Arthroscopic Synovectomy for Rheumatoid Arthritis Using a Holmium:YAG Laser

TOSHITAKA TAKAGI, TOMIHISA KOSHINO, and RENZO OKAMOTO

ABSTRACT. ***Objective***. To determine the usefulness of the holmium:YAG laser system in arthroscopic synovectomy (ASSX) for treating rheumatoid arthritis (RA).

Methods. ASSX was performed on 15 knees (one Larsen Grade 1, 7 Grade 2, 7 Grade 3) and 8 ankles (6 Grade 2, 2 Grade 3) of 17 female patients with RA. The average age at ASSX was 50.6 years (25–70). The average followup period was 24.4 months (10–47).

Results. Seven out of 8 knees with grade 1 or 2 had reduced pain and swelling, as well as decreased average serum levels of C-reactive protein (CRP) (from 3.6 ± 1.1 to 1.4 ± 0.3 mg/dl). However, 4 out of 7 knees with grade 3 showed recurrence of pain and swelling along with persistent average serum level of CRP (from 4.3 ± 1.0 to 3.8 ± 1.0 mg/dl). All 8 ankles with Grade 2 or Grade 3 experienced reduced pain and swelling, while the average serum CRP levels did not change (from 3.2 ± 0.9 to 2.9 ± 1.0 mg/dl).

Conclusion. The Holmium:YAG laser was useful in ASSX for treating RA knees and ankles. (J Rheumatol 2001;28:1518–22)

Key Indexing Terms:
ARTHROSCOPY SYNOVECTOMY RHEUMATOID ARTHRITIS
KNEE ANKLE LASER

Arthroscopic synovectomy (ASSX) has been performed to treat rheumatoid joints, mainly the knee, to prevent or delay destruction of the joint[1-6]. Conventional tools for ASSX, including various punches and shavers, have disadvantages: they involve mechanically cutting the highly inflamed rheumatoid tissue, thus leading to postoperative inflammation; accessing and operating in smaller spaces with these tools have proved difficult. Recently, the holmium:YAG laser system was found to be effective for cutting joint tissue[7]. We applied the laser system to ASSX for treatment of rheumatoid arthritis (RA) of the knee and also evaluated its use in the smaller joints of the ankle.

MATERIALS AND METHODS

Patients. We performed ASSX in 23 joints of 17 female patients with RA who fulfilled the 1987 American College of Rheumatology criteria[8], and ranged in age from 25 to 70 years (average 50.6 yrs) from 1993 to 1996. The breakdown of the 23 joints evaluated radiologically using the Larsen Classification Grade[9] was 15 knees (one Grade 1 and 7 each in Grades 2 and 3); plus 8 ankles with 6 in Grade 2 and 2 in Grade 3 (Table 1). The followup period ranged from 10 to 47 months (average 24.4 mo) during which swelling and range of motion were evaluated and serum level of C-reactive protein (CRP) and rheumatoid factor (RF) were measured.

From the Department of Orthopaedic Surgery, Yokohama City University School of Medicine, Yokohama, Japan.

T. Takagi, MD, PhD, Assistant Professor; T. Koshino, MD, PhD, Professor; R. Okamoto, MD, PhD, Associate Professor.

Address reprint requests to Dr. T. Takagi, Department of Orthopaedic Surgery, Yokohama City University School of Medicine, 3-9 Fukuura, Kanazawa-ku, Yokohama, 236-0004, Japan.

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Medication. Disease modifying antirheumatic drugs (DMARD) used to control rheumatoid inflammation are shown in Table 1. During the course of study, there were 7 cases in which a major change of medication was prescribed.

Operative methods. The highly inflamed and vascular surface of the synovium was vaporized using the holmium:YAG laser, which has a wavelength of 2100 nm and a high affinity for water, set at 2 joules/pulse and 10 Hz (Figure 1). The nature of the laser allows arthroscopy using conventional irrigating solutions such as saline, and the depth of thermal injury is limited to 0.5 mm; vaporization and coagulation are achieved simultaneously without having to change the handpiece. The diameter of the laser probe tip is 1.7 mm, which permits easy access to a substantial area of the synovium (Figure 2). In the knee, the medial and lateral infrapatellar approaches were applied in conjunction with the medial and lateral suprapatellar approaches. In the ankle, calcaneal traction was used to open the joint space, followed by anteromedial and anterolateral approaches. The total energy delivered to the joint was 39 ± 11 kJ in knees and 13 ± 8 kJ in ankles. Bleeding remained minimal without having to use a tourniquet in any case, and a clear view was maintained throughout the procedure.

RESULTS

Among the 8 knees graded 1 or 2 at the time of surgery, the amount of pain and swelling decreased during the followup period (Table 1). Range of motion improved in 5 knees and did not change in 3 knees. The average range improved from 117° ± 8° to 136° ± 3°. The serum level of CRP was reduced in 6 out of 7 patients with knees of Grade 1 or 2, and did not change in one patient. The average CRP level was reduced from 3.6 ± 1.1 mg/dl to 1.4 ± 0.3 mg/dl. The serum level of RF was reduced in 5 of 7 patients. Among the 7 knees graded 3 at the time of surgery, the amount of pain and swelling also decreased for several months after the ASSX; however, these increased during the followup period in 4

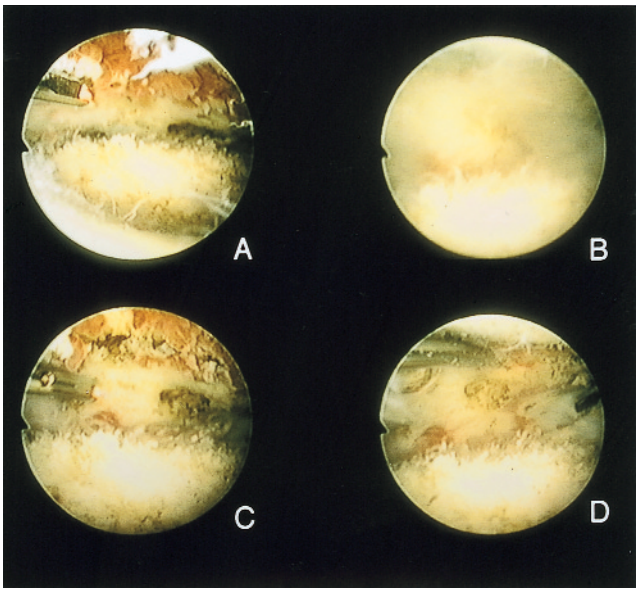

Figure 1. Arthroscopic synovectomy of a knee in a patient with RA using the holmium:YAG laser. A. Aiming the laser probe during synovectomy. B. Vaporization of inflamed synovium by laser pulses. C. Selective cutting of the synovium after the vaporization. D. Completed synovectomy with minimal bleeding.

Figure 2. Ease of access of the holmium:YAG laser probe in arthroscopic synovectomy in the tight space of the ankle joint (diameter 1.7 mm).

knees (Table 1). Range of motion decreased in 3 knees. The average range before ASSX was 126° ± 4°, and it did not change during the followup period (126° ± 5°). Serum CRP level increased in 2 out of 5 patients with Grade 3 knees. The average before ASSX was 4.3 ± 1.0 mg/dl, and did not change, even during the followup period (3.8 ± 1.0). Serum RF increased in all 5 patients. One patient with Grade 3

Table 1. Clinical and laboratory results of arthroscopic synovectomy (ASSX) with holmium:YAG laser.

Patient	Joint	Larsen Grade	Age at ASSX	Followup, mo	DMARD		Swelling	Pain	ROM		CRP*		IgM-RF†	
					pre	post	post	post	pre	post	pre	post	pre	post
1	Knee	1	62	46	None	GST	–	–	105	140	1.0	0	14.9	0
2	Knee	2	52	47	MTX	MTX	–	–	110	140	6.9	1.1	247.2	208.2
3	Knee	2	60	14	BUC	MTX	–	–	80	140	5.0	1.1	37.0	24.2
4	Knee	2	35	12	SSZ	SSZ	+	+	140	140	2.7	2.1	40.7	114.4
4	Knee	2	35	12	SSZ	SSZ	–	–	140	140	2.7	2.1	40.7	114.4
5	Knee	2	58	38	MTX	MTX	–	–	105	130	8.2	2.5	20.1	10.6
6	Knee	2	61	34	BUC	BUC	–	–	135	140	0.8	0.8	8.1	0.7
7	Knee	2	54	24	GST	GST	–	–	120	120	1.6	1.5	35.2	106.3
8	Knee	3	51	10	BUC, MTX	GST	–	–	110	120	5.8	4.6	131.9	172.2
8	Knee	3	51	10	BUC, MTX	GST	–	–	120	110	5.8	4.6	131.9	172.2
9	Knee	3	42	20	BUC, MTX	BUC, MTX	–	–	140	140	0.4	1.6	15.3	22.9
10	Knee	3	55	39	MTX	None	+	+	125	135	8.2	1.9	100.2	132.0
11	Knee	3	43	12	None	None	+	+	135	120	3.0	6.7	89.8	205.4
11	Knee	3	43	12	None	None	+	+	120	115	3.0	6.7	89.8	205.4
12	Knee	3	70	24	LOB, MTX	LOB, MTX	+	+	135	140	3.9	0.6	242.0	39.9
13	Ankle	2	53	39	GST	None	–	–	80	80	5.5	2.8	173.4	198.2
14	Ankle	2	25	31	BUC	BUC	–	–	70	70	0	0.5	14.9	26.0
14	Ankle	2	25	31	BUC	BUC	–	–	85	85	0	0.5	14.9	26.0
15	Ankle	2	63	24	GST, MIZ	MIZ	–	–	70	70	3.2	1.7	198.9	262.2
16	Ankle	2	60	10	BUC	BUC	–	–	60	60	5.1	6.8	2.5	0
16	Ankle	2	60	10	BUC	BUC	–	–	60	60	5.1	6.8	2.5	0
13	Ankle	3	54	21	None	None	–	–	50	50	4.9	2.8	184.8	198.2
17	Ankle	3	53	41	GST	BUC	–	–	65	65	1.4	1.0	12.7	28.2

DMARD: disease modifying antirheumatic drug; ROM: range of motion; CRP: C-reactive protein; IgM-RF: IgM rheumatoid factor; pre: at ASSX; post: at followup; GST: gold salt; MTX: methotrexate; BUC: bucillamine; SSZ: sulfasalazine; LOB: lobenzaride; MIZ: misoribine.
*mg/dl; †IU/ml.

knees underwent total bilateral knee arthroplasty 12 months after the ASSX. In all 8 ankles, the amount of pain and swelling decreased during the followup period (Table 1). The range of motion increased in 5 ankles. There were no significant changes in the levels of CRP and RF. There were no complications during the ASSX. Radiographs pre- and post-ASSX are shown in Figures 3 and 4.

DISCUSSION

While the etiology of RA remains to be identified, disease modifying antirheumatic drug (DMARD) therapy has been developed for its treatment. Whether these drugs can alter the course of RA, however, is not yet confirmed, but the severity of the side effects in some cases may prevent further application and worsen the condition[10,11]. Further, these drugs may not provide adequate treatment in certain patients, and therefore joint inflammation can continue, immediately requiring new or additional drugs or surgical intervention to prevent irreversible changes because destruction of these joints can be rapid and progressive. As for the surgical approach, the clinical results of synovectomy with arthrotomy have revealed that it does not alter the natural course of joint destruction caused by RA[12]. Recently, however, ASSX has received much attention and proved to be effective in treating rheumatoid joints[1-6]. Its advantages were further enhanced with the use of the holmium:YAG laser system introduced in this study. Compared to other lower energy laser systems used in ASSX[13,14], which may produce carbon debris and may therefore encourage further inflammation, the holmium:YAG laser delivers and concentrates much higher energy, can be used with conventional irrigating solutions, and simultaneously achieves ablation and coagulation of the tissue. Because of the last characteristic, a tourniquet was not needed in any case in this study. Moreover, since the tip of the holmium:YAG laser probe is only 1.7 mm in diameter, small joints were easily accessible, and iatrogenic damage to the fragile rheumatoid cartilage was avoided. In arthroscopic technique, obtaining a clear view is most important. With a highly inflamed knee, starting ASSX at the suprapatellar pouch is strongly recommended because it is easy to access. Then, a clear space to the rest of the joint can be opened.

Patients noted reduced pain and swelling from ASSX with holmium:YAG laser, and an increase in the range of motion in grade 1 and 2 knees was seen. These findings are consistent with those of previous studies performed using other apparatus in the ASSX[1-6]. Our study also demonstrated that the serum level of CRP diminished in cases of knees of either Grade 1 or 2, suggesting that ASSX may

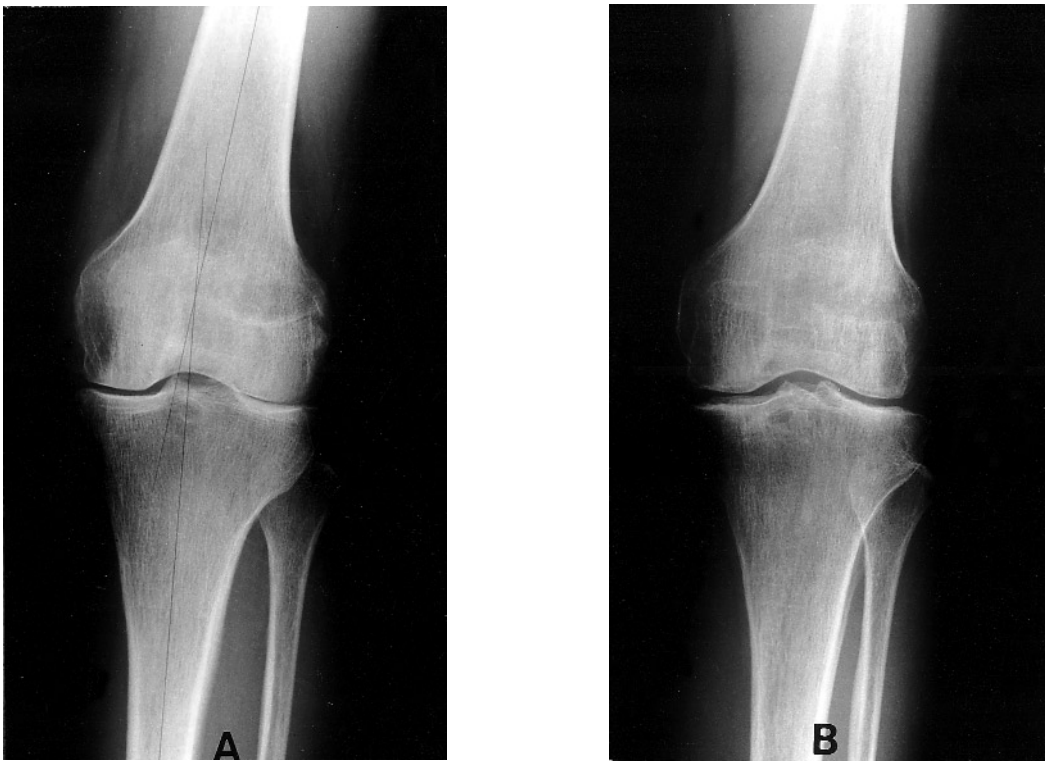

Figure 3. A. A 52-year-old woman with class 2 RA. Her left knee was grade 2, with severe pain and swelling with effusion. Serum CRP level was 6.9 mg/ml. B. Thirty-two months after arthroscopic synovectomy, pain and swelling had subsided, and there was no effusion. CRP decreased to 1.0 mg/ml. Radiograph showed no decrease of joint space.

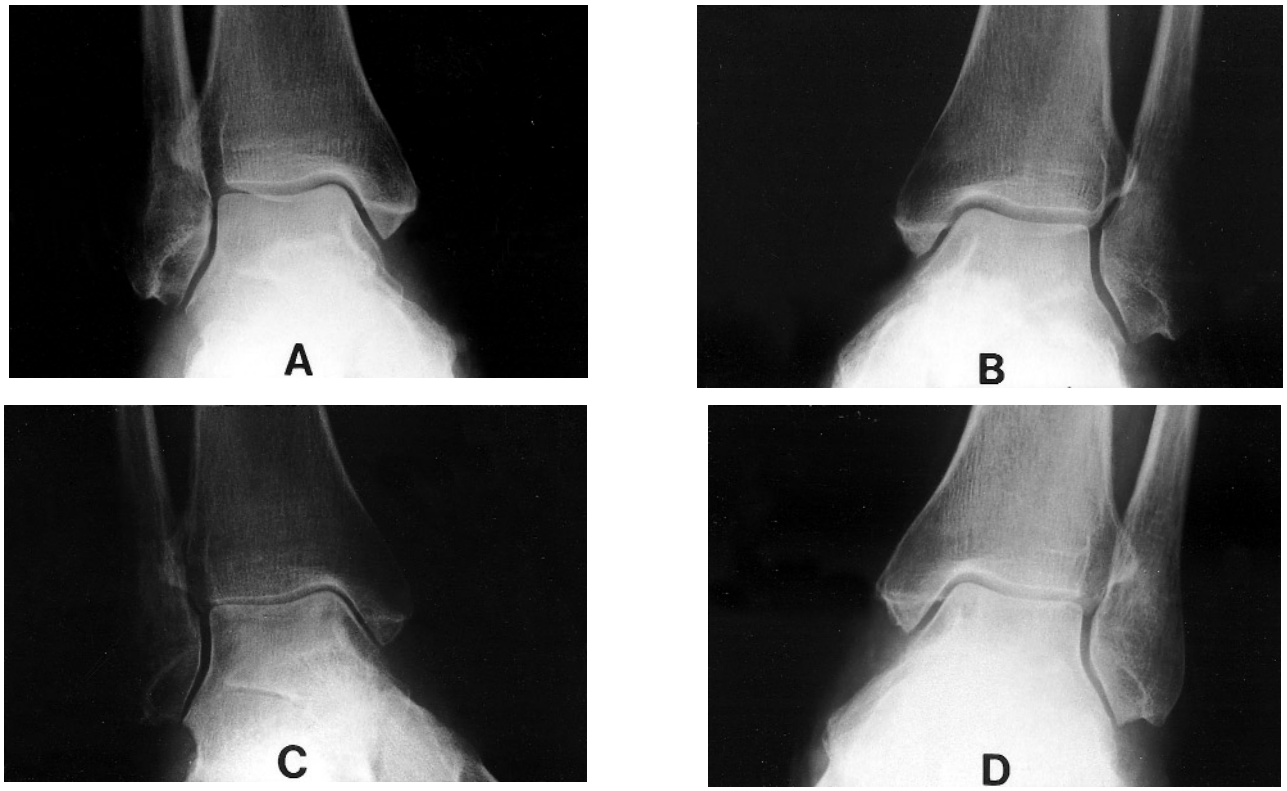

Figure 4. A 54-year-old woman with class 2 RA. Radiograph on June 22, 1993, showed bilateral ankles (A: right, B: left) with grade 2. The arthroscopic synovectomy was performed only on the left ankle on June 17, 1994. On June 3, 1995 (C: right, D: left), the pain and swelling of the left ankle had subsided and radiographic changes were minimal at 12 months after the ASSX, whereas joint space of the right ankle without ASSX was reduced, and radiolucency of the subchondral bone was increased after 2.5 years of observation.

reduce the source of proinflammatory agents such as cytokines, eicosanoids, enzymes, and autoantibodies. We should not disregard, however, that DMARD therapy might have been effective in cases in these early stages, which indicates that controlling the inflammation of RA could be the key to predicting and maximizing ASSX outcome. The poorer clinical results and increased serum CRP found in Grade 3 cases suggest that synovectomy alone cannot control chronic inflammation once cartilage degeneration has begun because rheumatoid cartilage can be a source of proinflammatory agents during the advanced course of the disease[15,16]. Further, satisfactory results of the ASSX in ankles should be emphasized because surgical alternatives including arthroplasty have not shown good results compared to that for knees and hips. Further, the holmium:YAG laser has been reported to increase the DNA synthesis of chondrocytes[17]. The effects on this matrix synthesis are now under further investigation in our laboratory.

ASSX performed with the holmium:YAG laser for treating rheumatoid joints at an early stage could serve as an alternative to DMARD therapy.

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