

O'CONNOR'S
Textbook of

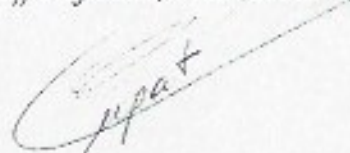
with 19 Contributors

Arthroscopic Surgery

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HISTORICAL BACKGROUND

Professor Kenji Takagi of Tokyo first applied the endoscopic principles of cystoscopy to the examination of the knee joint in 1918.¹⁰ He viewed the tuberculous knee through a cystoscope, and the clarity of the view encouraged him to design specific instruments for the inspection of joints. The first arthroscope designed by Takagi was a 7.3-mm instrument, available in 1920, which had a lens system similar to the Charrier No. 22 cystoscope. Because its size made it impractical for routine use, he continued to improve it, until, finally, in 1931, he devised a 3.5-mm arthroscope that included a lens system that was suitable for inspection of the smaller joints when they were distended with a saline solution.

Gas arthroscopy was first undertaken by Bircher in 1921.¹ He reported the results of his findings in knees distended by oxygen or carbon dioxide and examined with a Jacobaeus laparoscope.

The first writings appeared in the American literature in 1925, when Kreuzer reported on the use of the arthroscope in diagnosing meniscal disorders.⁷ Further advances were reported in the American literature when Finkelstein and Mayer reported the results of using punch biopsies under arthroscopic control in 1931.⁵ In the same year, Burman described an experimental cadaver study of arthroscopic visualization of the hip, knee, ankle, shoulder, elbow, and wrist joints.² Shortly thereafter, in 1934, Burman, Finkelstein and Mayer reported their findings on arthroscopy and mentioned the significance of the use of the arthroscope for an accurate diagnosis of knee disorders.^{3,4}

The European medical community had reports from Sommer in 1937, Vaubel in 1938, and Hurter in 1955, in which they described their methods, techniques, and findings after using the arthroscope in the examination of joint derangements.^{6,8,9}

All of these authors described both techniques and findings, but it was for the Japanese orthopaedic community, under the guidance of Takagi, Watanabe, Takeda, and Ikeuchi, to develop the single- and multiple-puncture techniques for performing arthroscopic surgery of the knee. Finkelstein and Mayer had reported their use of the punch biopsy under arthroscopic control in 1931, but it was Takagi who separately described the use of a flexible biopsy punch and cauterizing instrument under arthroscopic control. Passage of the instrument through an arthroscopic sheath was the cornerstone in the development of other instruments.

The Historical Background section of this chapter was contributed by Wesley M. Nottage. Masaki Watanabe wrote the section on Arthroscopic Surgery, The Early Years, and Robert C. Bechtol wrote the section on The O'Connor Years.

The Early Years

In 1950 I developed a sheath that was intended for use separate from the arthroscope, through which the punch biopsy could be introduced into the joint cavity and brought into the arthroscopic field of vision. The use of this separate sheath was a new idea, and it proved to be an exploitable technique, one that led subsequently to the development of a small knife, scissors, and other instruments that could be passed through the sheath in a similar fashion. Following the development of these instruments, removal of loose bodies became a routine procedure. Significant examples of arthroscopic surgery in the early stages of its development include the following cases.

The first case of true surgery under arthroscopic control was performed on March 9, 1955. Arthroscopy of a symptomatic knee demonstrated a pedicled oval tumor on the medial part of the suprapatellar recess (Fig. 1-1). Because the tumor was too big to be removed through the sheath, using arthroscopic visualization, it was held, its base was divided, and it was extracted together with the sheath from the knee joint. The subsequent histological diagnosis was that of a partially necrotized xanthomatous giant cell tumor.

On February 22, 1961, an osteochondral loose body was extracted from a 25-year-old female who had developed a symptomatic loose body following a patellar dislocation. It was removed under arthroscopic control (Fig. 1-2).

I performed my first case of arthroscopic partial meniscectomy on May 4, 1962. Arthroscopy of a symptomatic knee in a young Japanese man disclosed a typical L-shaped tear of the medial meniscus (Fig. 1-3A). A separate sheath was introduced into the knee through a small puncture wound, a scissors was passed down into the joint, and the flap was divided at its base. Owing to its size, the flap was passed into the suprapatellar recess, and a Kocher clamp was introduced percutaneously from the medial side to clamp the meniscal fragment. It was then extracted from the joint without opening the knee (Fig. 1-3B). The patient returned home on foot the same day, and 6 weeks later he had a full range of motion of 0° to 140°. He continued playing basketball.

Encouraged by these results, on July 26, 1967, I performed arthroscopy on a runner, which demonstrated a partial rupture of the anterior horn of the lateral meniscus (Fig. 1-4A). The medial infra-



Fig. 1-1. A pedicled tumor in the bottom of the suprapatellar recess.



Fig. 1-2. A loose body in the suprapatellar cavity.

patellar approach was used for the arthroscope, and surgical instruments were passed into the joint from the lateral infrapatellar approach. The frayed meniscal flap was cut at its base and removed under arthroscopic control.

A 26-year-old woman with right knee pain underwent arthroscopy in 1970. It was noted that the plica synovialis mediopatellaris had two insertions (fenestrated shelf), and that the remainder of the joint was normal (Fig. 1-4B). These insertions of the shelf were divided with scissors introduced through a separate sheath, and the patient's symptoms resolved completely.

Also in 1970, Dr. Hiroshi Ikeuchi of our orthopaedic clinic succeeded in totally removing a discoid lateral meniscus under arthroscopic visualization.

Overall during the period from 1958 to 1967, 154 knee joints with suspected internal derangements underwent arthroscopy in our orthopaedic clinic; 106 meniscal lesions were noted. Open surgery was performed on 58 of these 106 cases, and arthroscopic meniscectomy was performed on six cases. The results for those six cases of arthroscopic partial meniscectomy were excellent by comparison to the results of open meniscectomy.

Until 1959, arthroscopy of the knee joint, including the first case of arthroscopic surgery, was carried out with the #13 arthroscope. Because color photographs of the menisci were difficult to obtain, several attempts were made to improve the arthroscope. After working with the trial arthroscopes #14 to #20, Dr. Takeda and I succeeded in developing the #21 arthroscope, and we wrote of the proper technique for its use in 1960. Through the development of this arthroscope, color photography of the interior of the knee joint finally became possible. This was the arthroscope with which most American pioneers in arthroscopy learned their techniques and practices.

Based on the experience we had obtained from multiple arthroscopies, we first published the *Atlas of Arthroscopy* in 1957. Subsequently, based on 800 cases using the #21 arthroscope, we published a second edition of the *Atlas of Arthroscopy* in 1969.

In 1973, I presented the preliminary report on the "Selfoc Needlescope," a fiberoptic instrument that has since been refined and manufactured in diameters of 2.2 mm and 1.7 mm. This device has been applied to the examination of small synovial joints, including the shoulder, elbow, wrist, and metacarpophalangeal joints of the upper limb. In the lower extremity, arthroscopic examination has

been carried out on the hip, knee and ankle and on subtalar and metatarsophalangeal joints as well.

With these developments, arthroscopic meniscectomy became a very interesting and exciting field of orthopaedics. In 1970 and 1971, Richard O'Connor visited our clinic to learn of our experiences, and on his return to the United States he wrote often about his efforts in arthroscopic surgery. From his efforts I was convinced that O'Connor would be the man to perfect the methodology of arthroscopic meniscectomy, bringing most types of meniscectomy within the scope of arthroscopic control.



Fig. 1-3. (A) L-shaped tear of the medial meniscus (right knee joint). (B) Removed flap.

Fig. 1-4. (A) Partial rupture of the lateral meniscus (right knee joint). (B) Plica synovialis mediopatellaris with two proximal insertions. One insertion is being cut with intra-articular scissors.



The O'Connor Years

Inspired by the work and teaching of Watanabe and his associates in Japan, O'Connor returned to America in 1971 with the keen anticipation of putting into practice those skills he had learned from the Japanese. Takagi, Watanabe, Takeda, and Ikeuchi had used the single-puncture and multiple-puncture (or triangulation) techniques for arthroscopic surgery of the knee. Synovial biopsies, intra-articular cautery, removal of loose bodies, resection of tumors, partial meniscectomies, and total excision of discoid lateral menisci had all been achieved under direct vision using the arthroscope. There were, however, only relatively few of these cases.

Although many American surgeons were indifferent, even opposed, to the new approach, two orthopaedic surgeons in North America were already making the use of the arthroscope known and advocating its acceptance when O'Connor returned. Interest in arthroscopy had been stimulated when Robert Jackson, of Toronto, Canada, began teaching arthroscopy in 1965, after he had been taught the use of the instrument by Watanabe, Ikeuchi, and Takeda in Tokyo. In 1971, a paper entitled "Arthroscopy of the Knee Joint (a review of 150 cases)" by S. Ward Cassells, of Wilmington, Delaware, was published in the *Journal of Bone and Joint Surgery*. He presented a summary that compared the accuracy of arthroscopy to other diagnostic measures. In 1972, Jackson and Abe reported on the role of arthroscopy in the management of disorders of the knee, reviewing their experiences with 200 cases. These authors were using the #21 Watanabe arthroscope. These reports significantly increased the interest in arthroscopy in the United States.

John Joyce III and Michael Harty organized the first course on Arthroscopy in the United States in 1973 at the University of Pennsylvania in Philadelphia. The course was repeated in 1974 with faculty and other attendees from several countries. At the close of this meeting the International Arthroscopy Association was founded, with Watanabe as its first President, Jackson as Vice-President, Cassells as Secretary, and O'Connor as Treasurer.

In 1975, the American Academy of Orthopaedic Surgeons began sponsoring instructional courses on arthroscopy and arthrography of the knee under the leadership of John McGinty, of Newton Lower Falls, Massachusetts. Unique plastic knee models were devised by Robert Eilert, of Denver, Colorado, to allow surgeons to practice

with the arthroscope. These courses were so well accepted that arthroscopy became firmly established as a diagnostic tool among many orthopaedic surgeons.

Meanwhile, as the diagnostic use of the arthroscope was being established, O'Connor was successfully improving the standard arthroscope and designing an operating arthroscope with the cooperation of the Richard Wolf Medical Instruments Corporation. His all-consuming goal was to work out a practical method of doing meniscectomies with the arthroscope. In 1974, he began performing partial meniscectomies in carefully selected cases. He made a drawing of each meniscal tear he encountered and began devising a systematic technique for resection of the mobile portion of the meniscus in the various lesions. He carried sketches of the meniscal tears with him and quite often asked friends their opinions as to which attack on the lesion seemed best. Many thought the operative procedures he proposed were impossible, so advanced was his thinking. Others felt that the notion of partial meniscectomy was fallacious, being contrary to previous custom and teaching.

In 1975 O'Connor reviewed his cases of partial meniscectomy and found that the early results were encouraging when compared to classical open meniscectomy, with less pain and morbidity, shorter disability, and shorter hospital stay. He then began attempting partial meniscectomy on a less selective basis. At this time he was routinely using the Wolf prototype of his operating arthroscope. He believed that as techniques and operating instruments improved all torn menisci could be treated operatively with the arthroscope.

After the Second Congress of the International Arthroscopy Association (Copenhagen) in July, 1975, O'Connor took a cottage in Denmark, sequestered himself for a time, and wrote several chapters of the book on arthroscopy he was hoping to have published. He included an entire chapter on arthroscopic partial meniscectomy. This was also the year that H. R. Eickelaar of the Netherlands published his thesis on *Arthroscopy of the Knee*.

In early 1976 O'Connor provided Robert W. Metcalf of Salt Lake City and myself with identical prototypes of the O'Connor operating arthroscope for trial and critical evaluation. Through work with the operating arthroscope some of the problems of meniscal resection were solved.

At this time, very few of the accessory instruments being used were designed specifically for arthroscopic surgery. Quite frequently instruments were borrowed from other surgical special-

ties, or makeshift instruments were used. For example, although a specific meniscal probe was eventually manufactured, initially probing was performed using a crochet hook.

A breakthrough in arthroscopic surgery was made when it was discovered that cuttings of the meniscus did not have to be removed from the knee with each cut, but could be simply washed out later with no apparent ill effects. After learning this, those doing meniscal surgery removed the wires from their basket forceps, thereby allowing the cuttings to float free in the joint. This simple change in technique saved an enormous amount of operating time. Thereafter, basket forceps were made without the transverse wires underneath the basket.

Aware of the need for special instruments, O'Connor set up a machine shop with his assistant, Charles Erichsen, in order to modify and redesign some of the instruments being used at that time.

The first book on arthroscopy to be published in North America was *Arthroscopy of the Knee*, the work of Jackson and D. J. Dandy, published in 1976. This book included a small section on intra-articular surgery with the arthroscope, and it mentioned removal of the small loose bodies, biopsies, the use of transfixing pins in loose osteochondral fragments, and the removal of meniscal tags, as well as the excision of displaced bucket-handle tears of the meniscus.

In 1977, O'Connor's book *Arthroscopy* was published. In the preface he wrote, "My purpose in preparing this monograph is to share knowledge and experience with those interested in arthroscopy during what I believe to be its watershed period"—a sentence truly indicative of his desire to encourage others in this special field. The book contained a sizeable section on arthroscopic surgery, including the treatment of meniscal tears, loose bodies, the medial synovial shelf, osteochondritis dissecans, intra-articular adhesions, and fibrous ankylosis. In the chapter on "Partial Meniscectomy" he classified the various tears of the meniscus and indicated which were amenable to partial meniscectomy, and he described the techniques to be used.

In the same year, Lanny L. Johnson, of East Lansing, Michigan, was developing the motorized intra-articular shaver together with Dyonics, Incorporated. Later, Johnson was successful in working out the details of other motorized instruments, including rotary cutters for meniscectomy. The introduction of motorized equipment revolu-

tionized some of the techniques of arthroscopic surgery, such as meniscectomy and synovectomy.

As a result of the now flourishing interest in this type of surgery and because of a wide acceptance by the general public, many other surgeons turned to this field and made significant contributions. Space here permits naming only a few. Robert Metcalf, of Salt Lake City, simplified some of the meniscectomy procedures and showed that lateral patellar retinacular release could be done under arthroscopic control. His instructional courses on Arthroscopic Surgery of the Knee are well known. Robert Carson, also of Salt Lake City, developed an ingenious thinner, flatter operating arthroscope. James Guhl, of Milwaukee, Wisconsin, perfected a technique of treating osteochondritis dissecans by transarthroscopic pinning or bone grafting. Dinesh Patel, of Boston, Massachusetts, became known for his study of the synovial plica, as well as for arthroscopic resection of symptomatic medial patellar plicae. Patel is also known for the proximal approaches that he has described. Kenneth DeHaven, of Rochester, New York, popularized arthroscopic examination of the acutely injured knee, which has led to the performance of a series of meniscus repairs rather than excisions for peripheral tears of the meniscus. Robert Stone, of Dallas, Texas, worked out a technique of meniscectomy under arthroscopic control. Jan Gillquist, of Sweden, popularized the central, or transpatellar, ligament approach for arthroscopic knee surgery and documented the advantages of arthroscopy in acutely injured knees. Nils Oretorp, also of Sweden, devised special instruments and did basic research on the meniscal ligamentous complex. Hans R. Henche, of Germany, and Einar Eriksson, of Sweden, demonstrated the advantages of arthroscopy of the knee in a gas (CO₂) medium.

The first courses on Operative Arthroscopy were organized by O'Connor in 1978. In that year and in 1979 a series of three courses were sponsored by the University of California at Los Angeles. These meetings were so well attended that O'Connor was encouraged to plan the First International Seminar on Operative Arthroscopy, which was held in Hawaii in 1979 with a faculty drawn from various countries. The seminar was intended to be an annual program, and the second one was held in 1980. These annual seminars have been continued by the University of California, Los Angeles (UCLA), but, tragically, O'Connor died on November 29, 1980, a month after the second seminar. The first course on Arthroscopic Surgery to

be sponsored by the International Arthroscopy Association was held the next week in Long Beach, California, and was dedicated to him.

Writing of O'Connor, his associate H. Shahriarce said, "... he will be long remembered for his courage and integrity and his insistence on the importance of arthroscopic surgery." Certainly it was Dr. Richard L. O'Connor's independent thinking, single-minded determination, and, finally, his convincing surgical results that established arthroscopic knee surgery as a valuable and accepted procedure.

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