Ultrasound in Med. & Biol., Vol. 32, No. 5, pp. 627–632, 2006

0301-5629/06/$–see front matter

ELSEVIER

doi:10.1016/j.ultrasmedbio.2006.01.014

● *Original Contribution*

3-D SONOGRAPHY FOR DIAGNOSIS OF OSTEOARTHROSIS AND DISK DEGENERATION OF THE TEMPOROMANDIBULAR JOINT, COMPARED WITH MRI

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(*Received* 22 *September* 2005, *revised* 10 *January* 2006, *in final form* 31 *January* 2006)

Abstract—This study determined the value of three-dimensional (3-D) sonography for the assessment of osteoarthrosis and disk degeneration of the temporomandibular joint (TMJ). Sixty-eight patients (136 TMJ) with clinical dysfunction were examined by 272 sonographic 3-D scans. An 8- to 12.5-MHz motor-angulated transducer positioned inferior-parallel to the zygomatic arch scanned the region-of-interest. 3-D condylar morphology was compared with subsequent magnetic resonance imaging (MRI). Fifty-three datasets were complete, *i.e.*, 106 TMJ, 212 examinations. 3-D sonographic examination took 5 min and attained 70% sensitivity/76% specificity/75% accuracy; positive predictive value was 44%%; negative predictive value was 90%. Disk degeneration was diagnosed synonymously with 64%/73%/71%/42%/ 87%. 3-D sonography proved to be reliable for exclusion of osteoarthrosis as disk degeneration compared with MRI, whereas the presence of osteoarthrosis and disk dislocation cannot be reliably diagnosed. Prospective use will include routine screening, using more sophisticated equipment with higher frequency in real-time 3-D viewing. (E-mail: c.landes@lycos.com) © 2006 World Federation for Ultrasound in Medicine & Biology.

Key Words: **Temporomandibular joint osteoarthrosis, Disk degeneration, Temporomandibular dysfunction, MRI, 3-D sonography, Four-dimensional sonography.**

INTRODUCTION

Temporomandibular joint dysfunction (TMD) is a common disorder, and osteoarthrosis has been repeatedly associated with TMD (Stegenga et al. 1993), characterized by a deterioration of the articular surfaces and simultaneous remodeling of the underlying bone, including surface irregularity, underlying sclerosis, flattening and osteophyte formation. At the same time, the articular disk becomes flatter, scarified and eventually perforated (De Leeuw et al. 1995; Emshoff et al. 2003; Sokolow 1979). Magnetic resonance imaging (MRI) of the temporomandibular joint (TMJ) is widely used and yields fine anatomic detail in static examinations with high sensitivity, specificity and accuracy (Westesson et al. 1987). Rapid sequences permit reconstructed motion cycles (Eberhard et al. 2000); however, availability and cost hinder routine screening of TMD by MRI (depending on country, investigator and clinical setting).

Two-dimensional (2-D) sonography permits fast reliable assessment of condylar translation and considerable 2-D information of hard tissue structures (Emshoff et al. 2003; Landes et al. 2000). TMJ sonography is comfortable to the patient, with low cost and high availability (Emshoff 2003; Landes 2004; Landes and Sterz 2003). This study evaluated the benefit of 3-D sonography in the diagnosis of TMJ osteoarthrosis and disk degeneration, and compared 3-D sonograms with MRI after a previous study concerning correct assessment of disk position (Landes et al. 2006).

PATIENTS AND METHODS

From July 2002 to May 2003, 68 patients with TMD (136 TMJ) had 3-D sonography. These were 44 females, 24 males, with ages ranging from 14 to 77 y, mean age 32 y, referred to the TMJ Clinic at our department (Landes et al. 2006). All reported pain and dysfunction of the temporomandibular area as their primary complaint. When patients agreed to the study procedure with

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informed consent, sonography was performed single-blind, *i.e.*, sonograms were analyzed, ignorant of the MRI result beforehand, by the first author. The first author's results regarding disk position were reported to the second author for statistical evaluation, who then compared the results with those assessed by the radiologist in the identical joint. MRI examination was performed directly after the sonographic examination. To maintain comparable jaw position, the closed-mouth and maximum opening positions were used for comparison.

All 3-D sonographic trials were performed with 3-D sonographic equipment (V530, General Electric-Kretz, Solingen, Germany). The transducer was an 8- to 12.5-MHz linear array, moved by step motor.

A 2-D positioning in axial transection of the target volume over the joint and lateral mandibular condyle was performed first, when the transducer was tilted to optimum visualization. The orientation of the transducer was standardized according to the standard planes of head and neck sonography parallel-inferior to the zygomatic arch (Siegert 1987). Therefore, the transducer intersected axially the lateral superior and inferior joint compartment. Sections parallel to the route of condylar translation were obtained by positioning the transducer in anterioposterior orientation parallel to the zygomatic arch (Landes et al. 2006). The examination was held in occlusion and maximal mouth opening. While sitting relaxed but erect, the patient moved the mandible from occlusion to maximal opening.

Images were scrutinized for condylar surface irregularity, underlying sclerosis, flattening, osteophytes, effusion and thickness of the lateral articular space as a thickened or irregular joint capsule. The condyle was seen on its lateral aspect, together with the articular eminence as parallel hyperechogenic lines (Fig. 1).

The MR images were judged independently by an experienced radiologist. A 1.5-T MR tomograph (Magnetom Vision; Siemens, Erlangen, Germany) with a dedicated surface TMJ coil was used to acquire simultaneously bilateral sagittal oblique and coronal oblique images. The imaging protocol included sagittal oblique and coronal oblique T1-weighted spin-echo (SE) sequences (450/15 [repetition time ms/echo time ms], imaging matrix 256 $\times$ 256, field of view 128 mm, pixel size 0.5 $\times$ 0.5 mm, slice thickness 3 mm) and sagittal oblique T2- and proton density-weighted turbo spin-echo (TSE) sequence (2840/103 to 15, matrix 512 $\times$ 512, field of view 128 mm, pixel size 0.3 $\times$ 0.3 mm, slice thickness 3 mm). All sagittal oblique sections were orientated perpendicular to the long axis of the condyle in transverse plane. The patient was positioned in supine position. Sequential bilateral images were obtained in the closed-mouth and maximum opening position.

The MR images were interpreted without knowledge of the findings from the sonography. MRI diagnosis of TMJ osteoarthrosis was defined by the presence of flattening, surface irregularities, erosion or presence of condylar deformities, osteophytes and subcondylar sclerosis.

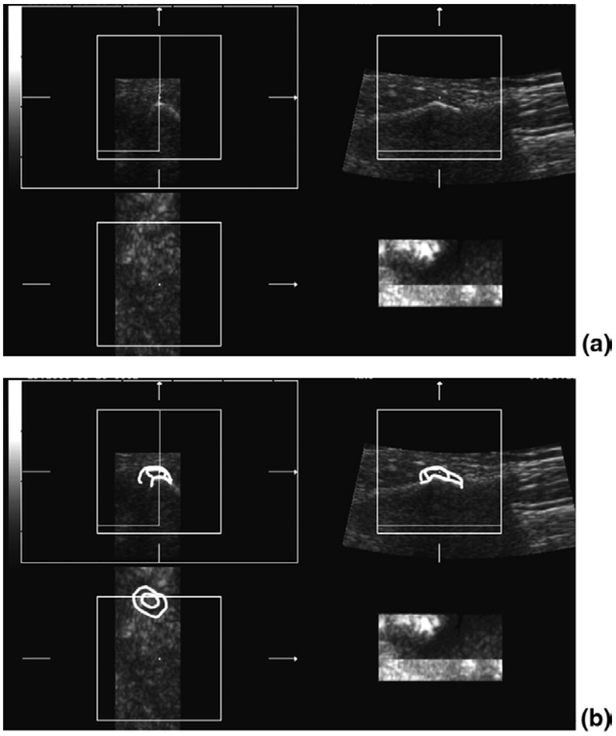

Fig. 1. (a) Shows the lateral condylar pole and articular capsule viewed as hyperechogenic bands, divided by the hypoechogenic disk *in situ* in a normal joint. Above left lies 2-D frontal, above right 2-D top and below left the 2-D side view. Below right shows the deliberately cut 3-D volume, not yet rotated for viewing; and (b) shows the identical picture with outlined condyle, disk and capsule.

The statistical parameters sensitivity, specificity, accuracy, positive and negative predictive value of 3-D sonography were compared with MRI. The statistical significance was assessed by χ^2 test.

RESULTS

The datasets of 53 patients (106 TMJ) were complete. Nine (14% of 68 joints) MRI examinations and four (6%) sonographics dropped out, as the images were lost. Two (3%) patients developed claustrophobia during MRI and interrupted the procedure. One patient had communication problems and did not properly open her mouth on demand. Altogether, 212 of 272 images were analyzed (105 in the closed-mouth position, 107 in the open-mouth position).

The 3-D sonography revealed 16 of 23 osteoarthroses, verified on MRI. 3-D sonography therefore evinced 70% sensitivity to detect osteoarthrosis if present on MRI. Specificity for osteoarthrosis was 76% and accu-