

Editorial

"In My Experience...My Years Involved in the Development and Use of Arthroscopy"

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The author discusses his multiyear experience with arthroscopy.

I want to opine on the consequential inventions and developments that I believe were most beneficial for improving arthroscopic surgery during my 43 years in practice. Since I have enjoyed working on arthroscopic product development with many different companies throughout my career, I have been keenly aware of the progress being made. This task inspired me to examine the many important innovations to formulate this conclusion.

I was fortunate to begin my Orthopedic Practice in 1981, about the time the arthroscope was being introduced into surgical practice in the U.S.

My belief that the most memorable and useful developments for arthroscopic surgery were these five:

1. The digital video camera and its refinements.
2. The mechanical rotatory shaver and burr.
3. The mechanisms for intraarticular suturing and reattaching torn tissue to bone.
4. Biologics, including allografts, PRP, and stem cell research.
5. The 4K, pre-sterilized, cloud-connected single-use arthroscope by Pristine Surgical.

I will expand on each of these to illustrate my logic.

1. When I was introduced to arthroscopy (originally only for the knee) during my Orthopedic residency train-

ing, the scope was a primitive tool. Illumination of the joint was achieved using an incandescent light bulb on the tip of a zero-degree telescope. Not uncommonly, the bulb would break off in the joint. There was no camera. Visualization required putting one's eye next to the ocular of the scope. The eyepiece and the cords connecting the scope to the camera and light box were covered by a sterile plastic sheath. Often, this setup resulted in the surgeon getting a splash of water on his or her face. It was only possible for an observer to watch the operation by trading places with the surgeon and viewing into the eyepiece. Shortly thereafter, an articulated eyepiece was developed to permit another person or assistant to simultaneously view the joint.

The addition of the 13-pound video camera by Hitachi became available around 1982-3. This revolutionized the surgical experience by allowing the entire surgical team to view and participate in the operation. Additionally, the surgery could be recorded and shared for teaching, documentation, and research. Within a few years, the video cameras were improved and miniaturized, as well as sealed to allow sterilization. Eventually, the camera was ex-

^a Dr. Stephen J. Snyder began practice with the Southern California Orthopedic Institute (SCOI) in Van Nuys, a suburb of Los Angeles in 1981 as one of the five founding partners. He became interested in shoulder arthroscopy in 1982. Since shoulder arthroscopy was a nascent and unfamiliar surgical procedure at the time, there was very little information available to guide an interested surgeon wishing to learn this new surgical discipline. To enable the performance of arthroscopic repairs of ruptured rotator cuff and biceps tendons, as well as the reattachment of torn ligaments for shoulder instability, Dr. Snyder partnered with several newly formed surgical equipment companies to develop a complete catalogue of novel miniature arthroscopic surgical tools. Some of the novel devices he invented and partnered on were cannulas, (Dry Docs, Crystal Cannulas) a complete suite of suture anchors (Revo®, Mini Revo®, Super Revo®, BioAnchors®, Threvo®), suturing tools (Spectrum -2®), various other arthroscopy tools (Tommy Bar, Liberator elevator®), shoulder braces (full line of Don Joy and DJOrtho shoulder braces including SCOI Braces®, Quadrant braces®, UltraSling® Gen 1-5), Suture Shuttle® tools, post op shoulder dressings(ProWick®), knot tying tools (Loop handle knot pusher®) etc. Snyder has also designed (with industry) a special device to support the shoulder during arthroscopy in the OR (STAR 3 Point Shoulder Holder®), designed a soft support sleeve to use with the shoulder holder (STAR® sleeve and Gelzone Sleeve), designed a unique industrial strength irrigation tower to be used to elevate bags of irrigation in the OR, and developed a electrical alarm warning system (Levelert®) to monitor level of irrigation fluid.

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panded to 3-chip digital technology. This has not changed much up to the present.

2. Once it was feasible to comfortably view the intra-articular anatomy and pathology, it was incumbent for surgeons to have tools to repair and resect damaged tissues. Simple tools like basket punches, miniature scalpels, and electro-surgical wands were useful for resecting tissue. It was the invention of the mechanical-rotatory shaver and burr by Dr. Lanny Johnson that truly revolutionized the practice. Torn and damaged tissues of the rotator cuff, meniscus, and cartilage could be easily resected and removed from the joint resulting in smooth edges and no residual debris.
3. Also, there was a need to repair and reattach torn ligaments and tendons to bone. The soft tissue stitchers were initially fashioned like traditional sewing needles with extended handles for manipulation from outside the body. These were cumbersome to handle. The next iteration was a hollow needle with a "shuttle" device that could carry a suture across the tear. Additionally, suture "punches," first introduced by Doctor Richard Caspari, further simplified the task. These tools could use a suture shuttle or a nitinol needle with a suture-holding eyelet on the tip to pass the suture.

The task of fixing torn tissue to bone was the next challenge. Initially, to reattach the torn rotator cuff, the approach was via a small trans-deltoid incision on the lateral shoulder. The sutures were inserted through the torn tendon and fixed to the bone using staggered trans-osseous drill holes in the tuberosity. Although this method worked well, it required an incision, thus complicating the recovery. Again, Lanny Johnson led the way. He developed a system that used a metal and later resorbable polymer staple that pinned the shoulder rotator cuff back to the bone. This was also used for the labrum and biceps repair. The first intra-osseous suture anchors were simple fish-hook-like devices made with barbs of the flexible metal, nitinol. The suture was inserted into an eyelet on the shaft of the anchor. Once the anchor was seated into a bony socket, it was available to reattach the damaged tissue to bone. Soon, these single anchors were modified to have two and, later, four barbs to afford a stronger hold and accept more than one suture. Since these barbed anchors could not be easily removed for revision surgery or when the sutures broke while tying knots, a screw-in anchor system was developed. These now have eyelets large enough to hold three sutures if needed and can be removed for revision. Finally, various materials are used to fabricate the latest anchors. Titanium, PEEK plastic, and resorbable polymers are the most common, but some also use calcium phosphate material and reprocessed bone.

The newest addition is a push-in anchor made of suture-like material or "soft anchor." These anchors are relatively small but have quite impressive holding

power in bone. They are considered safe because they won't damage the joint cartilage if they dislodge. The soft anchors work best in dense bone, such as the glenoid or subchondral bone, and are available with up to three sutures per anchor.

Several types of anterior cruciate fixation devices have helped restore stability and function to a damaged knee. These first were adaptations of cancellous bone screws, which were later modified by removing the heads and improving the thread pattern.

A final type of suturing tool is the meniscal repair device. This clever invention is designed to pass sutures around and through a torn portion of the meniscus thus stabilizing it while it heals. This leads to better long-term outcomes and reduces future arthritis.

4. To enhance, protect, and reinforce the healing of tendons, ligaments, bones, and cartilage, researchers discovered many useful biological materials. The first example I recall is a method to release bone marrow into the surgical site. This was performed to aid the healing of the ACL, articular cartilage defects, and rotator cuff repair. Usually, a miniature "micro-pick" was used to puncture the cortical bone, thus allowing the bone marrow to bubble out into the repair area. A platelet clot forms over the damaged area with a web of fibroblasts filled with stem cells and later with capillaries. The pluripotent stem cells help the regeneration of the damaged tissues.

It wasn't long before other methods to utilize the components of blood and bone marrow were developed. Some of these techniques included platelet-rich plasma and cultured mesenchymal stem cells. Also, stem cells collected from adipose tissue have shown promise. It remains to be proven if these methods will improve healing sufficiently to justify the cost of employing them.

Additional biological tissues of allograft and xenograft derivation have shown promise. A human dermal allograft has been used to reinforce and bridge defects in severely damaged tendons. Bone and cartilage grafts are useful for filling bony defects and restoring damaged articular cartilage. Future patients will undoubtedly see additional beneficial uses for biological tissues and cells as researchers continue to innovate.

5. A recent development that will likely revolutionize the practice of arthroscopy is the development of the single-use, pre-sterilized, 4K, cloud-connected arthroscope by Pristine Surgical. (note- I am currently the Chief Medical Officer of Pristine Surgical and an investor.)

The technology uses a 4K video chip and an LED light located on the tip of the scope. The scope connects to the IPU (Image Processing Unit) connected to a HIPAA-compliant Internet Cloud. This setup affords immediate data storage for videos, images, OP reports, and patient data. Restocking the scope after it is used is facilitated by scanning a QR code. A new scope is ordered to keep the PAR level current. The benefits of having this single-use arthroscope

are many. The scope is always new and never needs maintenance or refurbishing. There is no upfront cost for expensive arthroscopy stacks containing fiber optic light and cables, expensive reusable scopes, or cameras. Additionally, the set-up and take-down time is only a few minutes, and there is no need for sterile processing since the scope and camera are pre-sterilized. The time-saving and rapid room turnover can lead to more efficient use of the O.R. and reduce the cost of cleaning and sterile processing of the arthroscope and camera.

I hope this brief recollection of my top five historical and modern innovations in arthroscopy is interesting to you. Of

course, there have been innumerable other developments that I have not mentioned. I have enjoyed my life's work in product development and arthroscopic surgery and wish you all similar satisfaction and happiness.

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