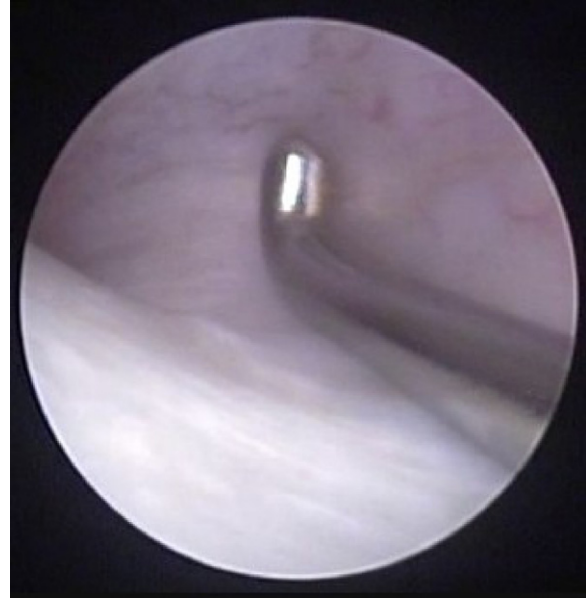


Fig. 4. Sweep and lysis along vascularised synovium of anterior recess. Increased vascularity and mild hyperaemia is present (grade 1).

Power Doppler US of 14 patients showed a significant drop in the levels of synovial vascularisation. One patient had a reduction from grade 3 to normal, seven had a reduction from grade 2 to grade 1, two had a reduction from grade 2 to normal, and five had a reduction from grade 1 to normal vascularisation.

Three patients remained at grade 1, and one patient remained at grade 2 vascularisation after arthroscopy (Fig. 8). The distribution and relation of preoperative and postoperative power Doppler US scores to arthroscopic scoring of synovial vascularisation are shown in Figs. 9 and 10.



Fig. 5. Moderate hyperaemia (grade 1).

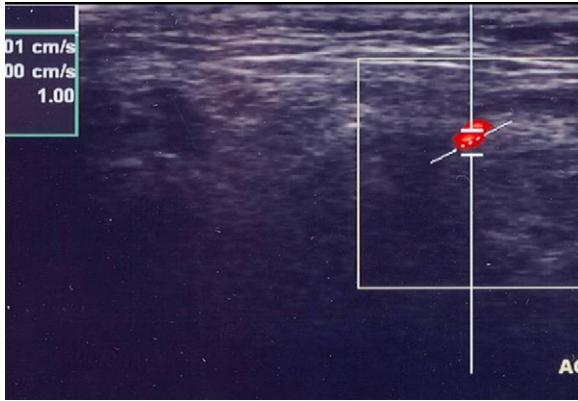


Fig. 6. Grade 1 vascularisation in colour power Doppler ultrasonography.

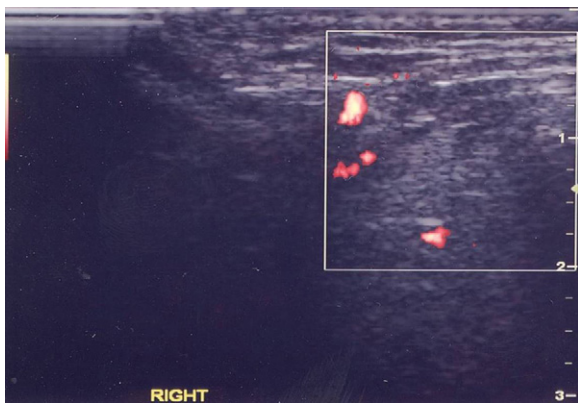


Fig. 7. Grade 2 synovial vascularisation in colour power Doppler ultrasonography.

Discussion

Histological differentiation that is characterised by inflammatory changes is found in retrodiscal tissues and in the entire synovium of affected joints.¹⁴ Internal derangements tend to cause synovitis.¹⁵ We know of few studies that point out the relation between synovitis and angiogenesis.^{6,8,9,14,16,21} Chronic synovitis is generally accompanied by angiogenesis.¹⁷

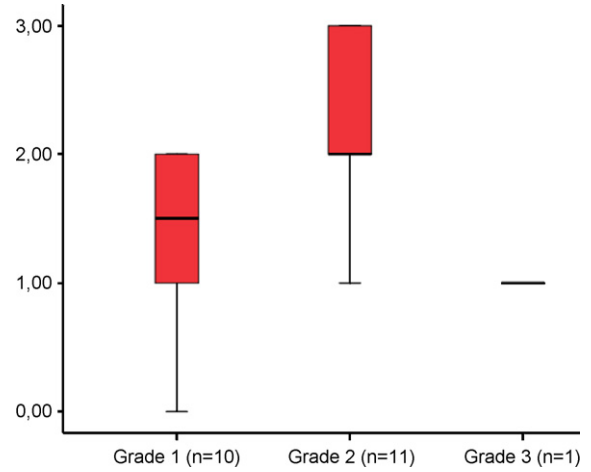


Fig. 9. Distribution, relation of preoperative power Doppler ultrasonography (horizontal axis) and arthroscopic scoring of vascularisation (vertical axis).

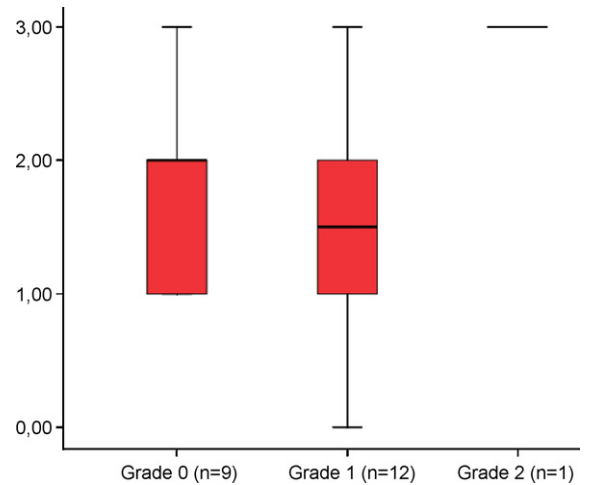


Fig. 10. Distribution, relation of postoperative power Doppler ultrasonography (horizontal axis) and arthroscopic scoring of vascularisation (vertical axis).

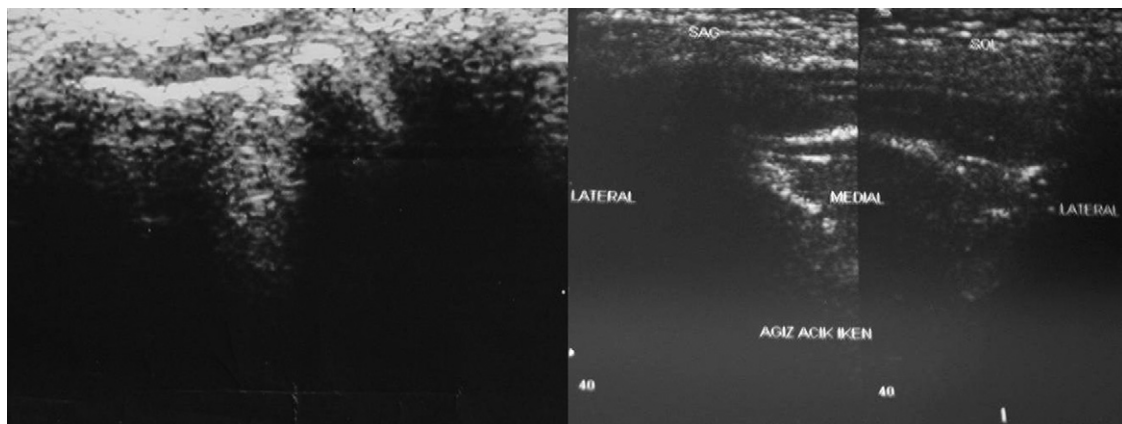


Fig. 8. (a) Preoperative grade 2, and (b) grade 1 vascularisation in power Doppler ultrasonography.

Table 1

Median (range) reduction in grade of synovial vascularisation after arthroscopy (n = 22)

	Power Doppler US		P
	Preoperative	Postoperative	
Grade	1.5	1.0	<0.001
Range	0–3.0	0–2.0	

Histological examination of the synovium confirmed the arthroscopic findings.^{2,3} Increased density of microvessels in inflamed synovium was often found in internal derangements.^{7,21} The correlation between the density of vessels in inflamed synovium and arthroscopic synovitis was shown by arthroscopic biopsy examination.^{2,7} Capillary hyperaemia and synovial hyperplasia were more reliable criteria as a sign of synovitis than increased synovial vascularity.^{1,2,5,7,14,16} Increased hypervascularisation and synovial redundancy as well as the degeneration of fibrocartilage is seen in patients with anterior disc displacement with reduction.² Arthroscopic synovitis was diagnosed by histological hypervascularisation in painful hypermobility and discal displacements.^{2–4,17,21}

In our study, synovitis with various grades of vascularisation was seen in arthroscopy of the TMJ. Synovial vascularisation was mainly localised at the posterior synovial recess, predominantly in the bilaminar zone where there was synovial redundancy. Creeping synovitis spanned mostly from the retrodiscal region to the fibrocartilage of the posterior articular eminence in most of the joints. It also predominated on the discal surface.

Power Doppler US has been suggested as a reliable and sensitive technique for assessing synovitis in joints with RA because it detects hypervascularisation.^{8,9} Its high sensitivity (89%) and specificity (98%) for detecting synovial inflammation has been validated in comparison with dynamic MRI as a reference.^{16,18} Many studies have advocated its routine clinical application because it is non-invasive, cheap, and reliable.¹⁹ It has been widely accepted as a powerful tool for assessing inflammatory and non-inflammatory diseases of the joints.¹⁷

Sonography has been used in craniomaxillofacial surgery since the last decade.^{13,20} We are aware of few studies that focus on intracapsular degeneration and detection of the discal position of the TMJ that were published in parallel with advances in US.^{13,22} We used power Doppler US to detect synovitis because it is accepted as the best way to detect synovitis in osteoarthritic joints.

High-resolution US of the TMJ has a diagnostic accuracy of 93% compared with MRI.^{13,19} Similar results were reported for the diagnostic use of MRI and US for the detection of dysfunction of the TMJ, the position of disc displacements, and effusions, but US was found to be inadequate for evaluating condylar anomalies.²²

Power Doppler US and MRI have the same diagnostic value for the detection of disc displacements in the TMJ,²² but

Table 2

Murakami's scoring of the intensity of synovitis

Score	Findings
0	Normal pale, almost translucent synovial lining with a fine network of anastomosing small blood vessels.
1	Increased vascularity and capillary hyperaemia (mild).
2	Increased vascularity and capillary hyperaemia (moderate).
3	Increased vascularity and capillary hyperaemia (severe).
4	Capillary dilation and increasing network (mild to moderate).
5	Capillary dilation and increasing network (severe).
6	Contact bleeding occurs on probe palpation (mild to moderate).
7	Contact bleeding occurs on probe palpation (severe).
8	Microbleeding and effusion.
9	Granulations, effusions, and debris (mild to moderate).
10	Granulations, effusions, and debris (severe).

power Doppler US has many advantages over MRI for detecting synovitis.^{8,9,11,12,18,23} We found synovitis only as posterior synovial hypertrophy (anterior disc displacement with and without reduction) in some cases, but we found that power Doppler US was the best for identifying synovial inflammation by detecting increased vascularisation. It was also able to distinguish between synovitis and intra-articular effusions.

The most important finding was the reduction of postoperative vascularisation (Table 1). Postoperative power Doppler US showed a reduction in one patient from grade 3 to grade 0; seven had a reduction from grade 2 to grade 1, and three had a reduction from grade 2 to grade 0. All power Doppler US examinations were confirmed by arthroscopy, which assured accurate diagnoses of synovial disease (Table 1). Patients with pain and hypomobility in their joints at power Doppler US levels of grades 2 and 3 had the greatest reduction in vascularisation (Table 2).

Postoperative reduction in vascularisation is attributed to arthroscopic lysis and lavage. Replacement of intra-articular fluid and the washing away of inflammatory cytokines cause suppression of oxidative stresses, which favour regeneration of synovial tissues.^{2,24} The destructive effect of cytokines could not be controlled only with conservative techniques.^{2,24} As the TMJ has limited intra-articular perfusion, the elimination of intra-articular inflammatory cytokines is related to the functional performance of the joint itself. Arthroscopic surgery should therefore be done at that phase to treat diseased and functionally impaired joints.^{10,15}

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