ATLAS OF ARTHROSCOPY

MASAKI WATANABE, M.D.
Director, Department of Orthopaedic Surgery
Tokyo Teishin Hospital

SAKAE TAKEDA, M.D.
Vice-Director, Department of Orthopaedic Surgery
Tokyo Teishin Hospital

HIROSHI IKEUCHI, M.D.
Vice-Director, Department of Orthopaedic Surgery
Tokyo Teishin Hospital

Third Edition

Igaku-Shoin Tokyo New York
Springer-Verlag
Berlin Heidelberg New York
1979

1

History of Arthroscopy

Since MAX NITZE invented his cystoscope in 1877, we have witnessed marked development in the application of endoscopy in many fields of medicine. Endoscopic examination of the articular cavity, however, stood neglected and no work was done on this subject until 1918, when KENJI TAKAGI, University of Tokyo, Faculty of Medicine (Fig. 1) made his first attempt at observing the internal appearance of a knee joint of a cadaver by means of a Charrier No. 22 (7.3 mm) cystoscope. TAKAGI's first arthroscope, which he constructed in 1920, was a primitive modification of a cystoscope having a diameter of 7.3 mm –said size rendering it unsuitable for practical use. With this apparatus, however, he managed to observe the interior of a tuberculous knee joint, using normal saline as a medium for dilating the joint cavity. He was extremely impressed, and became a life-long captive to the marvellous view thus obtained. All his efforts then centered on developing a practical arthroscope, centering his efforts on producing a thin arthroscope to be inserted into the knee joint without a skin incision.

TAKAGI attributed delay in the development of arthroscopy to factors such as narrowness of the articular cavity, complicated configuration of the joint and to its solid cartilaginous wall which inevitably prevented the endoscope from moving freely in the cavity.

In 1931, after many attempts to overcome these various difficulties, TAKAGI finally succeeded in developing his No. 1 Arthroscope, an instrument 3.5 mm in diameter (Fig. 2, 3). He proved its practical utility when applied to the knee joint, and other body cavities, subsequently publishing a report on these applications under the title "Panendoscope or Arthroscope." Against this background, the instrument was placed on the market.

The first report on arthroscopy was made by EUGEN BIRCHER (1882–1956) (Fig. 4) in 1921. He examined meniscus of the knee joint with a Jacobaeus laparoscope. About the same time, pioneering efforts in arthroscopy were also being made in Germany, in the United States of America and in other countries. Arthroscopic examination was carried out for diagnosis of meniscus disorders by P. KREUSHER (1925). In 1931 HARRY FINKELSTEIN and LEO MAYER devised an arthroscope for use in punch biopsy. The diameter of this instrument being 8 mm, its sheath was inserted into the joint through a skin incision. MICHAEL BURMAN reported further on the subject in 1931. He described arthroscopic investigation in smaller joints of cadavers, carried out arthroscopic investigations into the staining effect of the articular cartilage, while, at the same time, reporting on the subject of myeloscopy. In 1933 MICHAEL BURMAN and CHARLES SUTURO published a study on the fluorescence of the articular cartilage resulting from application of filtered ultraviolet rays. Clinical experience in arthroscopy of the knee joint, and an assessment of its value, were reported by MICHAEL BURMAN, HARRY FINKELSTEIN and LEO MAYER in 1934. Among

Fig. 1 Dr. K. TAKAGI.

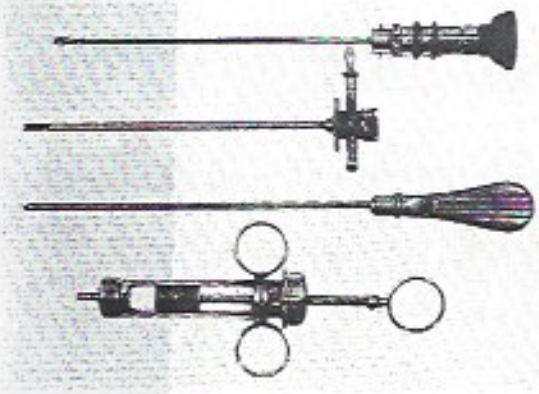


Fig. 2 Takagi No. 1 arthroscope.

Fig. 3 Takagi No. 1 arthroscope.

these, the work done by MICHAEL BURMAN (Fig. 5) of the Hospital for Joint Diseases in New York has been particularly extensive.

Still, in all of these instances, interest in the use of arthroscopy as a means of research and diagnosis was of short duration, and in each instance the use of the arthroscope for practical purposes had been abandoned.

Fortunately, however, the thread was again taken up by the publication of works by RENE SOMMER (1937), ERNST VAUBEL (1938), and WILCKE (1939). More recently, E.

Fig. 4 Dr. E. Bircher.

Fig. 5 Dr. M. Burman.

Hurter reported in 1955 on the availability of arthroscopy for the diagnosis of meniscus disorders of the knee joint.

In Japan, as has already been stated above, Takagi made his No. 1 practical arthroscope in 1931 and had applied it clinically. Subsequently he designed several new types of apparatus (Fig. 6–13), including 11 telescopes and several types of trocar sheath, as well as various other accessories for specialized purposes. His No. 7, 10 and 11 telescopes were the thinnest—having a diameter of 2.7 mm. His No. 11 arthroscope, for example, was small enough for use in the canine knee joint. With his No. 4 arthroscope it was possible to obtain a close-up view of up to 3 mm by using its adjustable focus. This type of instrument was exhibited in the Japanese Government Display at the International Exhibition held in Paris in 1937. His No. 12 arthroscope consisted of two telescopes, a flexible

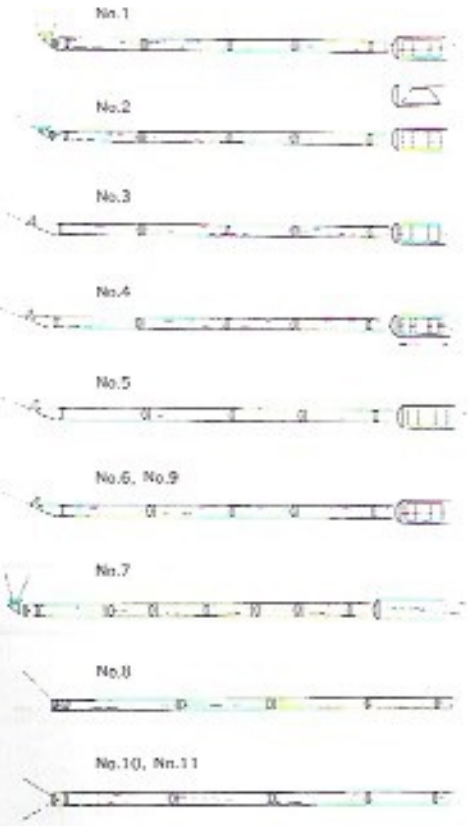


Fig. 6 Lens system of Takagi arthroscope.

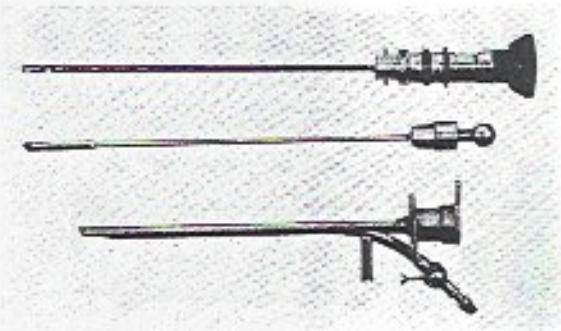


Fig. 7 No. 4 sheath. Cross section is oval so that both a telescope and a flexible biopsy punch or cauterizer can be introduced into the joint.

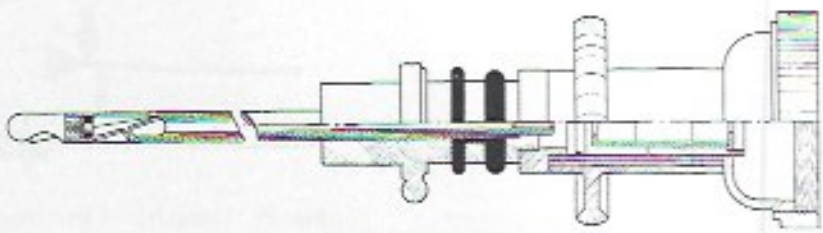


Fig. 8 Takagi No. 4 arthroscope.

Fig. 9 Lens system of No. 4.

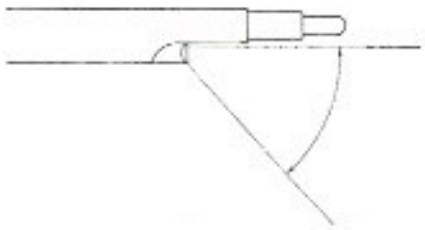


Fig. 10 Takagi No. 8 arthroscope.

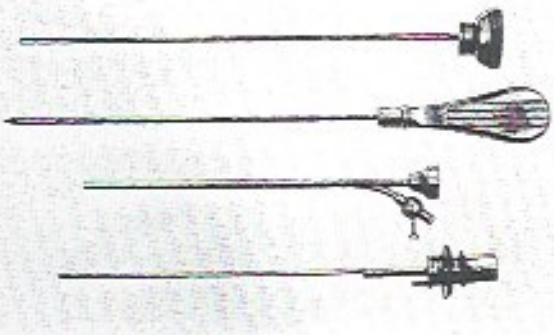


Fig. 11 Takagi No. 10 arthroscope.

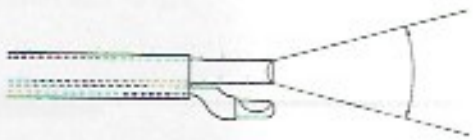


Fig. 12 Takagi No. 10 arthroscope.

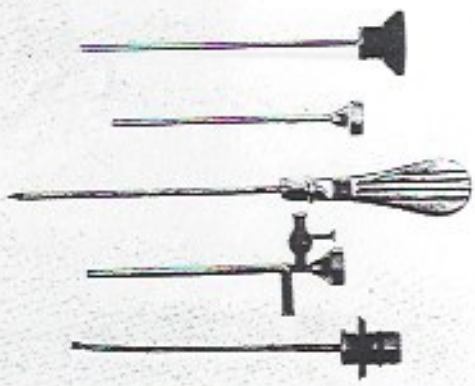


Fig. 13 Takagi No. 11 arthroscope.

biopsy punch and a cauterizer plus accessories. These instruments were introduced through the same sheath having an outside diameter of 4.0 mm and manipulated under arthroscopic visualization (Fig. 14). The No. 12 arthroscope was an advanced endoscope for that era. However, its fragility was a problem. Furthermore, repairs required many days, or even months, at that time.

Still, TAKAGI and his associates did persist in carrying on basic, as well as clinical investigations. In 1932 TAKAGI succeeded in taking black and white photographs through the arthroscope (Fig. 15). Then, in 1936, he and IINO managed to take color pictures, as well as cinematographs on 16 mm black and white film, through the arthroscope. At the Annual Meeting of the Japanese Orthopaedic Association in 1938, the main presentation connected with the arthroscope was presented by TAKAGI, who in addition to discussing arthroscopy in general, provided details regarding clinical experiences with 16 cases of tuberculous arthritis, 14 cases of chronic arthritis, 4 cases of osteoarthritis, 4 cases of sarcoma

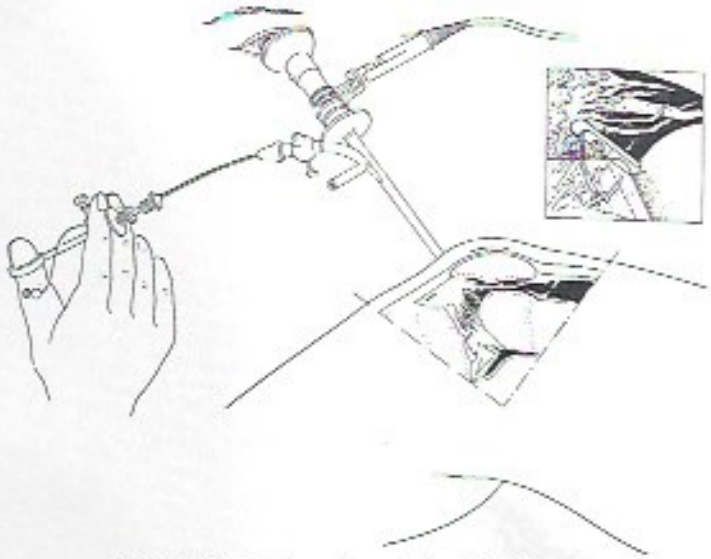


Fig. 14 Punch biopsy through No. 12 arthroscope.

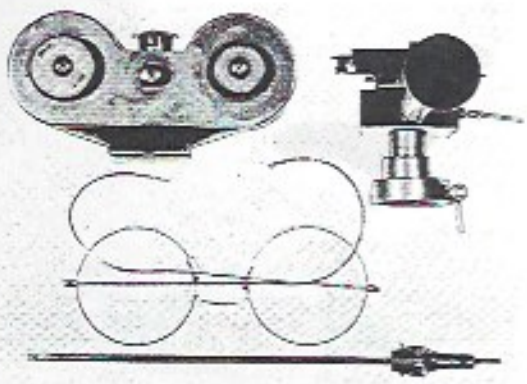


Fig. 15 Camera, attachment, eyeglass and supplementary bulb.

involving the knee joint, 4 cases of rheumatoid arthritis, 3 cases of contusion of the knee, 3 cases of fracture of the patella, 3 cases of the knee joint of a paralyzed limb (poliomyelitis), 2 cases of meniscus disorders, 2 cases of Charcot's joint, 1 case of tuberculous hip joint, 1 case of suppurative arthritis and 1 case of dislocation of the patella (Fig. 16–19).

Basic investigations essential for arthroscopic interpretation were carried out by Saburo Iino, Masashi Miki, Fumihide Koike and others, as will be described in the next chapter.

1

2

3

4

Fig. 16

1. Contusion of the right knee joint. Dilatation of the blood vessels.
2. A flap of torn lateral meniscus (left knee).
3. Pannus over the outer rim of lateral meniscus (right knee).
4. Torn lateral meniscus (left knee).

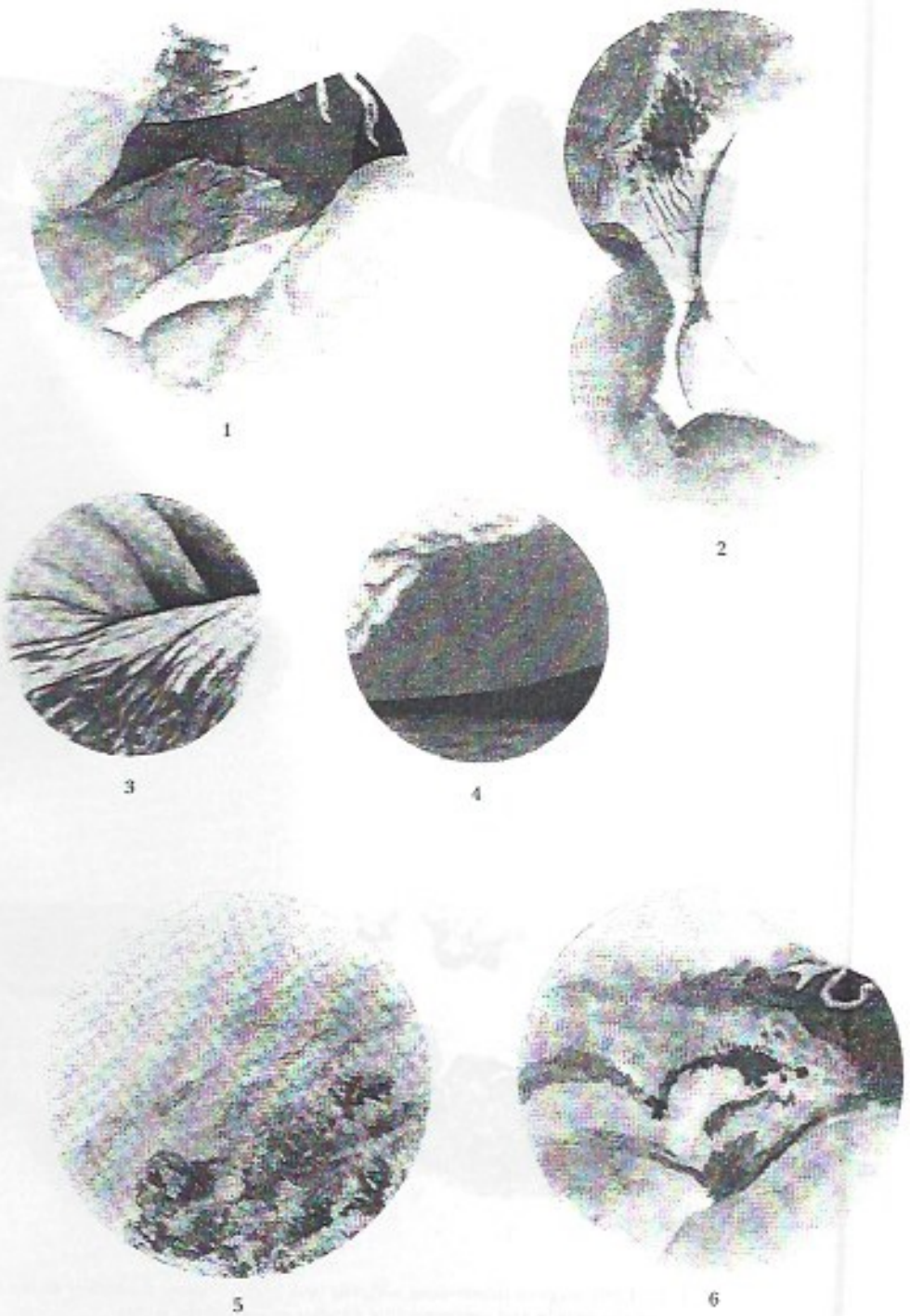


Fig. 17

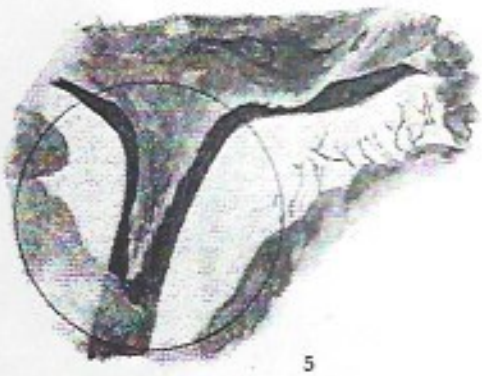
1. Contusion of lateral femoral condyle, patella and infrapatellar fat pad.
2. Paramenisical tear of the medial meniscus (left knee).
3, 4. Chronic synovitis (left knee). Marked dilatation of blood vessels in the bottom of suprapatellar recess.
5, 6. Tuberculous arthritis (left knee). Synovial membrane and cartilaginous surface are covered with granulation and necrotic tissues.

1

2

4

3



5

Fig. 18

1, 2. Early stage of tuberculous arthritis (left knee). Ulcer formation in the cartilaginous surface of the patella and correspooding patellar groove of the femur.
3. Tuberculous arthritis (right knee).
4. Tuberculous arthritis (left knee). Granulation tissue with fibrinous coating in the bottom of suprapatellar recess (below right). Blood vessels in the plica synovialis suprapatellaris (upside right).
5. Flail joint (right ankle joint). Fat pad protruding into the talotibial joint space.

Fig. 19

1. Prepatellar bursitis. Thread-like tissues are seen.
2. Invasion of giant cell sarcoma into the knee joint. Tumorous tissue is seen between anterior cruciate ligament and plica synovialis infrapatellaris.
3. Invasion of osteochondromyxosarcoma into the knee joint.
4, 5. Bone cyst in the femur.

The arthroscope was also used by TAKAGI as a panendoscope which could be employed for other body cavities. For instance, he employed it for myeloscopic purposes in the case of *spina bifida* (Fig. 20), for observation of the interior of tuberculous abscess in the iliac fossa and for internal observation of the effects of phonation training after surgery for the cleft palate. TAKAGI also laid down routine methodology for arthroscopy of the knee, shoulder, elbow and ankle joint. The most frequently used of these was, of course, that for the knee joint. Further investigation was interrupted by advent of the World War II and resumed on a reduced scale during the difficult, immediate post-war period.

In 1954 arthroscopy again was adopted as one of the main subjects at the Annual Meeting of the Japanese Orthopaedic Association. At that time, "The development and present status of the arthroscope" was presented by MASAKI WATANABE, "Clinical arthroscopy of traumatic disorders of the knee joint" by KOZO SATO, "Clinical arthroscopy of tuberculous arthritis" by WATARU KAWASHIMA and "Clinical arthroscopy of osteoarthritis" by MASAKI WATANABE.

The first edition of this Atlas was published in 1957. The development of the Watanabe No. 21 arthroscope in 1959 opened the way for consistently successful observation of the meniscus and for color photographic recording. Consequently, in 1969, the second edition of the Atlas appeared illustrated with color photographs. Knee arthroscopy with the No. 21 has subsequently been spread throughout the world through the efforts of Drs. ROBERT JACKSON, WARD CASSCELLS, RICHARD O'CONNOR, ROBLES GIL, GÁBOR KÁTONA, MILLET TISSON, HENRI DORFMANN and others.

Fig. 20 Meningocele, female aged 50, 1954. Mycloscopy with WATANABE No. 15 Arthroscope.