Diagnostic Evaluation of an Ultrathin 15,000 Fiberoptic Arthroscope: Comparison of Arthroscopic and Histologic Findings in a Sheep Model

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Purpose: An ultrathin 15,000 fiberoptic–based arthroscope was evaluated for the detection of osteoarthritic intra-articular pathologies in sheep temporomandibular joints.

Materials and Methods: Osteoarthritis was bilaterally induced in the temporomandibular joints in sheep. Twenty osteoarthritic temporomandibular joints were arthroscopically examined and rated with use of the ultrathin arthroscope. The arthroscopic observation was then compared with the histologic findings.

Results: The arthroscope provided excellent vision of the osteoarthritic joints. Correlation between arthroscopic and histologic findings was 80%.

Conclusion: The recently developed ultrathin (15,000) arthroscope was found to be a highly reliable and efficient tool to diagnose joint space pathologies of the osteoarthritic temporomandibular joint.

J Oral Maxillofac Surg 63:319-322, 2005

Arthroscopy is useful to detect early changes in the temporomandibular joint (TMJ) intra-articular space that cannot be detected with magnetic resonance imaging (MRI) and computed tomography (CT).[1,2] Ultrathin arthroscopes are valuable in examination of the pathologic TMJ, because the joint space is small and susceptible to damage. There are 2 kinds of TMJ arthroscopes: the rod lens type and the fiberoptic type.[3,4] Rod lens–type arthroscopes provide clearer images than do fiberoptic ones, but they are fragile. Fiberoptic-type arthroscopes are durable because they are flexible, but usually they have a poorer resolution than the rod lens–type arthroscopes. We previously reported that diagnostic accuracy of a thin arthroscopy with 4,200 optic fibers was clinically acceptable in detection of the osteoarthritis in the sheep TMJs.[5] We have recently been involved in the development of an arthroscope with 15,000 optic fibers.[6] In this report, the diagnostic accuracy was compared with histologic assessment of osteoarthritic sheep TMJs.

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The authors have no financial relation to the manufacturer of the arthroscope (M&M Co, Tokyo, Japan).

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0278-2391/05/6303-0006$30.00/0
doi:10.1016/j.joms.2004.05.224

Materials and Methods

The instruments used were the FVS-3000 arthroscopic system and TR-106 ultrathin fiberoptic-based arthroscope (M & M Co, Ltd, Tokyo, Japan). The diameter of the outer sheath and encased optical fibers of the ultrathin arthroscope was 1.48 mm and 1.06 mm, respectively. The imaging bundle of the TR-106 arthroscope contained 15,000 coherently aligned optical fibers. The arthroscope had a 70° field of view in the air.

The animal model of TMJ osteoarthritis was induced using 10 adult Merino sheep. Anesthesia was induced with an intravenous injection of thiopentone

TABLE 1. ARTHROSCOPIC AND HISTOLOGIC STAGES OF OSTEOARTHRITIS

Arthroscopic stage	
1	Fibrous smooth surface
2	Fibrillation of the surface layer
3	Bone exposure
Histologic stage	
I	Smooth and even thickness of fibrous layer
II	Uneven thickness of the surface layer
III	Bone exposure

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sodium into the external jugular vein. After tracheal intubation, anesthesia was maintained with isoflurane/N_2O/O_2. The preauricular region was draped in a sterile manner. A preauricular vertical skin was incised to expose the lateral capsule of the joint. The joint space was entered via incision of the capsule. The fibrous layer was gently removed from the condylar articular surface. The central part of the disc was perforated 3.9 mm in diameter in a standardized manner. The wound was closed in layers. The sheep were returned to a field condition after a week of observation in a covered animal house.

At 2, 4, 6, 8, 12, and 24 weeks after the initial operation, the sheep were reanesthetized and draped in a sterile manner. The ultrathin arthroscope was introduced into the joint space through a small skin incision over the TMJ. No trocars were used, to avoid scratching the joint surface. The ultrathin arthroscope was flexible enough for passage into the joint space. The joint space was adequately distended with normal saline irrigation to achieve optimal visualization. The articular surface and synovial recesses of the superior joint space were inspected. At first, the posterior part of the joint space was observed to recognize the posterior recess and then anteriorly scanned to see the intra-articular pathologies of the joint space. The images of the joint space were viewed through a color television monitor. Arthroscopic photographs were taken for documentation with a 35-mm SLR camera. Arthroscopic findings of the articular surface were classified into 3 stages (Table 1) and evaluated by one of the authors (K.K.).

After arthroscopic investigation, the sheep were killed with a lethal overdose injection of thiopentone sodium injected intravenously into the external jugular vein. The joints were then removed en bloc and fixed in neutral buffered formalin. The joint blocks were decalcified and sectioned in the parasagittal plane. The specimens were prepared, sectioned, and stained with hematoxylin-eosin for microscopic evaluation. Histologic stages were classified into 3 stages (Table 1) and applied to the articular surface. The histologic sections were observed and rated by one of the authors (N.O.). Each histologic slide was randomized and blinded to the scorer. The most advanced arthroscopic and histologic findings in each joint were chosen and compared with each other.

Results

HISTOLOGIC FINDINGS

Of the 20 joints, 12 joints (60%) were histologic stage I, and 8 joints (40%) were histologic stage II. There were no histologic stage III joints (Table 2).

ARTHROSCOPIC FINDINGS

The ultrathin arthroscopic view clearly showed articular surface abnormalities without pixelation (Table 2).

The correlation between the arthroscopic and histologic findings is presented in Table 2. Of the 20 joints, 16 joints (80%) were correctly diagnosed with the ultrathin arthroscope (Fig 1). Three joints (15%) were arthroscopically overdiagnosed (Fig 2), and 1 (5%) was underdiagnosed (Fig 3).

Discussion

This study suggests that the ultrathin 15,000 fiberoptic–based arthroscope showed highly detailed pathologic information of the intra-articular architecture with high diagnostic accuracy. Eighty percent of osteoarthritic joints were correctly graded with respect to findings of the intra-articular abnormalities. The diagnostic accuracy of this study was higher than that of the previous study on an ultrathin 4,200 fiberoptic arthroscope regarding advanced TMJ osteoarthritis in sheep.[5] Liedberg and Westesson[8] used 2 different rod lens–type arthroscopes to inspect the upper compartment of the TMJ of fresh human cadavers and reported 78% and 74% diagnostic accuracy of the articular surface on the fossa and tubercle, respectively. The external diameter of the 2 arthroscopes was 1.7 mm to explore the joint space and 2.4 mm to

TABLE 2. CORRELATION BETWEEN ARTHROSCOPIC AND HISTOLOGIC DIAGNOSIS

Arthroscopic Diagnosis (stage)	Histologic Diagnosis I	II	III	Total
1	11	1	0	12
2	1	5	0	6
3	0	2	0	2
Total	12	8	0	20

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