

ARTHROSCOPY OF THE KNEE

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The History of Arthroscopy

BACKGROUND OF ENDOSCOPY

The search for diagnostic certitude has led physicians to the endoscopic exploration of almost all of the previously sacrosanct body cavities. Yet the history of endoscopy is less than 200 years old. In the beginning, the problems were twofold: (1) how to introduce light into a body cavity to illuminate the structures within, and (2) once lit, how to see them.

Most historians attribute the beginning of endoscopy to Phillip Bozzini (1773–1809), who in 1806 presented his *lichtleiter* to the assembled members of the Joseph Academy of Medical Surgery in Vienna. The original instrument is long lost, but the apparatus reflected the light of a candle into a body cavity by means of several specula. Through the back of the instrument, there was a small opening, so that the cavity could be visualized. Although the principle of the experiment was appreciated, the members of the academy did not accept the *lichtleiter* and condemned it as a toy.

A few years later, Pierre S. Ségalas (1792–1875) used the same principle of light conduction to inspect the urethra and bladder. He demonstrated his instrument to the Royal French Academy, but the illumination it provided was minimal, and he failed to interest most of the surgeons in attendance.

A.J. Desormeaux (1815–1882) introduced the "cystoscope" in 1853. He developed a light source called a gazogene lamp, which used a mixture of turpentine and alcohol. The light generated by this lamp was then reflected into the bladder by a series of silver tubes and mirrors. A small opening in the center of a mirror enabled him to visualize the mucous membranes of the bladder. Improvements in instrumentation soon followed, but these new developments

were largely concerned with transmitting light more effectively from an external source to the interior of the bladder.

The next major advance came in 1876 when Max Nitze (1848-1906) introduced a light source *into* the bladder cavity. Nitze developed an instrument that used a heated platinum wire filament near the end of a tube that also contained reflectors. His main problem was that the lamp was extremely hot and had to be cooled. He was apparently heavily criticized for his "fire and water" invention.

Meanwhile, on the other side of the Atlantic Ocean, another invention was being perfected which proved to be a milestone in the development of endoscopy. In 1880, Edison introduced his incandescent lamp, a filament in a glass bulb, and in 1886, both Leopold Van Dittel (1815-1898) and Nitze incorporated the Edison lamp (called the Mignon lamp) into the cystoscope.

Shortly after this significant advance, Nitze also introduced the telescope principle to enlarge the field of vision, and in 1890 Nitze produced the first photocystoscope. R. Kutner took the first endoscopic photographs in that year.

Improvements in lighting and optics then followed in rapid succession. In 1907, the Zeiss Company improved their optical system by using a combination of lenses in a different type of prism (the Amici prism). This produced a vertical and sharper image which was also much brighter because less light was lost in transmission. Before this, the image was always inverted.

ARTHROSCOPY

Professor K. Takagi (1883-1963) of Tokyo University was the first to explore the interior of a human knee joint in 1918 (Fig. 1-1). He used a cystoscope, Charrière number 22, and from this experience he began to design an endoscopic instrument particularly suitable for inspecting joint cavities. The first "arthroscope" Takagi designed was 7.3 mm in diameter and contained no lens system; however, it had an incandescent bulb at the tip. Because it involved direct visualization down a narrow tube, the field of vision was very small. Moreover, the large diameter of the scope made it relatively impractical for use in human knee joints. Takagi therefore concentrated on reducing the diameter of the scope and made a series of models with progressively smaller diameters. By 1931, he had reduced the diameter to 3.5 mm. Subsequent models were even smaller; number 11 had a diameter of 2.7 mm and was designed for use in the canine knee. With the smaller scopes, a lens system was needed to magnify the images seen.

The original impetus for this work was a desire to diagnose tuberculosis of the knee joint in its earliest stages, and possibly therefore to influence treatment. The end result of the tuberculous knee was frequently an ankylosed joint, and the inability to bend the knee was a serious social as well as physical disability in Japan.

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Fig. 1-1. Kenji Takagi (1883-1963), Professor of Orthopedics, University of Tokyo. The first man to adapt endoscopy to the knee joint (1918).

Takagi's next scope, the number 12, was 4 mm in diameter; this slightly larger, more robust scope enabled the surgeon to perform biopsies under direct vision. His number 13 introduced forward oblique and side viewing lenses for the first time. Takagi developed the number 14 scope in the mid 1930s, and this instrument (which was 5 mm in diameter and had a straight ahead lens system) was used in 1936 to take the first color photographs of the inside of a knee joint. The photographs were obtained using an additional light source through a second insertion (Fig. 1-2).

Professor Takagi's talented pupil and successor was Dr. Masaki Watanabe (Fig. 1-3), who continued to develop new arthroscopes when optical and electronic technology was becoming one of the major industries of Japan. Dr. Watanabe also continued the consecutive numbering system for each new scope.

The number 19 "Watanabe" arthroscope proved extremely practical and was widely used in his clinic for several years.

The first *Atlas of Arthroscopy* was published by Watanabe in 1957 and was illustrated by intra-articular views painted by Mr. S. Fujihashi.

Another major advance came in 1959 when the number 21 arthroscope was developed. This instrument had a sheath 6.5 mm in diameter, a straight ahead view wide angle lens that provided a field of vision of 102°, and an excellent tungsten light source at the tip. For almost 10 years, this instrument has been the instrument of choice for arthroscopists around the world. Excellent photographs can be obtained using the number 21 scope.

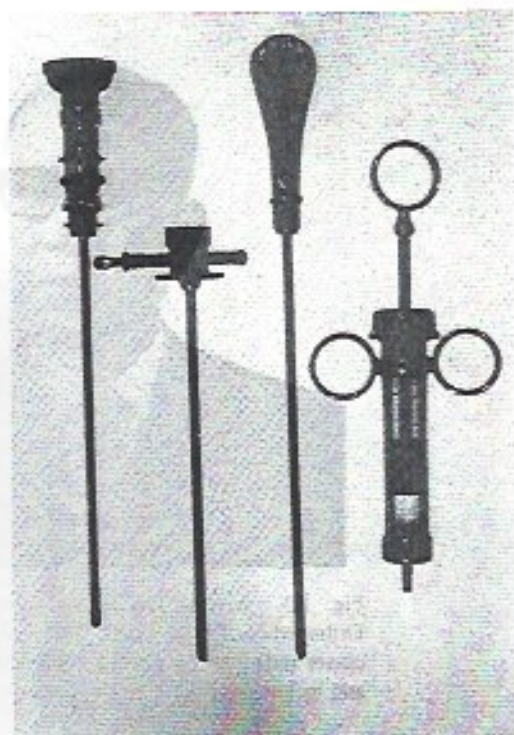


Fig. 1-2. An early Takagi arthroscope (number 13), 1932.

In Watanabe's number 22 scope, developed in 1967, fiber light is used for illumination at the expense of a slightly reduced field of vision.

Watanabe's number 23 scope was a prototype fiber optic scope 2 mm in diameter which was rapidly improved with models 24 and 25.

As is often the case, another pioneer on the other side of the world to Takagi was at the same time, and quite independently, exploring endoscopic applications to the human knee joint. In 1921 Professor E. Bircher (1882-1956) (Fig. 1-4) in Switzerland reported his experience in "Arthroendoscopy". In 1922, using a Jacobeus laparoscope built by George Wolf of Berlin and a technique that involved distending the knee joint with oxygen and nitrogen (using an artificial pneumothorax apparatus), Bircher reported his findings in 20 cases of traumatic osteoarthritis. It is of clinical interest that he commented, almost in passing, that insured patients did not get well as quickly as those who did not have insurance.

In 1924 Philip H. Kreuscher (1884-1943) presented to the Illinois Medical Society a paper that was published in the Illinois Medical Journal in 1925.

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Fig. 1-3. Masaki Watanabe, current Professor of Orthopedics, Tokyo Teishin Hospital. Takagi's successor and pioneer in developing modern arthroscopes and techniques.

Handwritten note:
Masaki Watanabe
The Great One

His topic was semilunar cartilage disease, and he pleaded for the early recognition of meniscal damage by means of the arthroscope. Unfortunately, his paper gave no details about the arthroscope that he developed and used, although it provided a picture of the instrument.

In the early 1930s, Dr. Michael Burman (1901-1975) at the Hospital for Joint Diseases in New York City began his studies on arthroscopy. In a classic article published in October 1931, Burman described his work to that date using an arthroscope constructed by Mr. R. Wappler. The trocar was 4 mm in diameter, and the telescope was 3 mm in diameter. A constant irrigation system was used.

Using this instrument, Burman explored all possible approaches to the knee joint and also explored arthroscopic applications in other joints. The instrumentation of that time, however, was not robust and occasionally he had problems with the light source. Thus, Burman's colleagues only partly appreciated his work.

Drs. L. Mayer, H. Finkelstein, and C.J. Sutro, at the same hospital, also explored possible applications of endoscopy to synovial joints, and over the next 8 years they were responsible with Dr. Burman for several significant articles on the subject.



Fig. 1-4. Eugen Bircher (1882-1956), Aarau, Switzerland, developed his own technique of arthroendoscopy using a Jacobeus laparoscope and was the first person to publish an article on the subject.

In 1937 and 1938, articles by Drs. R. Sommer and E. Vaubel were published in the German literature.

Over the next few years, possibly because of the martial turmoil in the world at that time, there was a noticeable hiatus in publications on the subject, although Dr. F. Koike in 1943 and Dr. T. Okamura in 1945 published articles in the Japanese literature. Perhaps also the technology of that time was still insufficient to permit adequate and useful application of the technique to joints.

In 1955 E. Hurter, writing in French, described a "new" method of examining joints by an arthroscope, and in 1956 and 1957 R. Imbert also published articles in French on the significance and technique of arthroscopy. In 1960 R. Suckert wrote in German about photoarthroscopy of the knee joint.

In 1960 the Watanabe number 21 arthroscope was made available for general use, and in 1967 J. Robles-Gil and G. Katoma in Mexico published articles on the use of this instrument in studies of rheumatoid joints.

In 1964 the senior author of this book lived in Tokyo while working in the Department of Anatomy at Tokyo University. He heard about the work of Dr. Watanabe but was extremely skeptical. His first reaction on seeing the interior of a joint with such clarity was typical of everyone who has also had this opportunity: enthusiasm and appreciation for what the future might hold through applying this technique to the study of joint disease and trauma. Dr. Watanabe and his colleagues Dr. H. Ikeuchi and Dr. S. Takeda taught the author as much as they could about arthroscopy, and on returning to Canada in 1965, the author in turn taught others and revived interest in the technique in North America.

Since that time, many individuals—including Drs. Jayson, Dixon, Ohn-sorge, Dorfmann, Dreyfuss, Casscells, O'Connor, Joyce, Johnson, Eikelaar, and many others—have made significant contributions to the field of arthroscopy. These and other interested arthroscopists from around the world formed the International Arthroscopy Association in Philadelphia in 1974, with this objective: "to foster by means of arthroscopy the development and dissemination of knowledge in the fields of orthopedics and medicine in order to improve the diagnosis and treatment of joint disorders." Dr. Masaki Watanabe was elected the first president.