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Reviews

BASIC PRINCIPLES OF ARTHROSCOPY: REVIEW OF LITERATURE

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Abstract: Since its invention at the beginning of the 20th century by Hans Christian Jacobaeus, arthroscopy has brought about a radical change in the treatment of many pathologies in the field of Orthopedic Surgery and Traumatology. In order to carry it out, both materials are needed that allow access to the interior of the joint (scalpels, needles, light sources, etc.), and utensils that allow treating the lesion in question (tweezers, motors, vaporizers, etc.) . A fundamental element in this procedure will be the arthroscopy tower. Due to its characteristics, arthroscopy benefits from the advantages of minimally invasive surgery, minimizing pain and surgical aggression, postoperative complications or hospital stay, among others. However, it is necessary to take into account its technical difficulty and the need for a learning curve. In the present work, we intend to carry out a sweep through the most important basic points that make up this procedure for the diagnosis and treatment of joint pathology, from its definition to its benefits and modalities.

Keywords: ”arthroscopy”; “arthroscopy tower”; "optics"; "joint"; "engine"; “infusion pump”; "barter"; “milling system”.

1. Introduction

Arthroscopy is considered one of the great revolutions of the 20th century in the field of medicine, and more specifically in musculoskeletal pathology. Unlike other achievements at this stage, such as joint replacement surgery or internal fixation, arthroscopic surgery is the most minimally invasive surgical approach. The term arthroscopy alludes to its function, since it is made up of two Greek roots: *arthro-,* which means articulation, and *-scopia,* which means visualization. For this reason, arthroscopy is defined as that surgical procedure in which, through small incisions, a camera called an arthroscope is inserted, as well as surgical instruments, which allow the visualization and treatment of a certain joint [1].

Arthroscopic surgery as such originates in the 20th century. It was a Swedish professor of internal medicine, Hans Christian Jacobaeus, together with the company Georg Wolf of Berlin, who developed a laparoscope to examine the inside of the knee. It was this very procedure that received the name "arthroscopy." Over the years, other important figures emerged, who were perfecting the techniques and utensils used, coming to develop those that are used in hospitals today [1-3].

2. Essential material for an arthroscopy and elements of an arthroscopy tower

In order to carry out an arthroscopy, on the one hand, materials are needed that will help to access the interior of the joint, among which it is possible to find bis turís to make the access portals, Abbocath® needles to locate the second portal, a source of light to illuminate said cavity, optics, an irrigation system, a sheath with a blunt trocar, a visualization system made up of a camera and monitors or a palpator hook, among others. Once inside, there is a large number of utensils that will allow treating the lesion in question. Among them are the Basket® forceps with their different angles and blade sizes, an arthroscopy motor for tissue regularization, as well as vaporization or radiofrequency equipment [4].

In another order of things, it must be borne in mind that, depending on the joint or tendon to be explored, it will be necessary to resort to certain specific materials. For example, for shoulder arthroscopy, both an articulated table that can be adapted to different positions, as well as a traction and decoaptation system will be needed.

For its part, the arthroscopy tower is a mobile element where all those components that will form part of the arthroscopy team are located. The devices that make it up include monitors (currently with HD and even 4K high-definition technology), imaging equipment (camera and image or video capture), light source, arthroscopy motor and motor console, infusion, coagulation and radiofrequency systems (electric scalpel and vaporizer), among others [4-6].

2.1 Optics

The optics, endoscope or arthroscope (Figure 1), is that element that allows capturing all those images existing in the surgical field to take them to the video camera and from this to the monitors.

It consists of three types of angle of vision (0º, 30º and 70º), although the 0º angle is little used, since, when working on small areas, the frontal vision it generates is not usually useful. Therefore, the most used optics are 30º and 70º. In addition to the angulation, the optical diameters must be assessed, the most commonly used being 1.9, 2.7 and 4 The smaller ones are usually used for the examination of small joints, such as the wrist, while the larger ones are reserved for the examination of larger joints, such as the hip [4-6].

Figure 1: Image from an optic, endoscope, or arthroscope

There are three maneuvers to increase the field of vision: rotation, pistoning and sweeping. The first, as its name suggests, consists of rotating the optics with the light cable without moving the camera, thereby enlarging the field of view. The second manoeuvre, the piston stroke, is performed by advancing or withdrawing the optic, without actually leaving the joint itself. The last one, the scan, consists of using the portal as a pivot to maneuver the arthroscope and with it move the vision vertically or transversely [4].

2.2 Light Source

It is the element that allows a beam of light to be introduced into the surgical field during surgery. From a light bulb, light is transmitted through a fiber optic cable to the field. In the past, 250 W halogen or 300 W xenon sources were used, although today the most widely used are LED [4,5].

It is important to take special care of the light cable, since its quality will depend on the percentage of fibers that remain intact. Another detail to take into account will be the white balance before the start of the arthroscopy, in order to have a good natural vision of the structures that are going to be explored.

Lastly, you must ensure that the light cable to be used is compatible with both the existing light source and the lens of the arthroscope being used.

2.3 Camera and image or video recorder In

arthroscopy, as well as in other endoscopy modalities, microcameras are used coupled to the optical system by means of a head. Everything that it records is sent to the image capture system (Figure 2), a means that will allow its digitization for later editing or storage. Currently it is possible to find operating rooms in which high definition (HD) cameras are used, and even some with 4K, with HDMI (high definition multimedia interface) connections [4-6].

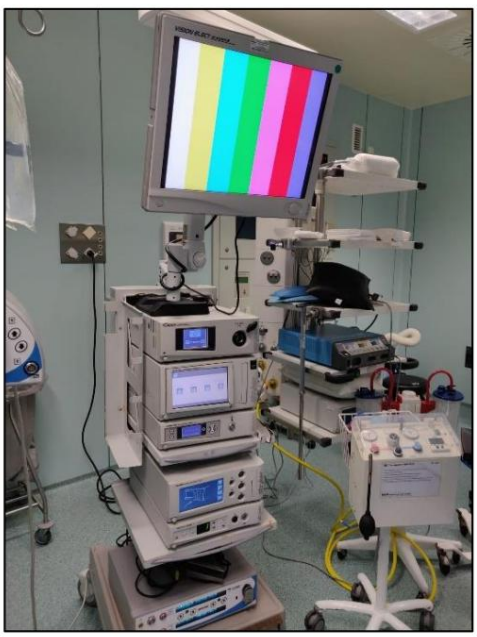

Figure 2: Camera and image or video capture

2.4 Trocar and

cannulas The trocar (Figure 3) is perhaps the device that makes it possible to differentiate between open and endoscopic surgery, since thanks to it it is possible to access the arthroscope, as well as the different surgical instruments, in the joint. It consists of an irrigation bridge, connected to an irrigation system, and a spherical-shaped sheath or sleeve, which ends in a point or awl, which allows it to pass through the different tissues, and which it will be withdrawn later to be able to introduce the surgical instrument. In order not to damage the cartilage when inserting the sheath, a blunt trocar should always be used. The sheaths have developed pressure-tight closures, so that the optics do not pop out when the irrigation pump is used [4,5,7].

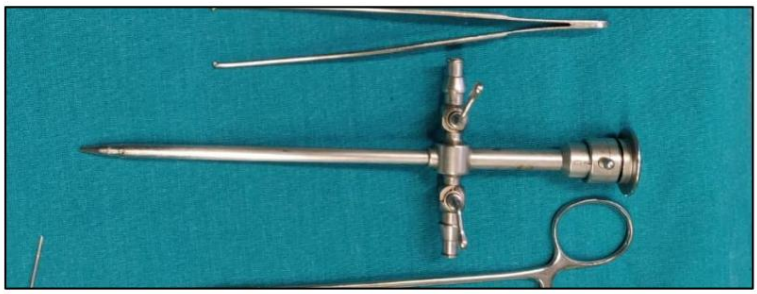

Figure 3: Trocar with irrigation bridge and sheath

The cannula, like the trocar, allows the introduction of optics and surgical material into the surgical field. They are threaded, smooth or with fins, transparent (which allow to see those instruments that enter the joint) or colored, with or without trocar and of different calibers and lengths. Its use is recommended when there is a large amount of soft tissue, or when it is necessary to slip knots [4,6].

2.5 Tweezers and manual instruments

Composed of instruments that offer a large number of functions (dissection, cutting, grasping or grasping, clamping, etc.). Depending on their use, we can find the Basket® forceps, with different blade sizes, depths and angles, which are used to regularize tissue or resection of meniscal lesions. On the other hand, there are the Grasping® forceps (straight, angled, smooth, with slots, with spoons, etc.), which are used to extract intra-articular materials or to grasp different tissues (Figure 4) [4].

As in other types of endoscopy, arthroscopy also has thread guides and suture forceps, which consist of a needle to pass the thread, retrieving it with the same forceps. Regarding suture passers, there are direct (those that go through the tissue with the final suture) and indirect (go through the tissue with a transporter cable that must be replaced by the suture that is desired to go through the tissue).

In addition, a Palpator Hook is also available, which facilitates the handling of the different intra-articular structures, as well as Wissinger Rods, through which it is possible to exchange portals and create portals from the inside out or from the outside in. inside, thanks to the help of dilators [4,5,7].

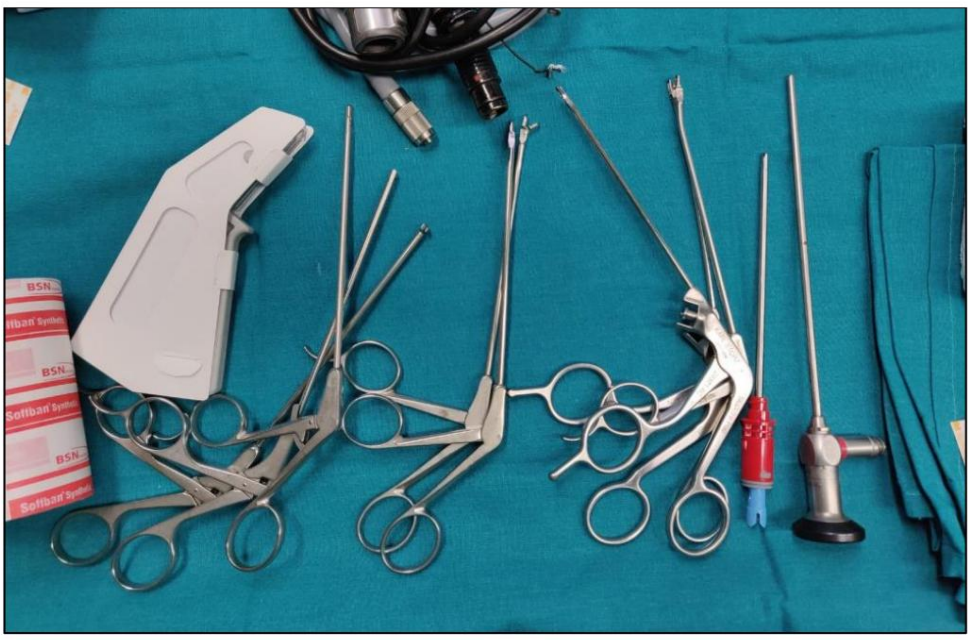

Figure 4: Tweezers and manual instruments

2.6 Arthroscopy motor and milling systems

They are those elements used for the regularization and molding of the different tissues (meniscus, synovium, cartilage, bone, etc). They come in different shapes and sizes: rounded, polyhedral, pineapple-shaped, etc. On the one hand, the synoviotome is used as a soft tissue resector, while the burr is mainly used for blooding and bone remodeling [7].

2.7 Infusion pumps

The infusion pump allows constant flushing during the various phases that make up an arthroscopic surgical procedure. It facilitates both the irrigation and the suction of the different intra-articular fluids, reacting to variations in intra-articular pressure and thereby allowing constant joint distension. Its use is not mandatory, although the current trend is towards its routine use [4].

2.8 Coagulation and radiofrequency systems

As in other endoscopic modalities, including open surgery, both electric scalpels and vaporizers are used for resection or regularization of soft tissue, as well as for coagulation of bleeding blood vessels [7].

3. Benefits and disadvantages of arthroscopy

As previously mentioned, arthroscopy is a minimally invasive surgical technique, and as such it uses small incisions to introduce the necessary material to visualize joints such as the shoulder, elbow, wrist, hip, knee or the ankle. Thanks to this, arthroscopy benefits from the characteristics of minimally invasive surgery. The realization of these small incisions allows a minimization of pain and the biological response to the aggression that the intervention itself entails. Likewise, it reduces possible postoperative complications, hospital stay and offers a better aesthetic result. For all these reasons, it improves family and work reincorporation, therapeutic efficacy and reduces hospital resources [1,8].

The main disadvantage or inconvenience of arthroscopic surgery would be the technical difficulty itself, as well as the learning curve required to achieve results that offer a significant improvement compared to open surgery [1,6,7].

4. Main joints where arthroscopy is performed

Arthroscopy is not only limited to the therapy of the large joints, since over the years its use has been extended for the diagnosis and treatment of pathologies as diverse as synovectomies in the wrist or the extraction of foreign bodies in the ankle. . The shoulder is perhaps one of the joints most benefited from the implantation of endoscopic surgery. This allows for the repair and treatment of rotator cuff syndrome, as well as supraspinatus tears, subacromial entrapment, SLAP injuries, or acromioclavicular injuries. For its part, elbow arthroscopy allows the evaluation and treatment of various pathologies such as septic and inflammatory arthritis, the extraction of loose bodies, intra-articular fractures or joint stiffness, among others [9,10].

Arthroscopic wrist surgery facilitates the extraction of a pathology as common as intra-articular ganglions, as well as the performance of synovectomies, the treatment of scapholunate dissociation or the repair of triangular fibrocartilage [8].

Knee arthroscopy (Figure 5) is the most frequent surgical procedure in orthopedic surgery. This allows not only diagnostic arthroscopy, but also the repair of pathologies as frequent as meniscal and cruciate ligament tears or tears. It also allows the extraction of free bodies, synovial membrane biopsy or even the treatment of joint stiffness [4,11].

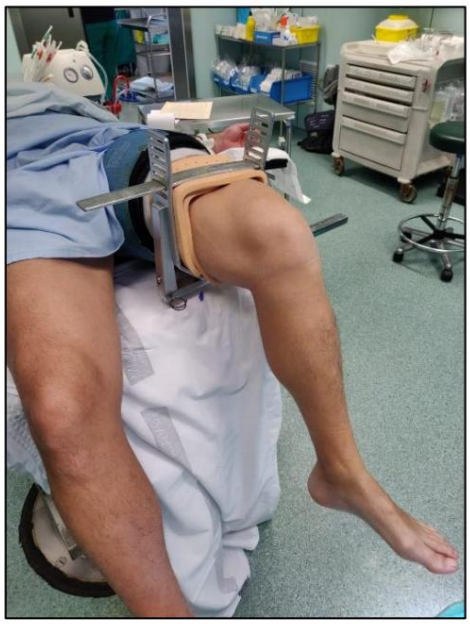

Figure 5: Patient positioning for knee arthroscopy

Regarding the hip, arthroscopy facilitates its exploration and treatment, as well as the different structures that form it, such as femoro-acetabular impingement or labral tears. Its use is not limited here, it is also possible to perform intra-articular lavages, and the treatment of tendinopathies, such as iliop soas [12,13].

Lastly, ankle arthroscopy makes it possible to treat osteochondral lesions or synovitis, repair fractures, instability or entrapment of the ankle (anterior ankle impingement), remove foreign bodies and perform intra-articular lavages [14-16].

5. Working pressures and water infusion systems

One of the key elements when performing an arthroscopic intervention is the correct visualization of the joint. To achieve this, not only is the proper functioning of the elements that make up the endoscope system essential, but those that are responsible for adequate joint distension are also important. To achieve this, different irrigation systems have been developed with the purpose of introducing liquid during the intervention. Its pressure and the flow generated allow distension of the joint space, as well as the elimination of debris and blood. Various irrigation systems exist, such as those that work by gravity, with or without pressurized bags, or those that use automatic perfusion pumps [4,6,9].

5.1 Gravity irrigation

It is the most frequent arthroscopic irrigation system. Using hydrostatic pressure, the saline bag is placed above the plane in which the joint to be operated is located, and a pneumatic cuff can also be used around the joint.

same bag. The difference in height between the bag and the surgical field will determine the pressure gradient and the flow generated. It represents a safe, simple, and cheap system, although it can compromise visualization, since fluctuations in the inflow cause surgery to be temporarily interrupted [9].

5.2 Irrigation using automatic perfusion pumps

Automatic perfusion pumps (Figure 6), unlike gravity irrigation, allow the generation of a specific and constant flow, and even with higher pressures than those achieved with other mechanisms, which leads to better vision and cleaning of the surgical field during the intervention. By not relying on gravity or reservoir volume and height, infusion pumps can even maintain high flow in the presence of high pressures, allowing them to flush and distend a joint in a short time [9].

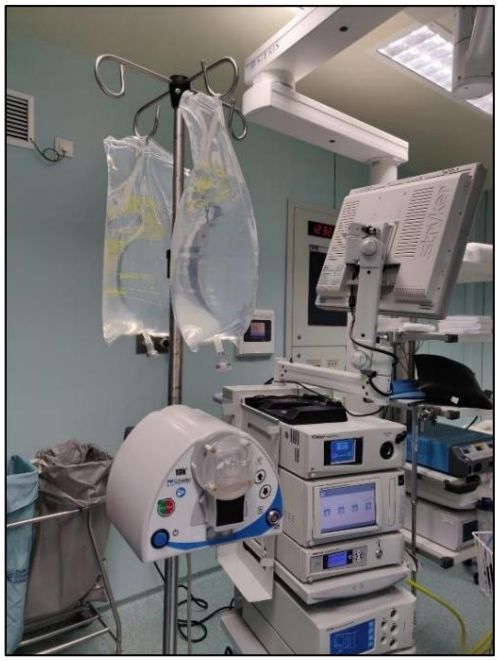

Figure 6: Irrigation by automatic perfusion pump

6. Dry vs. wet arthroscopy For

the correct visualization of any joint, traditional or wet arthroscopy has required distension of the joint capsule with serum, in order to create a correct working cavity. However, this procedure has not been exempt from risks and complications, since the expansion itself favors inflammation of the structures involved, and with it a greater post-surgical edema. Some authors even describe the possibility of generating a compartment syndrome due to the infiltration and extravasation of fluid into the surrounding tissues through portals or trocars. To all this must be added the anatomical distortion generated by the infusion of fluid in the joint, as well as the difficulty of performing surgery after arthroscopic exploration due to the use of serum (for example, open procedures such as osteotomies or ligament reinsertions).) [9,10].

For all these reasons, over the years a new modality known as dry arthroscopy has been implanted, which makes it possible to explore and intervene on a specific joint without the need for the administration of serum. With this technique it

it leaves aside the existing concerns around the management of intra-articular fluid, as well as the complications derived from intra-articular pressure [8,10,17].

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