
Modern Temporomandibular Joint Arthroscopy: Operative Single-Cannula Arthroscopy

2

Samer Srouji and Joseph McCain

Abstract

Since the introduction of arthroscopy, the management of temporomandibular joint (TMJ) disorders has improved significantly. The arthroscope facilitates both assessment of the joint and its pathologies as well as visualized surgical interventions. The traditional arthroscopy technique requires the creation of one puncture for diagnosis and two punctures to enable visualization and operation. The alternative operative single-cannula arthroscopy (OSCA) technique presented here is an advanced TMJ arthroscopy technique which requires only a single cannula, through which a single-piece instrument containing a visualization canal, irrigation canal, and a working canal is inserted. OSCA empowers performance of “one-track arthrocentesis” and standard arthrocentesis under diagnostic visualization and supports introduction of hand or mechanical instruments or laser (holmium:YAG) to perform visually guided surgery. The technique has proven as efficient as the traditional technique, with the added benefits of a short learning curve and simplicity of execution. This chapter provides a detailed protocol for the management of TMD using the OSCA technique.

2.1 History and Goals

Masatoshi Ohnishi performed the first temporomandibular joint (TMJ) arthroscopy in 1974 [1]. In 1982, Murakami and Hoshino developed the nomenclature of TMJ arthroscopic anatomy [2]. Modifications and new arthroscopy techniques have since been introduced by McCain [3, 4], Sanders [5], Holmlund and Hellsing [6], Nitzan and colleagues [7], Koslin [8], and others, with the overall goal of establishing a safe and accurate diagnosis, effectively reducing pain and joint

S. Srouji, DMD, PhD (✉)
Department of Oral and Maxillofacial Surgery,
Galilee Medical Center,
Road 89, Nahariya 22100, Israel
e-mail: Dr.samersrouji@gmail.com

J. McCain, DMD
Miami Oral and Maxillofacial Surgery,
Baptist Hospital, Miami, FL, USA
e-mail: jmccain@miamioms.com

pathologies, and providing a favorable joint environment for ideal function restoration. Today, two main approaches to TMJ arthroscopy exist, the first being the single-puncture technique, suitable only for diagnostics and basic interventions, while the second, the traditional double-puncture arthroscopy technique, requires insertion of two cannulas; the first cannula is used for the introduction of the endoscope, while the second cannula is for surgical intervention, as described by McCain triangulation technique [9]. In line with the trends in modern surgery, all contemporary arthroscopy techniques aim to allow for minimalized and less invasive surgeries. Yet, the relative complexity of arthroscopy requires a high level of coordination and demands a steep learning curve, presenting major obstacles to heightened embracement of advanced arthroscopy by maxillofacial surgeons. In this chapter, the operative single-cannula arthroscopy (OSCA) technique, which precludes the need for coordination of two instruments inside the joint space, is presented. The proposed technique provides the surgeon with the ability to perform a single-hand operation, and a platform for performing advanced, visually guided arthroscopic surgery [10].

2.2 Anatomy of the Temporomandibular Joint Region

While a detailed anatomical description of the TMJ and surrounding structures extends beyond the scope of this chapter, a brief review of struc-

tures associated with possible complications is presented here. The TMJ is a bilateral synovial articulation between the glenoid fossa and articular eminence of the temporal bone, the condylar head of the mandible, and the dense fibrous connective tissue structure known as the articular disc [11] (Fig. 2.1). The biconcave articular disc divides the joint into two compartments. The lower compartment permits hinge motion or rotation (ginglymoid), while the superior compartment allows for sliding (or translatory) movements (arthrodial), hence the term ginglymoarthrodial joint. The superior head of the lateral pterygoid muscle penetrates into the anterior portion of the disc, while posteriorly, the articular disc is connected to the retrodiscal tissue, a highly vascularized and innervated structure. The temporomandibular, stylomandibular, and sphenomandibular ligaments are associated with the TMJ, and define the border movements of the mandible.

The facial nerve has intracranial and extracranial branches distal to the stylomastoid foramen, with the temporal, zygomatic, buccal, marginal mandibular, and cervical branches comprising the five major extracranial facial branches. The temporal and zygomatic branches can be injured when approaching the TMJ, as detailed below. The trigeminal nerve, responsible for sensory function in the face and motor innervation to the mastication muscles, is another important nerve which must be preoperatively identified. The auriculotemporal nerve is a branch of the mandibular nerve (V/1) that

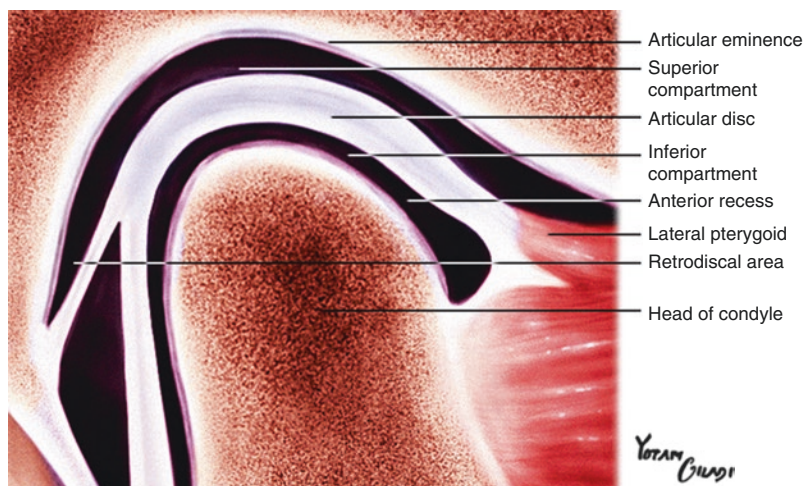
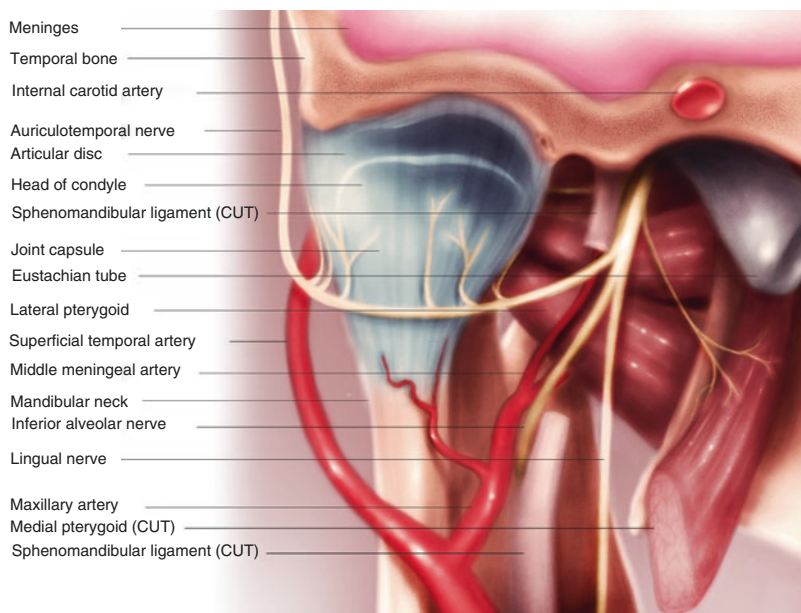


Fig. 2.1 The temporomandibular joint (lateral view)

Fig. 2.2 Anatomy of the temporomandibular joint region



runs with the superficial temporal artery and vein. It passes between the neck of the mandible and the sphenomandibular ligament in proximity to the fossa puncture site. The most important blood vessels in this region are the superficial temporal artery and vein. The superficial temporal artery is the smaller of two terminal branches of the external carotid artery and passes behind the neck of the condyle, superficially over the posterior root of the zygomatic process of the temporal bone, before splitting into frontal and parietal branches (Fig. 2.2).

2.3 Temporomandibular Joint Disorders

The term temporomandibular disorders (TMD) is a term that encompasses pathology of the TMJ itself and myofascial pain dysfunction (MPD) syndrome. The prevalence of TMD in the general population is 40–60%, while females are more likely to be affected than males, females are more likely to request treatment, and their symptoms are less likely to resolve. TMD can be caused by injury to the joint, degenerative diseases such as rheumatoid arthritis, and parafunction of the jaw (tooth grinding/

clenching), and in some cases there is no known cause. TMD can interfere with speech, eating, and sleeping, resulting in additional psychosocial effects and health risks.

2.3.1 Diagnosis

Patients suffering from TMD should undergo an initial assessment that includes a detailed history, and clinical and general examination. Imaging of the TMJ should be performed. Conventional radiographs and panoramic X-ray are used to evaluate the bony elements of the TMJ only, while computed tomography (CT) is useful in evaluating both the bony elements of the TMJ and the adjacent soft tissues. Magnetic resonance imaging (MRI) has proven to be extremely reliable in assessing the shape, position, mobility, and intrinsic structural integrity of the disc itself and for providing additional information on the status of the soft tissue. Subjective parameters include pain assessment using the ten-point visual analog scale (VAS) (0 = no pain, 10 = severe pain), reported change in diet consistency, and required nonsteroidal anti-inflammatory drugs (NSAIDs). Objective parameters include maximal inter-incisal opening (MIO) measurements (Fig. 2.3a), joint noises,

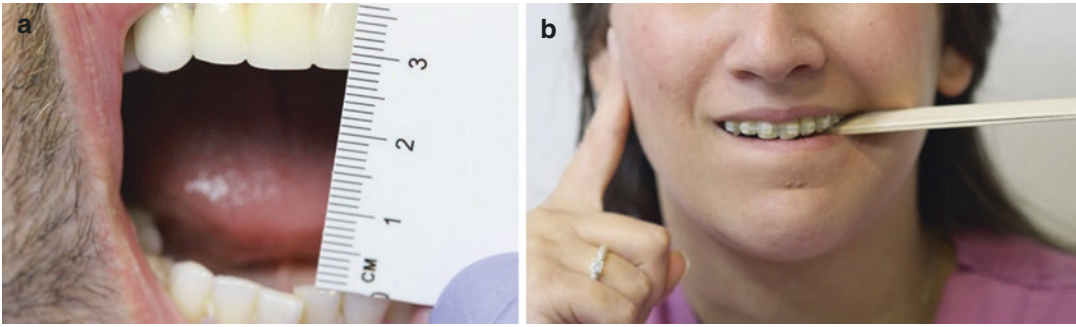


Fig. 2.3 (a) Patient with a limited maximal inter-incisal opening. (b) Positive direct-pressure loading (Mahan test) to assess contralateral pain upon biting

Table 2.1 Clinical, radiologic, and anatomical/pathological signs for Wilkes classification of TMJ ID

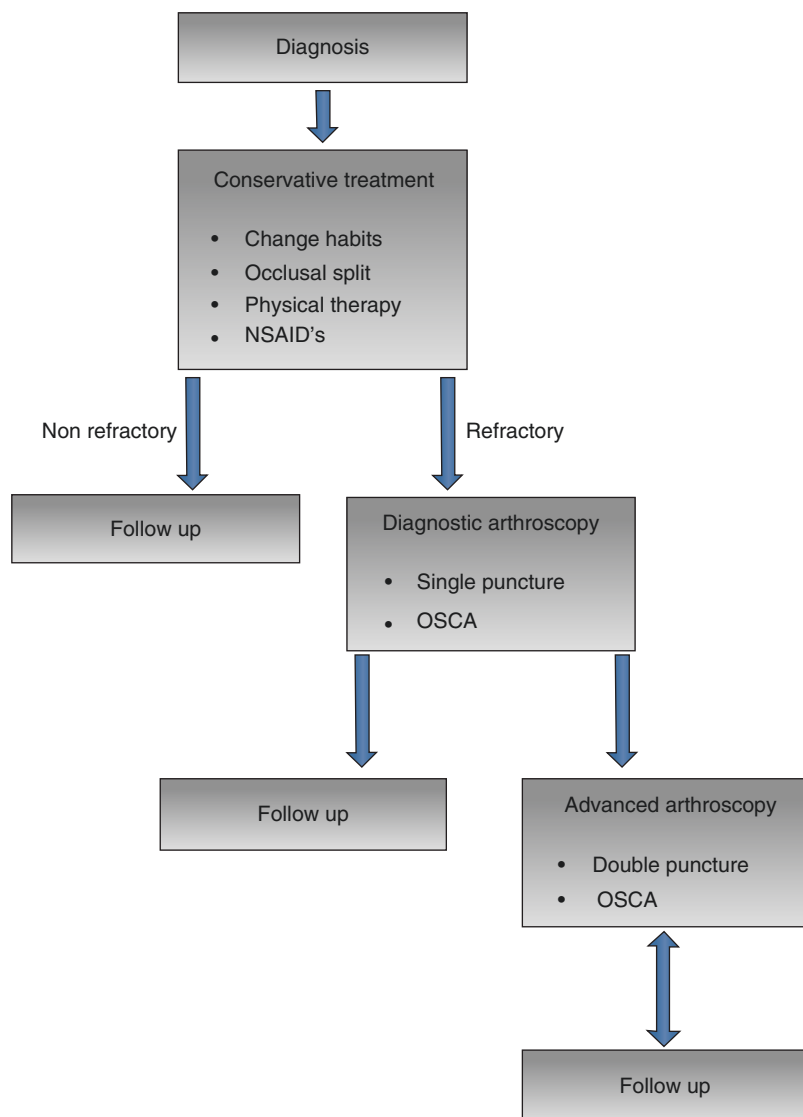
Stage	Clinical	Radiologic	Anatomic/pathologic
I. Early stage	No significant mechanical symptoms other than early opening, reciprocal clicking; no pain or limitation of motion	Slight forward displacement; good anatomic contour of the disc; negative tomograms	Excellent anatomic form; slight anterior displacement; passive incoordination demonstrable
II. Early/intermediate stage	One or more episodes of pain; beginning major mechanical problems, loud clicking, transient catching, and locking	Slight forward displacement; early signs of disc deformity with slight thickening of posterior edge; negative tomograms	Anterior disc displacement; early anatomic disc deformity; good central articulating area
III. Intermediate stage	Multiple episodes of pain; major mechanical symptoms including locking (intermittent or fully closed), restricted motion, and functional difficulty	Anterior disc displacement with significant disc deformity/prolapse (increased thickening of posterior edge); negative tomograms	Marked anatomic disc deformity with anterior displacement; no hard tissue changes
IV. Intermediate/late stage	Slight increase in severity as compared to intermediate stage	Positive tomograms showing early-to-moderate degenerative changes—flattening of eminence; deformed condylar head; sclerosis	Hard tissue degenerative remodeling of both bearing surfaces; multiple adhesions in anterior and posterior recesses; no perforation of disc or attachments
V. Late stage	Crepitus; scraping, grating, grinding; episodic or continuous pain; chronic motion restriction; functional difficulty	Disc or attachment perforation; filling defects; gross anatomic deformity of disc and hard tissues; positive tomograms with essentially degenerative arthritic changes	Gross degenerative changes of disc and hard tissues; perforation of posterior attachment; multiple adhesions; flattening of condyle and eminence; subcortical cystic formation

and direct-pressure loading (Mahan test) (Fig. 2.3b), performed using two wooden spatulas placed between the posterior teeth, where contralateral pain suggests some extent of joint inflammation.

2.3.2 Classifications

The Wilkes classification system is the broadly accepted terminology used to define internal derangement (ID) disorders (Table 2.1) [12].

Fig. 2.4 Cascade for the management of patient with TMD



2.3.3 Conservative Treatment

Treatment usually begins with a conservative regimen, which includes advice, reassurance and change of habitual habits, NSAID administration, use of a stabilization (flat-plane) appliance at night for a period of at least 3 months, and physical therapy [3]. Effectiveness of conservative treatment is assessed by improvements in VAS scores and MIO, changes in the consistency of diet from soft/semiliquid to a more solid one,

and decreased dependency on NSAIDs for pain management. Patients refractory to conservative treatment, who continue to suffer from pain during physiological function, presenting hypomobility or hypermobility, or with degenerative joint diseases, subluxation, or dislocation, are referred for diagnostic arthroscopy (Fig. 2.4). Diagnostic arthroscopy can be performed using the traditional two-port technique or by OSCA, which enables visualization of various pathological signs of TMJ, such as adhesions, synovitis,

internal derangement, and disc perforation. An advanced arthroscopy, employing the double-puncture technique or OSCA, is performed as needed.

2.4 Arthroscopy

2.4.1 Indications for Arthroscopy

The American Association of Oral and Maxillofacial Surgeons (AAOMS) established the following main indications for arthroscopy of the TMJ [11, 13–15]: internal derangement of TMJ, mainly Wilkes stages II, III, and IV; degenerative joint disease (osteoarthritis, OA); synovitis; painful hypermobility; hypomobility caused by intra-articular adhesences; inflammatory arthropathies (systemic arthritis); and articular symptoms subsidiary to orthognathic surgery.

2.4.2 Contraindications for Arthroscopy

The OSCA technique, like the traditional arthroscopy technique, is ineffective in cases of severe fibrous or osseous ankylosis. Bony ankylosis usually requires alloplastic or autogenous joint replacement, while fibrous ankylosis responds better to open-joint surgery (debridement or joint replacement). The approach is also contraindicated in the presence of tumor or metastasis in the TMJ. Skin infection over the puncture site contraindicates arthroscopy, since it increases the risk of contamination of the joint space during surgery. Medical conditions that may contraindicate general anesthesia or surgery must be taken under consideration as well.

2.4.3 Armamentarium

2.4.3.1 The Arthroscope

The ideal arthroscopic system should provide an angle of view of at least 30°, and a focal distance, i.e., the distance over which initially collimated rays are brought to a focus, as close to zero as possible. Image resolution is a key

parameter, as it sets the limits of visualization details. A color temperature of 5000 °K accurately reproduces natural daylight illumination. Color response and brightness vary across the available systems. Capacity to perform “white balance,” to adjust the electronic red, green, and blue signals, is important as well. In the OSCA technique described below, the authors used a Polydiagnost (Hallbergmoos, Germany) interdisciplinary semirigid, 0.9 mm diameter endoscope (PD-DS-1083), which provides high resolution (10,000 pixel), a 120° viewing angle, and a focal distance of 1–15 mm. The device is 181 mm long and uses a standard light connection (ACMI/Storz/Wolf) (Fig. 2.5a).

The optic fiber is passed through the middle connection of a three-way female Luer lock connection handle, while the other two connections are designated for irrigation and instrumentation (Fig. 2.5b). A 26 mm optic shifter is used to adjust the optic fiber length (Fig. 2.5c). The system setup is shown in Fig. 2.6.

The endoscope can be connected to various recording and visualization instruments. In the authors’ operation room setup, an AESCULAP endoscopy cart with a 26” full HD flat-panel display, full HD 3-Chip Camera, AXel 300 xenon light source, and an Eddy Full HD Digital Documentation System is used (Fig. 2.7).

2.4.3.2 Cannulas

A 1.6, 2, or 2.4 mm cannula can be used (Fig. 2.8). When using a 2 mm cannula, instruments or laser fibers of a diameter <1 mm can be introduced into the joint space. The authors have a special set of small-diameter manual and mechanical instruments which will soon become commercially available. The 2.4 mm cannula can accommodate a wider variety of mechanical and manual instruments. A sharp trocar (Fig. 2.9a) is introduced into the superior joint space and removed after penetrating the joint. A blunt obturator (Fig. 2.9b) is then inserted to separate soft tissues within the TMJ. Using a special elastic rubber, the cannula should be marked 25 mm from the working end, to allow the surgeon to monitor the depth of penetration into the joint space during the procedure (Fig. 2.10).

Fig. 2.5 (a) Polydiagnost, interdisciplinary semirigid 0.9 mm diameter endoscope. (b) Three-way female Luer lock connection handle. (c) Optic shifter

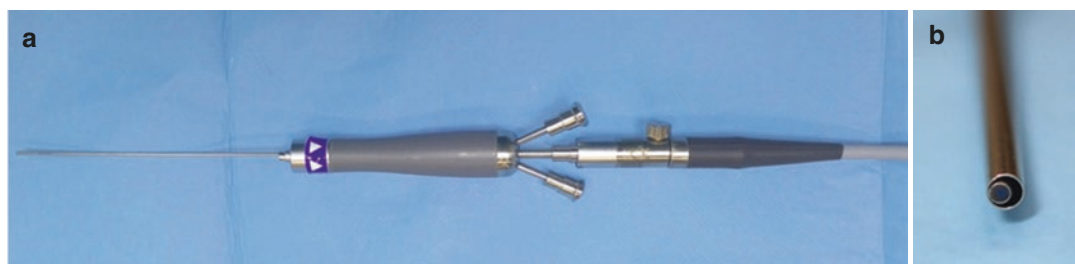
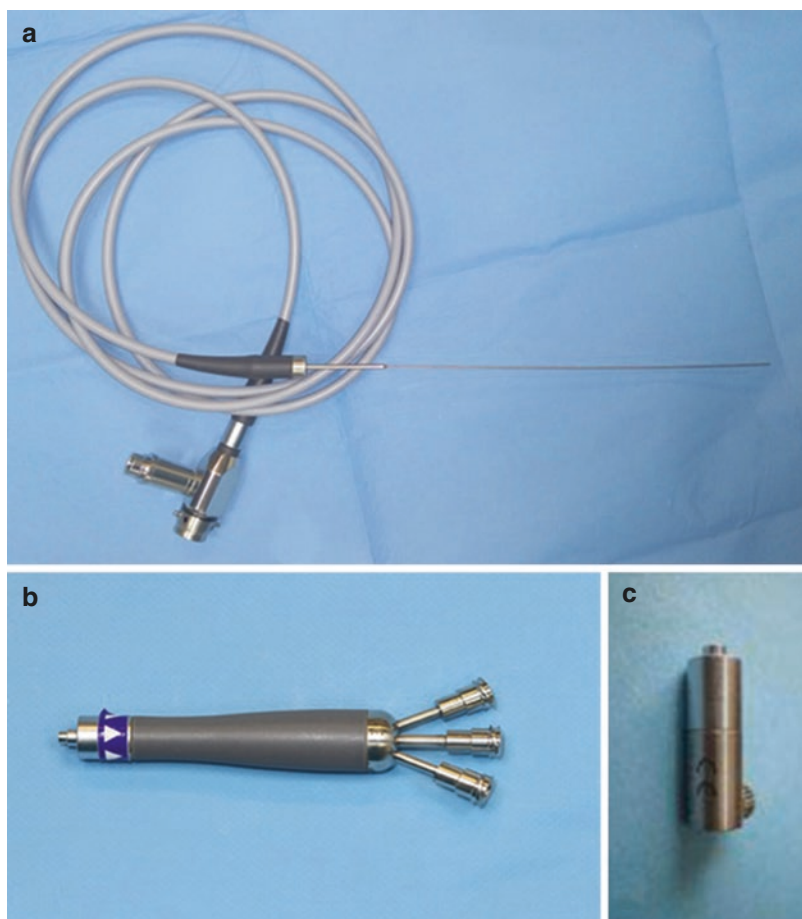


Fig. 2.6 (a) Endoscope, handle, and optic shifter attached in tandem. (b) Optic fiber emerging from the cannula

2.4.3.3 Probes

Any straight or hooked probe, with a diameter <1 mm, can be used. The probe is the most basic hand instrument used for palpation, severing adhesions, and mobilization/temporary immobilization of tissue. In cases of chondromalacia, the hooked probe is the preferred instrument for palpation and is typically used to elevate the anterior aspect of the disc after

anterior releasing procedures and to complete the dissection of the disc from the capsule and the pterygoid muscle.

2.4.3.4 Graspers and Biopsy Forceps

Graspers and biopsy forceps are used when collecting small biopsy samples and for debridement of pathologic or fragmented tissues (Fig. 2.11).

Fig. 2.7 AESCULAP endoscopy system

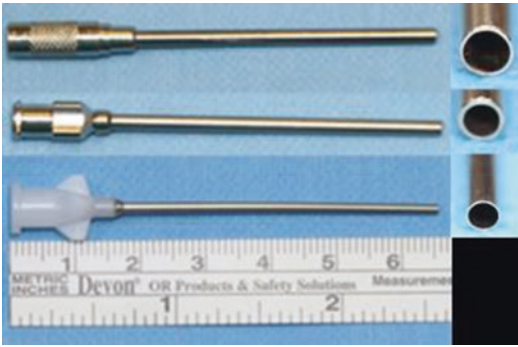
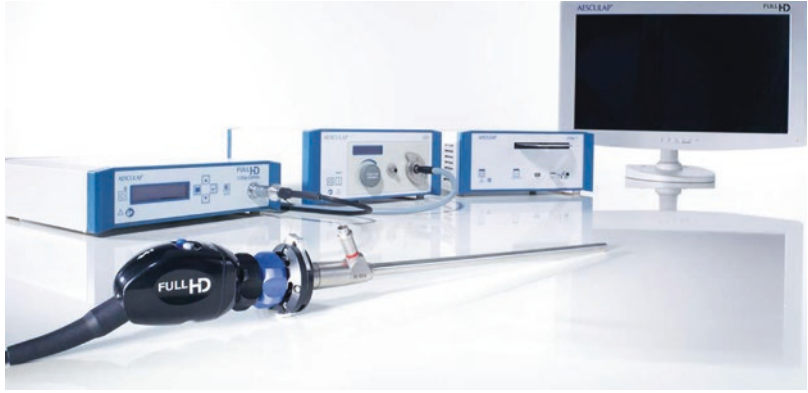


Fig. 2.8 1.6, 2, or 2.4 mm cannulas



Fig. 2.11 Semiflexible grasper

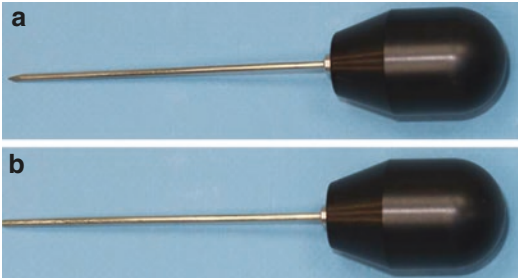


Fig. 2.9 (a) Sharp trocar. (b) Blunt obturator



Fig. 2.12 Spinal needle, 150 mm long with diameter of 0.72 mm

2.4.3.5 Spinal Needles

Long spinal needles (≥ 150 mm) with a diameter of < 1 mm are necessary for accurate, visualized injection of medications into the joint space or adjacent structures (lateral pterygoid, connective tissue, or articular disc) (Fig. 2.12).

2.4.3.6 Laser

Lasers emit light based on the stimulated emission of radiation and can operate in either a pulsatile or continuous mode and their physical properties provide for an array of laser setting, each eliciting well-defined and localized effects. Although there are many types of lasers, most have been found ineffective in treating TMJ. The

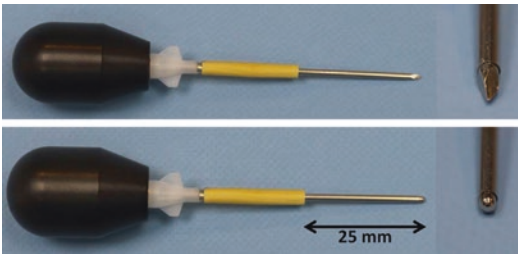


Fig. 2.10 Sharp trocar and blunt obturator inserted into a 1.6 mm cannula marked 25 mm from the working end

Fig. 2.13 (a) LISA LASER PRODUCTS Sphinx jr. Holmium:YAG laser. (b) The laser fiber emerging from its metal protection

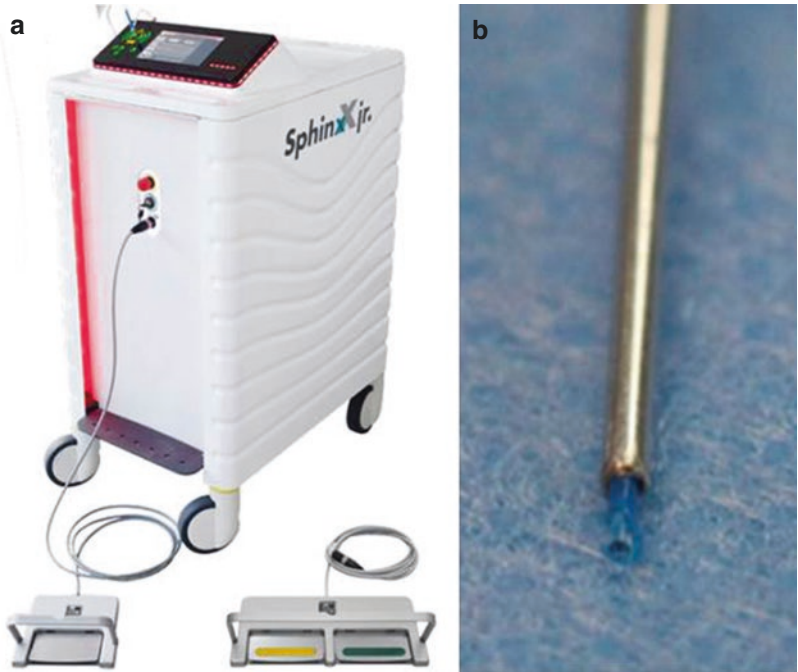


Table 2.2 Holmium:YAG laser settings for specific purposes

Laser setting for cutting	10 Hz	9 W	0.09 J
Laser setting for ablation	8 Hz	4 W	0.5 J
Laser setting for contracture	5 Hz	2 W	0.4 J

authors recommend use of the air-cooling holmium:YAG laser, and themselves use the relatively compact (H 1000 × W 450 × L 740 mm) and lightweight (approx. 95 kg) LISA LASER PRODUCTS Sphinx jr. Holmium:YAG laser (Fig. 2.13), which operates at a wavelength of 2123 nm. The laser produces 30 W at the fiber tip, 0.3–5 J pulse energy, 100–650 μs pulse duration, and 1–25 Hz frequency. The holmium:YAG laser beam is strongly absorbed by water and therefore can target most biologic tissues. It has a limited depth of penetration (0.3–0.5 mm), rendering it very practical and safe for intra-articular use. In the OSCA technique, a 230 μm fiber laser is used, and is sufficiently small to safely access the small-sized TMJ. The laser can be set for cutting, ablation, or contracture (Table 2.2) and is used for synovectomy, retrodiscal scarification, cutting of tissue, and debridement of fibrocartilage [9] (Table 2.3).

Table 2.3 Comparison of OSCA to the single- and double-puncture arthroscopy techniques

Parameter	Single puncture	Double puncture	OSCA
Main indication	Diagnosis and basic interventions	Advanced arthroscopy	Advanced arthroscopy
Proficiency required	Low	High	Low
Duration of operation	Short	Long	Short
Number of punctures	1	2	1
Number of working cannulas	1	2	1
Risk for facial nerve injury	Low	High	Low
Risk for facial scar	Low	High	Low
Effectiveness is pain relief	Low	High	High
Effectiveness is mouth opening improvement	Low	High	High

2.5 The Operative Single-Cannula Arthroscopy Technique

OSCA is a single-puncture arthroscopy procedure, appropriate for both diagnostics and operative needs; it can be performed under either sedation and local anesthesia or general anesthesia, in a fully equipped operating room. Usually preoperative antibiotics and glucocorticosteroids are intravenously injected to prevent skin contamination and for edema management, respectively. The patient is then placed in a supine position on the operating table and subjected to nasal endotracheal intubation. The skin is prepared and disinfected with chlorhexidine gluconate solution (Unisept), povidone iodine, or any comparable antibacterial solution. The surgical field is then isolated and the anatomical landmarks are identified to avoid possible complications. A tragocanthal line is first established, and the penetration point of the cannula is set at 10 mm anterior to the midtragus and 5 mm caudally to the tragocanthal line (Fig. 2.14a, b).

Before penetrating the TMJ capsule, 2 mL of bupivacaine (Marcaine) is injected into the superior joint capsule, using a 22-gauge needle, in order to expand the structures. A 3 mL syringe is used so that backpressure can be felt when the joint space is entered (Fig. 2.15).

Injection of epinephrine directly into the joint space remains a topic of debate, since it may affect visualization of the synovial vasculature. The pattern and character of synovial vessels may indicate the level of inflammation present; therefore, any administration of a vasoconstrictor should be after the initial evaluation. Puncture is made using a sharp trocar, which introduces a cannula into the superior joint space, using a standard inferiolateral technique, to a depth of 25 mm [16] (Fig. 2.16).

A cannula is introduced into the superior joint space to a depth of 25 mm. Once penetrating the joint, the sharp trocar is removed and a blunt obturator is inserted to separate the soft tissues within the TMJ (Fig. 2.17). The arthroscope is inserted through the middle connection of the three-way female Luer lock.



Fig. 2.14 (a) Marking of the tragocanthal line. (b) The tragocanthal line and penetration point of the cannula 10 mm anterior to the midtragus and 5 mm caudally in relation to tragocanthal line



Fig. 2.15 Injection of 2 mL bupivacaine (Marcaine) into the superior joint capsule, using a 22-gauge needle

2.5.1 One-Track Arthrocentesis

One-track arthrocentesis enables initial location of the TMJ, in addition to its visualization while performing irrigation and arthrocentesis. Two female Luer lock connector pipelines are connected to the other two ports. “One-track arthrocentesis” is performed through the irrigation canal and rinsing is performed through the working canal (Fig. 2.18). Ringer’s lactate solution is the preferred irrigation fluid, but standard saline may also be used. A large syringe (50 mL) can be used with a pumping motion, or when there is a need for continuous irrigation (Fig. 2.19), the bag



Fig. 2.16 A cannula is introduced into the superior joint space to a depth of 25 mm

can be placed in a pressure cuff. Caution must be exercised due to possible fluid extravasation.

2.5.2 Standard Arthrocentesis Under Diagnostic Visualization

An 18-gauge needle is inserted 5 mm anteriorly and 5 mm caudally from the puncture point of the working cannula (Fig. 2.20). This needle serves as an outflow port, while the outflow canal becomes the operating canal of the OSCA system. Depending on the pathological findings within the superior space of the TMJ, the operator can decide to proceed with the full OSCA technique, using hand or mechanical instruments or a laser fiber.

A diagnostic sweep of the TMJ is then performed, during which seven points of interest should be visualized and assessed (Fig. 2.21):

1. The **medial synovial drape** has a gray-white translucent lining and a tense appearance, with distinct superior-to-inferior striae (Fig. 2.22). This articular entity represents one of the most important barometers of TMJ synovitis (Fig. 2.23). In acute inflammatory states, capillary proliferation with hyperemia of the medial synovial drape is increased. In chronic synovitis, the drape has a fibrotic or whitish appearance.
2. The **pterygoid shadow** is located anterior to the medial synovial drape. In pathologic

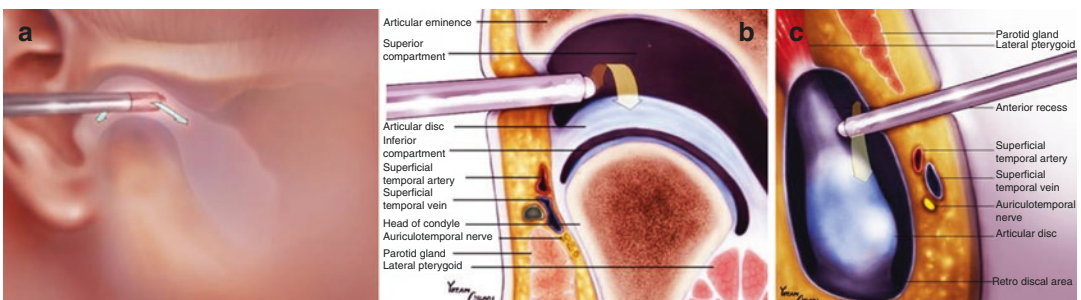


Fig. 2.17 (a) Illustration of the sweeping motion of the obturator used for soft-tissue separation. (b, c) Illustration of the obturator and cannula introduced into the upper

compartment of the TMJ (coronary (left) and horizontal (right) sections)

Fig. 2.18 One-track arthrocentesis. (a) The arthroscope is introduced into TMJ through the middle connection of the three-way female Luer lock; the irrigation pipeline is also seen. (b) Illustration of the arthroscope, showing inflow through the irrigation canal and rinsing through the working canal

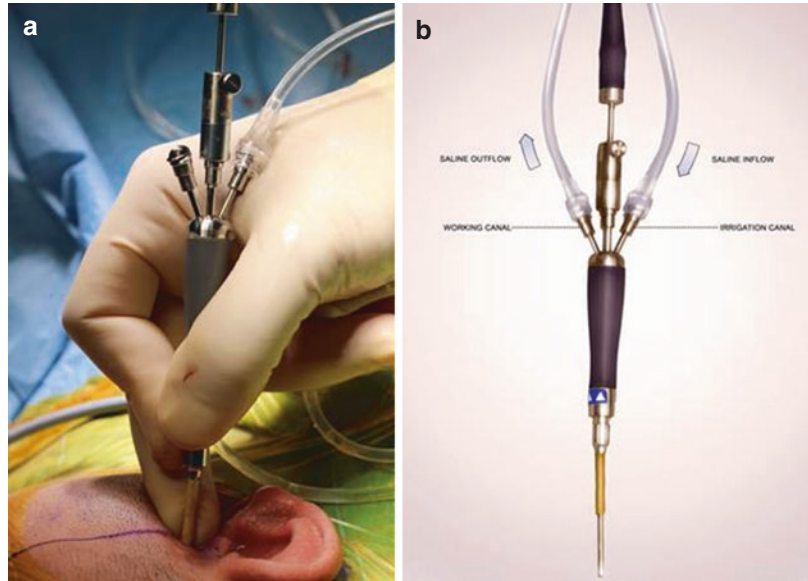


Fig. 2.19 A 50 mL syringe is used for irrigation

states, it exhibits marked erythema and hyper-vascularization, and can thin to the extent of perforation, coupled with herniation of the pterygoid muscle directly into the anteromedial aspect of the superior joint space (Fig. 2.24).

3. The **retrodiscal synovium**: Here, the synovial membrane covers the posterior insertion of the disc and is reflected superiorly to the temporal fossa. While the mouth is open, the posterior insertion covered by the synovial lining appears as a crest, called the oblique protuberance (zone 1). The retrodiscal tissue is located posterosuperiorly, attached to the posterior glenoid process (zone 2), while the lateral recess of the retrodiscal/synovial tissue (zone 3), which in pathologic states imparts a hyperemic or petechial appearance to the synovium, can be lateral to the oblique protuberance. Chronic synovitis in this area is characterized by synovial hyperplasia, with

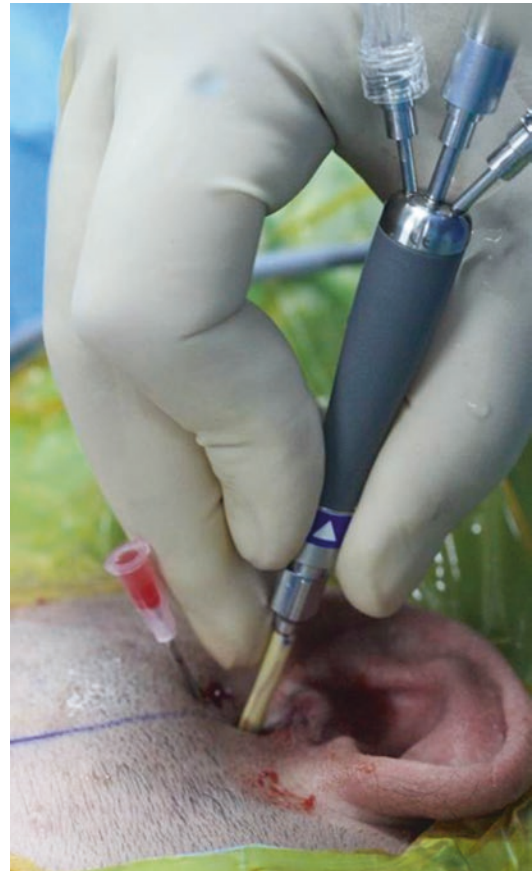


Fig. 2.20 Standard arthrocentesis under diagnostic visualization

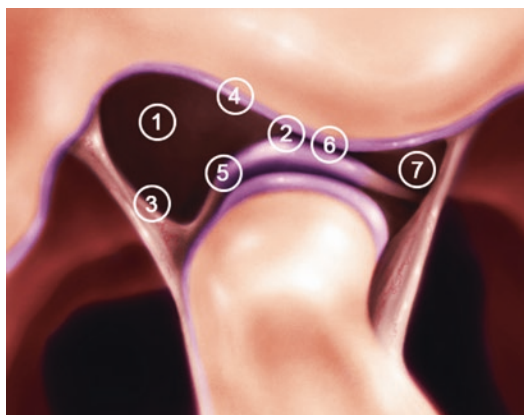


Fig. 2.21 The seven points of interest of the TMJ arthroscopic examination. (1) Medial synovial drape. (2) Pterygoid shadow. (3) Retrodiscal synovium. (4) Posterior slope of the articular eminence. (5) Articular disc. (6) Intermediate zone. (7) Anterior recess

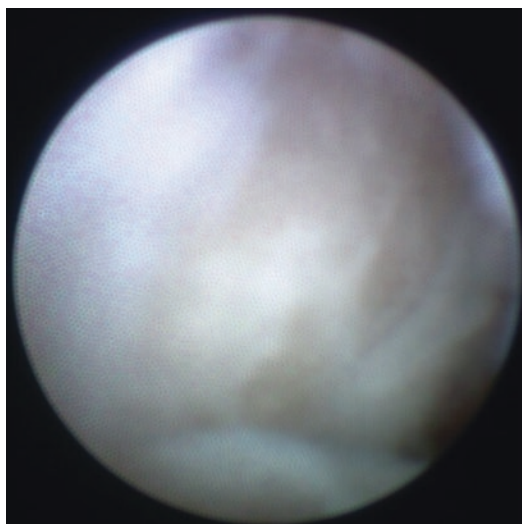


Fig. 2.22 Medial synovial drape

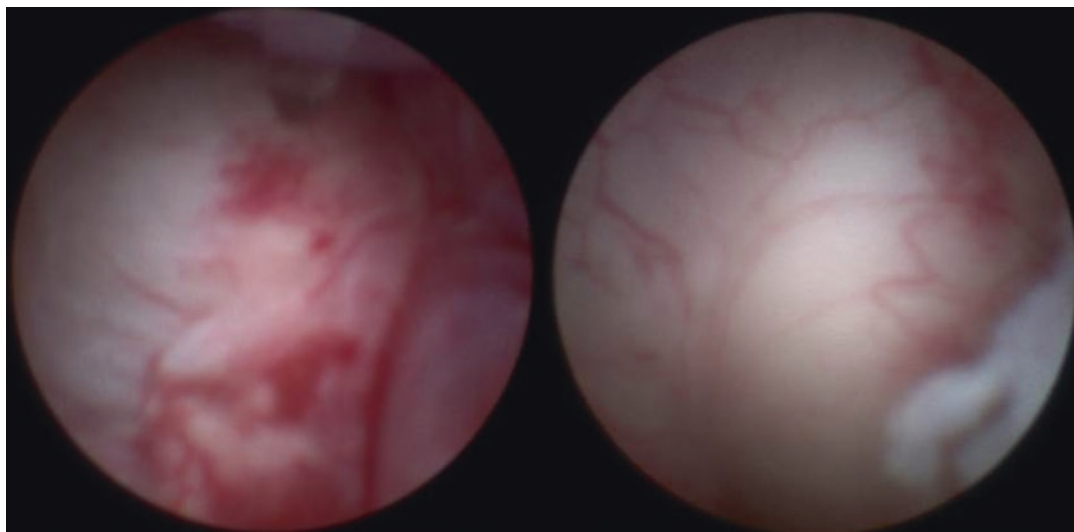


Fig. 2.23 TMJ synovitis with capillary proliferation

increasing proliferation of tissue folds (Fig. 2.25).

4. The **posterior slope of the articular eminence** is characterized by thick, white, and highly reflective fibrocartilage, with antero-posterior striae within. In pathological states, various stages of chondromalacia, i.e., softening of the articular fibrocartilage caused by digestion by proteoglycan collagenases from injured chondrocytes, is often detectable, and

can reach a grade of crater formation and subchondral bone exposure. In inflammatory states, creeping of the synovial tissue can be observed in the glenoid fossa and the posterior slope of the eminence (Fig. 2.26).

5. The **articular disc** is milky white, highly reflective, and without striae. In pathologic states, the synovium creeps onto the surface of the disc. Fragmentation of the disc surface is usually an indication of imminent or existing

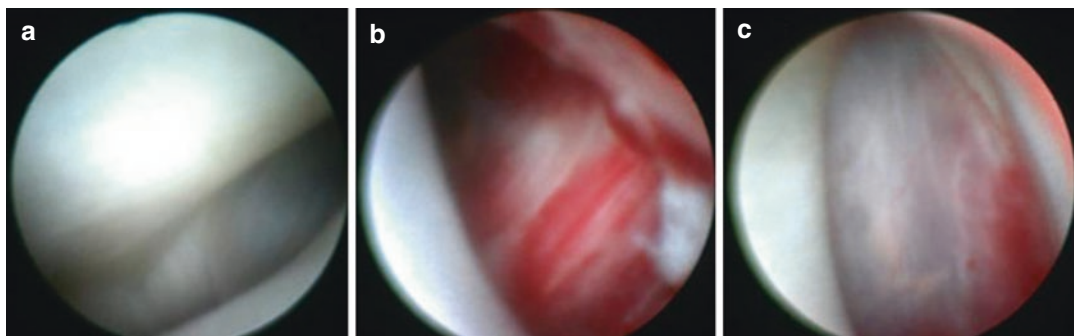


Fig. 2.24 (a) The pterygoid shadow (normal arthroscopic appearance). (b, c) Erythema at the pterygoid shadow

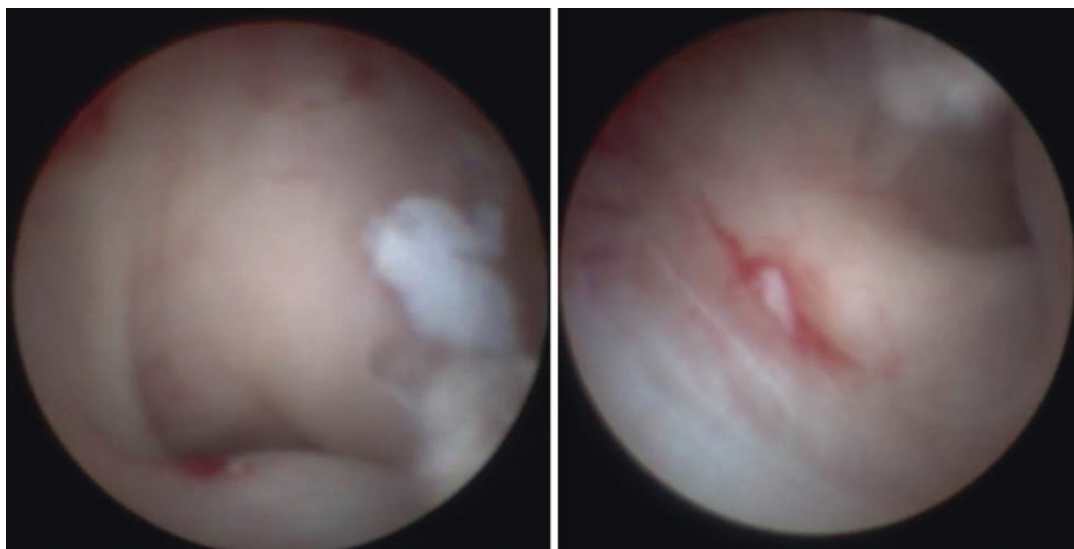


Fig. 2.25 Retrodiscal area

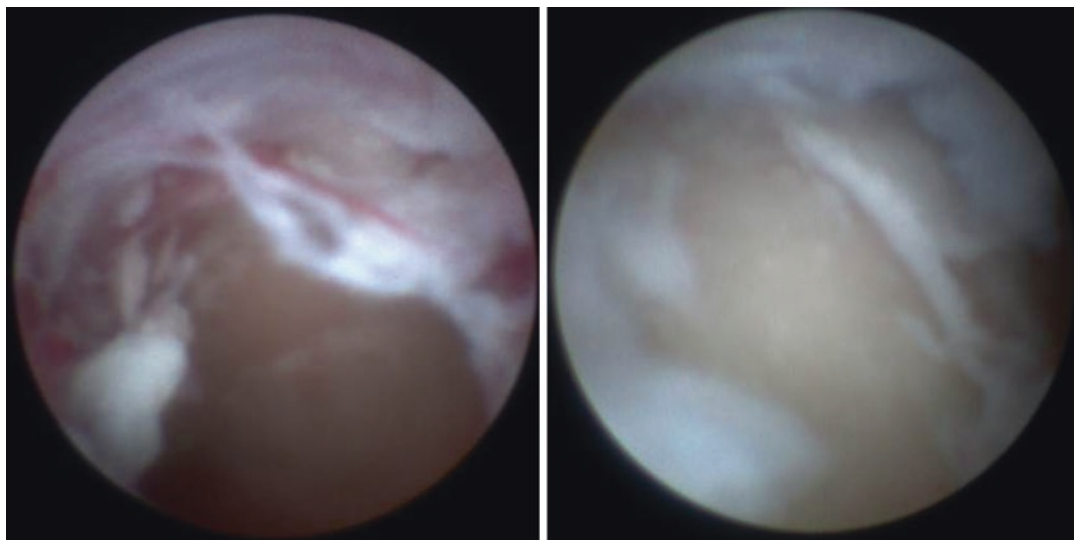


Fig. 2.26 Various stages of chondromalacia

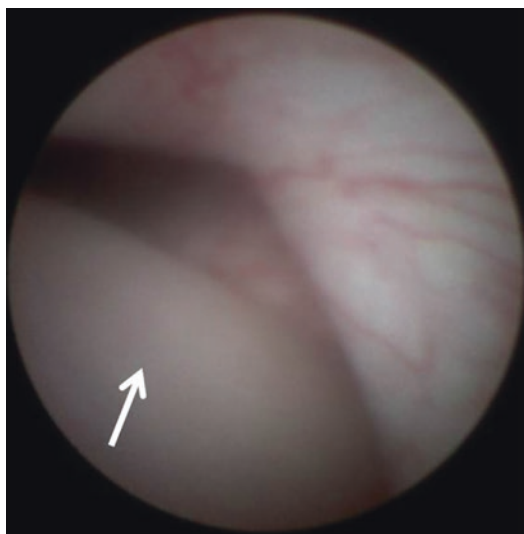


Fig. 2.27 Normal articular disc (arrow)

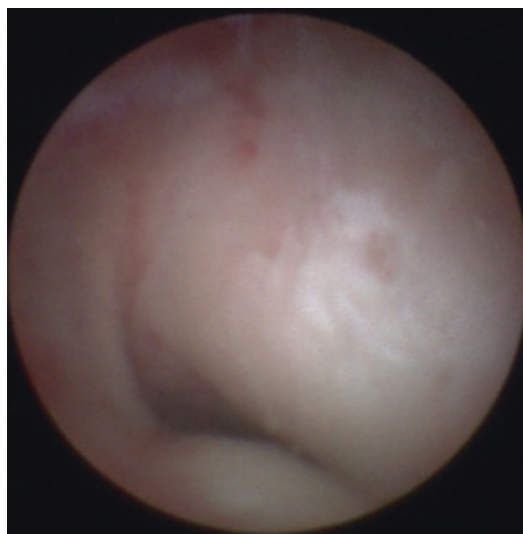


Fig. 2.28 Normal anterior recess

disc perforation. In cases of disc perforation, the inferior joint space can be examined by introducing the scope through the perforation into the inferior joint space (Fig. 2.27).

6. The **intermediate zone** has a white-on-white appearance, and the concavity of the disc can be seen.
7. The **anterior recess** begins with the condyle seated, in which the anterior disc synovial crease is identified. The crease is examined by following it to the terminal medial point, the most extreme medioanterior corner of the crease, and the pterygoid shadow. At the anterolateral site, the union between the lateral synovial capsule and the anterior disc synovial crease can be observed. In pathological states, the vascularity of the anterior synovial pouch increases and all characteristics of synovial inflammation are present. Occasionally, synovial redundancy and synovial plicae are also present (Fig. 2.28).

2.5.3 Visually Guided OSCA

As stated before, many different hand or mechanical instruments can be used during OSCA; the most suitable instrument is selected based on pathological findings or indication (Fig. 2.29).

The Ho:YAG laser provides for a wide range of treatment options for internal pathologies and derangements of the joint and also secures precision and safety (Figs. 2.30 and 2.31). Its cutting options can be exploited to sever adhesions and to execute anterior release combined with discopexy. Its ablative capacities are applied on the dilated blood vessels of the synovial and chondromalatic tissue. The contracture mode is used to induce contraction of the retrodiscal synovial tissue for posterior disc repositioning. Of note, the cannula can be inserted through the second port, as in the triangulation technique, to gain better access to the anterior recess, primarily necessary for anterior release during discopexy.

2.5.4 Surgical Interventions Using the OSCA Technique

2.5.4.1 Anterior and Posterior Recess Adhesion Release

Sequential lysis of adhesions in the superior joint space, aimed at restoring the volume and architecture of the joint, should follow an anterior-to-posterior pattern, avoiding repeated motion of instrumentation from the back to the front of the joint, which could increase the risk of unnecessary articular surface scuffing. The probe is first placed

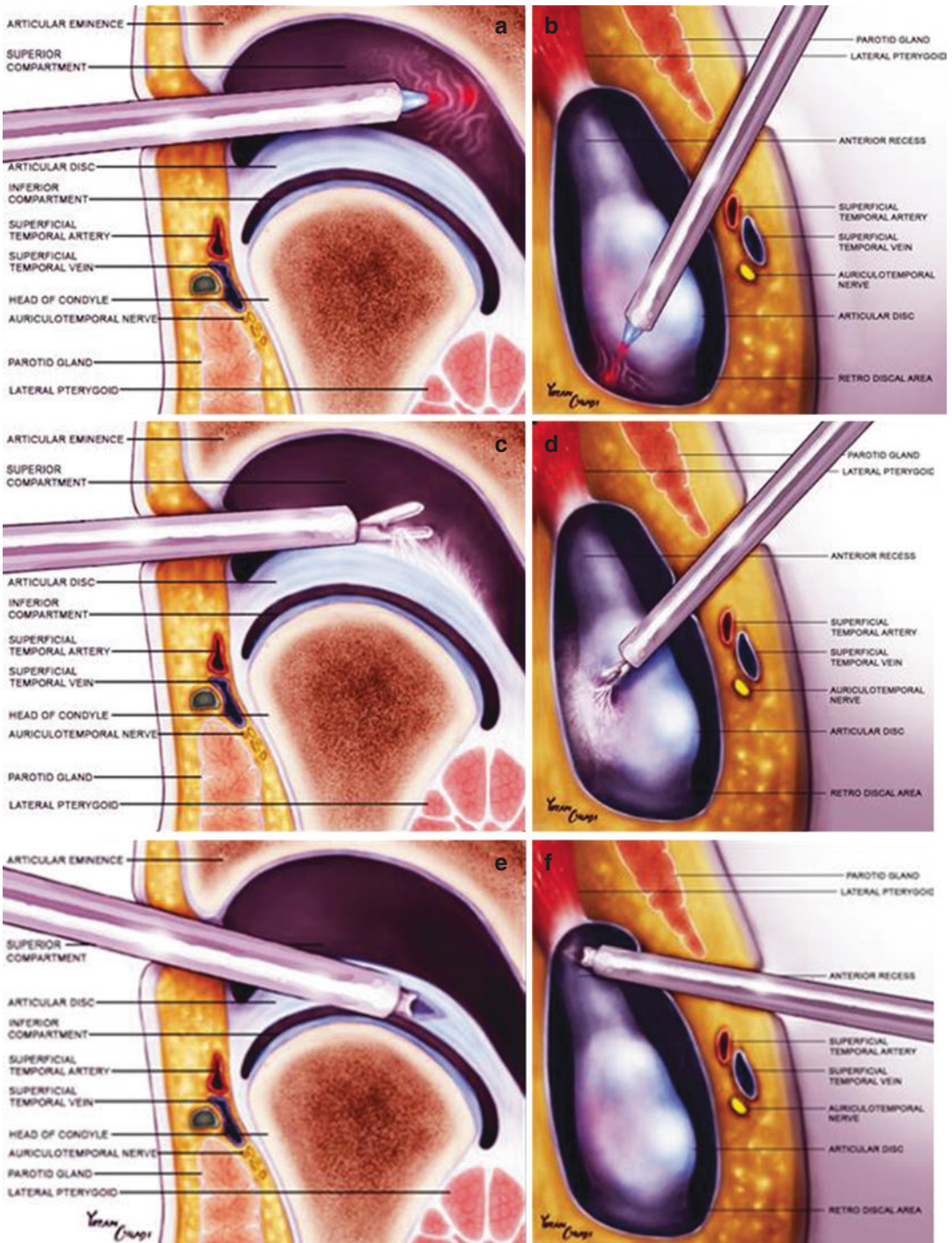


Fig. 2.29 Illustration of visually guided OSCA showing various instruments introduced into the TMJ. (a, b) Ho:YAG laser used for contraction of the retrodiscal syno-

vial tissue. (c, d) Grasper used for biopsy or chondromalacia removal. (e, f) Spinal needle used for injection of intra-articular medication into lateral pterygoid muscle



Fig. 2.30 Setup of the Ho:YAG laser fiber with the arthroscope, in tandem



Fig. 2.31 Visually guided OSCA. Intraoperative setup of the Ho:YAG laser fiber

in the most medial aspect of the joint and then swept laterally along the disc-synovial junction with an inferoanterior maneuver. Then, by sweeping medially to laterally along the articular eminence, a superoanterior maneuver is executed to complete the lysis. These maneuvers are repeated until an adequate recess volume is restored. In

many instances, anterior recess lysis is followed by posterior recess lysis. A marked increase in the range of movement (ROM) of the condyle is immediately achieved. For this procedure, the authors prefer the highly versatile Ho:YAG laser, set on cutting mode, over the probe.

2.5.4.2 Synovectomy

Effective reduction of a redundant synovium can be performed via Ho:YAG-assisted OSCA. A redundant synovium is most often observed in the posterior pouch, especially after disc reduction procedures. Occasionally, it can be encountered in the anterior recess. Hypervascularity and redundancy can effectively be reduced by Ho:YAG laser vaporization. The synovial clinical response is manifested by a change in color from bright red to off-white or even a light brown (Fig. 2.32).

2.5.4.3 Anterior Release

Conditions such as chronic disc dislocation, fibrosis, adhesive bands, or pseudowall formation can obliterate the disc-synovial crease. A blunt probe is used for the lysis procedure. If the anteroposterior disc dimension appears adequate and a relatively normal disc shape is ascertained, the release procedure is initiated in the medial half of the disc-synovial crease. Using an Ho:YAG laser in cutting mode, the synovial capsule is incised just anterior and parallel to the anterior margin of the disc. The surgeon observes the muscle fibers penetrating into the disc and capsule. Dissection should be performed to a depth no greater than 5 mm or until the anterior band is fully mobile, without tethering. Caution must be exercised when performing the myotomy at the most anteromedial corner. When the anteromedial synovial drape is incised at its junction with the disc, an artery, approximately 1–2 mm in diameter, can usually be found directly subjacent to the junction. Arthroscopically, it appears as a white tubular structure. If this vessel is inadvertently incised, copious intra-articular hemorrhaging will occur. This vessel cannot be cauterized or tied off by any current means. To tamponade the bleeder, all instruments must be removed and constant lateral pressure maintained

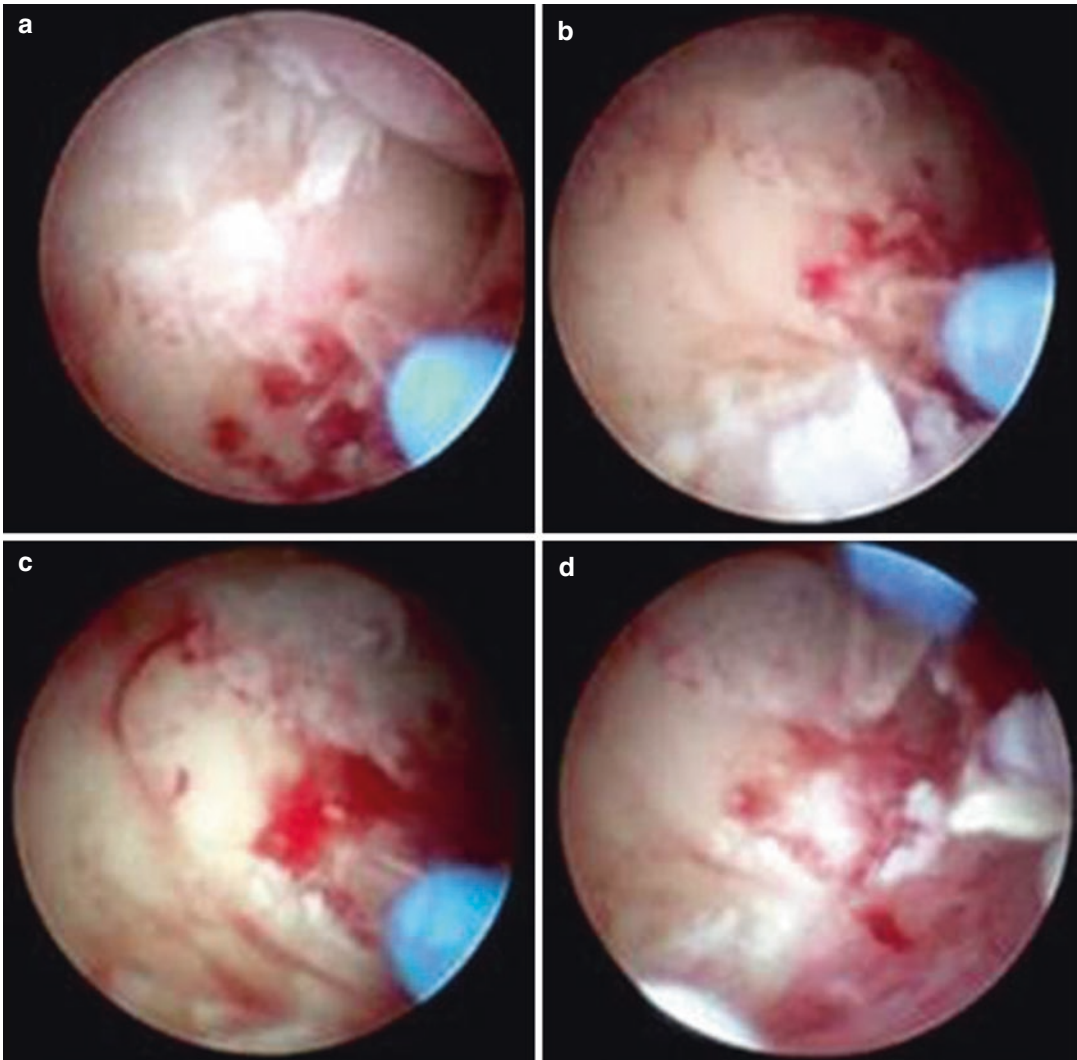


Fig. 2.32 (a–d) Adhesions, fibrillations, and synovitis treated intraoperatively using Ho:YAG-assisted OSCA

on the joint for 5 full minutes, while the condyle is held in a forward and contralateral position. The OSCA technique is then repeated and the joint is lavaged and suctioned free of clots. No further releasing is performed in the area and the release is completed laterally. Identification of this artery will avoid this problem and the myotomy can be carefully completed around the artery. The lateral one-third to two-thirds of the anterior release can be performed more expediently, with less concern for hemorrhage. Probing to assess anterior band mobility should be routinely performed during the anterior release.

2.5.4.4 Posterior Scarification/Contracture

Once disc reduction is achieved, an increased amount of redundant synovium is noted in the retrodiscal flexure. Even with minor disc repositioning and less evidence of redundancy of the posterior synovium, in the absence of discopexy, this procedure should be performed. Typically, “reefing,” or bunching up, of the retrodiscal tissue occurs and requires bulk reduction using an Ho:YAG laser; otherwise, this fairly large amount of tissue can fibrose during healing, which can later displace the disc upon postoperative settling.

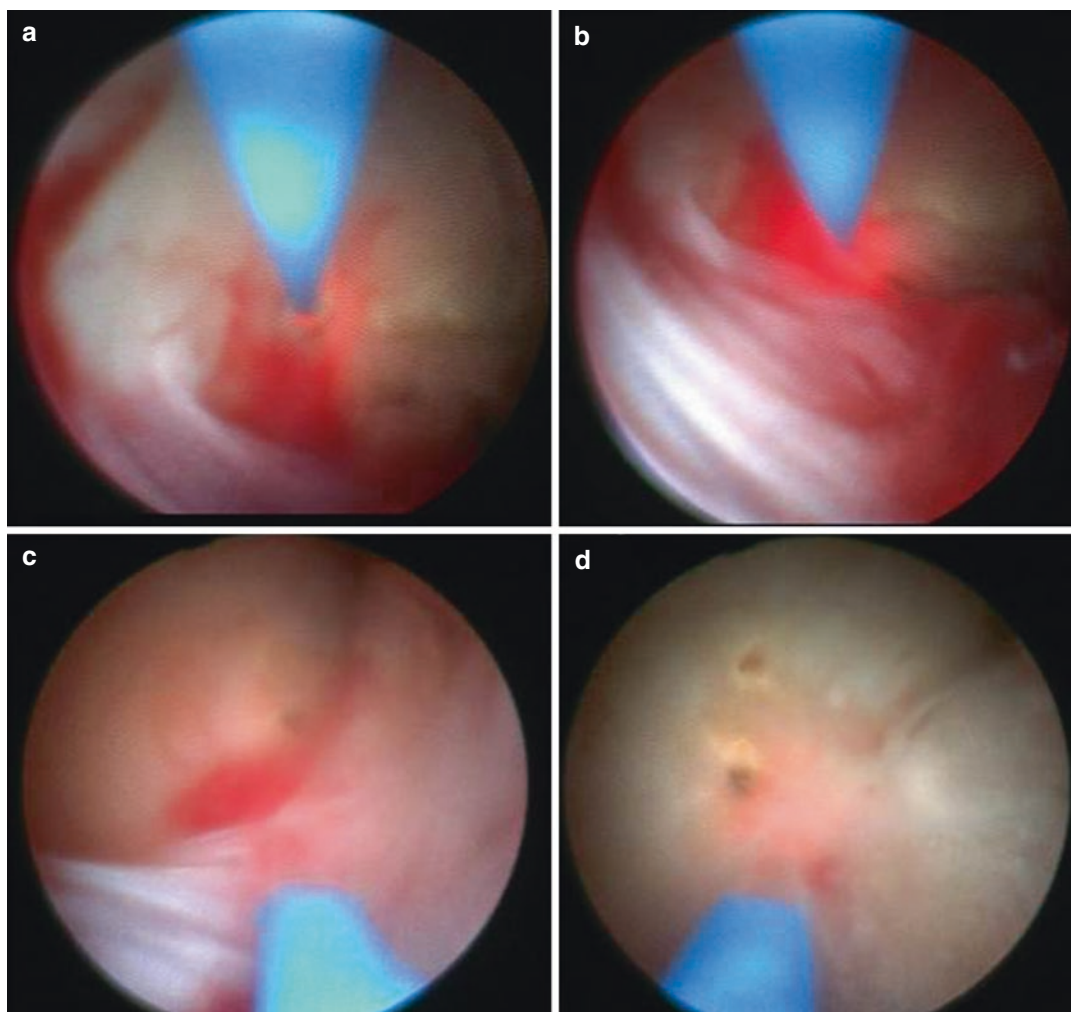


Fig. 2.33 (a–d) Contracture of retrodiscal synovium using Ho:YAG-assisted OSCA

Retrodiscal ablation should, therefore, be performed until a normal-shaped retrodiscal flexure is sculpted. The inflamed synovium and the areas of excess tissue bulk are ablated. Deep laser contracture of the oblique protuberance should then be performed. An examination of the anterior and posterior pouches is then performed (Fig. 2.33).

2.5.5 Advantages and Disadvantages of OSCA

The central advantage of the OSCA technique over the single-puncture technique lies in its provision for performance of advanced visually

guided arthroscopy through a single cannula. In comparison to the traditional double-puncture arthroscopy technique, OSCA is relatively simple, requires less proficiency and less coordination from the surgeon, and is associated with a shorter learning curve. Its requirement for one working cannula only, without the need for a second puncture, decreases facial scarring and may reduce incidence of facial nerve injury. It is as effective as the traditional technique, with regard to pain relief and mouth opening improvements (Fig. 2.34a, b) [10]. Operative time is shorter, rendering the approach more cost effective (Fig. 2.34c) [10]. Another advantage of OSCA is the ability to inject medication to specific tissue

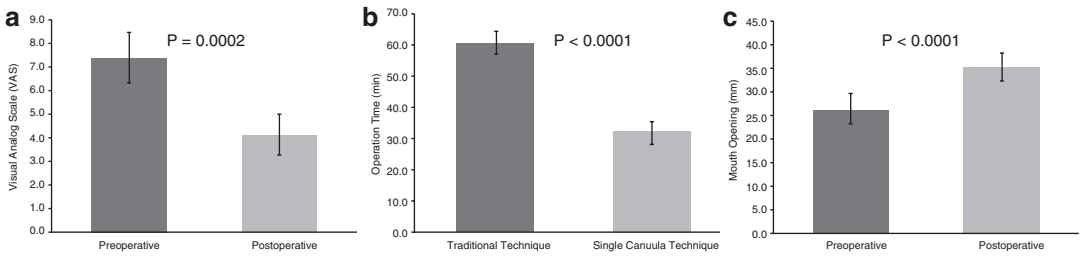


Fig. 2.34 (a) Pre-OSCA versus post-OSCA pain VAS scores (scale 0–10: 0 no pain, 10 severe pain), showing statistically significant (p value = 0.002) improvement in pain levels 3 months following the procedure. (b) Maximal mouth opening before versus 3 months after OSCA

(p value <0.0001). (c) Surgery times for the OSCA versus traditional arthroscopy technique, showing a significantly (p value <0.0001) shorter mean operation time for the OSCA technique [10]

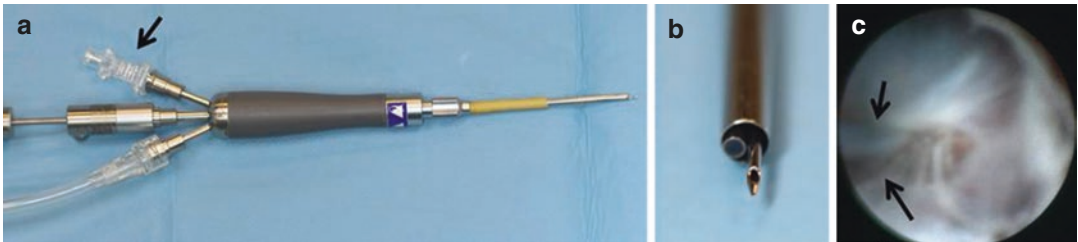


Fig. 2.35 Visually guided injection. (a) Spinal needle (150 mm length, 0.72 mm diameter) with an arthroscope. (b) Optic fiber and needle passing through the cannula. (c)

Injection of Depo-Medrol (white solution) into the joint space using a spinal needle (arrows)

regions under visual guidance. The main drawback of OSCA in comparison to the traditional technique is the relatively higher focal distance which may result in poorer image quality. However, to date, the image quality has proven satisfactory and all anatomical and pathological structures can be adequately observed.

2.5.6 Intra-articular Delivery of Medications via OSCA

Before the advent of arthroscopy, intra-articular medications were injected using a blind technique. The OSCA technique enables visually guided injection of medications, specifically targeting various anatomic articular sites.

2.5.6.1 Steroids

The authors' experience and research support the claimed benefit of steroid injection in the reduction of muscular irritation and spasm, conse-

quently decreasing joint pain during function. The technique employs a 3 mL syringe with a 25-gauge spinal needle to intra-articularly inject methylprednisolone acetate (depo-medrol by Pfizer Inc.) or to perform visually guided injections into TMJ structures (Figs. 2.35 and 2.36).

2.5.6.2 Botulinum Toxin A

Local injection of Botox to treat chronic facial pain associated with hyperactivity of the masticatory muscles has been well documented. The efficacy of direct, arthroscopy-assisted injection of Botox into the superior head of the lateral pterygoid at the pterygoid shadow has very promising outcomes.

2.5.6.3 Hyaluronic Acid

Hyaluronic acid, a polysaccharide of the glycosaminoglycans family, is a component of many extracellular tissues, including the synovial fluid and cartilage, and is produced by the articular chondrocytes and synoviocytes. Hyaluronate



Fig. 2.36 Visually guided intraoperative injection of Depo-Medrol

injection into the TMJ aims to stimulate the endogenous synthesis of hyaluronic acid (HA) from the exogenously generated hyaluronic acid. Hyalgan is a 500–730 kDa fraction of highly purified avian sodium hyaluronate, buffered (pH 6.8–7.5) in physiologic saline. The authors believe that hyaluronate can serve as an excellent intra-articular lubricating agent to facilitate navigation while minimizing iatrogenic intra-articular injury.

2.5.6.4 Platelet Concentrates

Autologous platelet concentrates (PCs), derived from the patient's own blood, contain a highly concentrated cocktail of platelet-derived growth factors and endogenous fibrin scaffolds, which can be harnessed for regenerative purposes and other biological therapies [17]. They have been shown to accelerate healing and their transforming growth factor (TGF)- β component has been

associated with chondrogenesis during cartilage repair [18]. Recent data support the application of platelet-rich plasma (PRP), a subtype of PC, to effectively and safely treat the initial stages of knee osteoarthritis (OA) [19, 20]. Furthermore, a number of randomized clinical studies have concluded that PCs provide for superior clinical results compared to hyaluronic acid (HA) in symptomatic alleviation of mild-to-moderate osteoarthritis of the knee [21, 22]. The content of the PC can vary according to preparation technique, and can be in a solution or a gel form. For TMJ purposes, PCs must be in solution form, as they are delivered via injection. The authors are currently conducting a study to assess the efficacy of post-OSCA injection of PCs into the TMJ, in comparison to other injectable medications, such as HA and steroids, in pain reduction and mouth opening improvement.

2.5.7 Post-OSCA Patient Management

2.5.7.1 General Anesthesia Considerations

The spastic perimandibular musculature contractions secondary to the gag reflex must be avoided, especially in patients who have undergone suture discopexies or posterior scarification procedures. Extubation in a semi-obtunded patient is ideal in such clinical situations. To ensure uneventful extubation, the surgeon passes a nasogastric tube and suctions all gastroesophagopharyngeal contents or secretions at the end of surgical procedure.

2.5.7.2 Anti-inflammatory and Pain Management

Patients receive tapered doses of intravenous/oral steroids for 18–24 h postoperatively. NSAIDs are also prescribed for no longer than 7 days.

2.5.7.3 Antibiotics

Notwithstanding the minimally invasive (MI) character of TMJ arthroscopic procedures and impeccable surgical technique, we have begun to routinely administer postoperative antibiotics;

ever since, our rate of postoperative infection has dropped to 0%. Every patient is bridged from intravenous to oral antibiotics such as cephalexin (Keflex) or amoxicillin and clavulanic acid (Augmentin) for no more than 7 days, conditional on absence of intolerance or allergic reactions.

2.5.7.4 Diet

A fully liquid diet is advanced to a strictly soft diet in a very gradual fashion. The expected transitional malocclusion, usually with posterior occlusion, is a period of intra-articular settling that should be allowed to progress in an undisturbed environment. This critical postoperative transition to norm occlusion should not be encroached upon by an accelerated return to function or parafunction.

2.5.8 Complications of Traditional Arthroscopy and OSCA

Owing to its minimally invasive nature, arthroscopy is usually associated with few complications. Use of a single cannula in the OSCA technique renders it even less invasive than the traditional double-puncture arthroscopy technique, and it is therefore expected to elicit an even lower percentage of complications.

2.5.8.1 Scuffing of Fibrocartilage

The cartilage covering the eminence and fossa is most prone to iatrogeny, this being the most common arthroscopic complication. At the time of insufflation, the needle point is directed toward the posterior slope of the eminence, making contact with the fibrocartilage. Also, examination sweeps of the joint cavity, involving translation of the arthroscope along with cannula, could also release pieces of cartilage into the superior joint space. If scuffing becomes significant, it impairs procedural visibility, to the point of misdiagnosis of chondromalacia by the inexperienced arthroscopist.

2.5.8.2 Damage to the VII Cranial Nerve

When using the OSCA technique and introducing the cannula 10 mm medially and 5 mm caudally along the cantho-tragal line, the temporal

branch should be anterior to the entry point. Yet, injury to the temporal nerve and the adjacent zygomatic branch may occur, resulting in direct nerve damage arising from scarring of the nerve fibers or perineural tissue. Alternatively, the damage can be the consequence of extravasation, during which irrigation solution is forced beyond the joint capsule into adjacent tissues, resulting in compressive forces on the nerve, subsequent release of ischemic factors, localized nerve fiber changes, and segmental demyelination. Extravasation of irrigation solution usually occurs upon blockage of the irrigation system or an excessively high-inflow current. While it is a common and self-limiting condition, quickly reabsorbed via the venous and lymphatic systems, it is imperative to visualize the soft palate and clear the airway before extubation. Injury to the temporal branch results in inability to elevate the eyebrow, while injury to the zygomatic branch results in inability to tightly close the eyes. Such assessments are made 24 h following surgery. Typically, the duration of nerve weakness varies from 1 week to 6 months.

2.5.8.3 Damage to the V Cranial Nerve

The auriculotemporal nerve is a branch of the mandibular nerve (V3) that runs along the superficial temporal artery and vein. It passes between the neck of the mandible and the sphenomandibular ligament in proximity to the fossa puncture site. Postoperative hypoesthesia in the area of the puncture site is quite common and usually spontaneously resolves within 2 weeks. Medial extravasation of the irrigation solution secondary to medial capsule perforation may result in compressive forces on the lingual and inferior alveolar nerves. Since the irrigation solution is quickly reabsorbed, symptoms resolve within a few days to weeks.

2.5.8.4 Damage to the VIII Cranial Nerve

The vestibulocochlear nerve transmits sound and equilibrium from the inner ear to the brain. Tympanic membrane perforation with subsequent hypoacusia may occur upon penetration into the middle ear via the osseous or soft-tissue

external acoustic meatus. If perforation does occur, the procedure must be immediately discontinued and intraoperative consultation with an ear, nose, and throat specialist is required. A study by Park et al. indicated that perforation size and pneumatization of the middle ear influence the degree of conductive hearing loss in cases of tympanic membrane perforation [23]. Treatment include use of antibiotic ear drops (e.g., ciprofloxacin), a gelfoam plug, fibrin glue, a patch composed of a hyaluronic acid ester, and a dressing component or, in cases of large perforations, tympanoplasty. Following small perforations of the tympanic membrane, patients usually regain normal hearing levels within 2 months.

2.5.8.5 Damage to Vessels and Hamartosis

Injury to the superficial temporal artery and vein may occur, since it passes behind the neck of the condyle, superficially over the posterior root of the zygomatic process of the temporal bone, in close proximity to the point of entry. Applying controlled pressure is usually sufficient. Laceration of the medial pterygoid artery during myotomy may also occur, resulting in hamartosis. Hamartosis prolongs healing and increases postoperative discomfort. It also increases the risk for the formation of adhesions, scarring, and fibrous ankyloses, resulting in a limited range of mandibular movements.

2.5.8.6 Perforation of the Glenoid Fossa

Very rarely, the glenoid fossa is perforated. Such a complication can be easily prevented by marking the length of entry (25 mm) and directing the instruments toward the tubercle and away from the fossa. Perforation may result in cerebrospinal fluid leakage and require immediate cessation of surgery and neurosurgeon consultation.

2.5.8.7 Instrument Failure

Instrument failure can be the result of wearing of parts, manufacturing defects, or misuse, such as application of excessive force on the instrument. It is obligatory to have backup instruments, especially “golden retrievers” or graspers, to remove

broken pieces. In case of a broken part within the TMJ space, it is mandatory to stop the operation, prepare the retriever, and maintain visibility while removing the fragment. If retrieval is not possible, a second attempt should be made as early as possible, i.e., within 6 weeks. It goes without saying that the patient must be informed of the possibilities of future osteoarthritis and infection.

Acknowledgment We would like to express our deepest gratitude to Dr. Daniel Oren and Dr. Adeeb Zoabi who were valuable contributors to the writing of this chapter. They both accompanied us and provided considerable support from the early initiation stages of the OSCA technique.

References

1. Onishi M. Arthroscopy of the temporomandibular joint. *Kokubyo Gakkai Zasshi*. 1975;42:207–13.
2. Murakami K, Hoshino K. Regional anatomical nomenclature and arthroscopic terminology in human temporomandibular joints. *Okajimas Folia Anat Jpn*. 1982;58:745–60.
3. McCain J. Arthroscopy of the human temporomandibular joint. *J Oral Maxillofac Surg*. 1988;46:648–55.
4. McCain JP. Principles and practice of temporomandibular joint arthroscopy. St. Louis: Mosby; 1996.
5. Sanders B. Arthroscopic surgery of the temporomandibular joint: treatment of internal derangement with persistent closed lock. *Oral Surg Oral Med Oral Pathol*. 1986;62:361–72.
6. Holmlund A, Hellsing G. Arthroscopy of the temporomandibular joint: an autopsy study. *Int J Oral Maxillofac Surg*. 1985;14:169–75.
7. Nitzan DW, Dolwick MF, Martinez GA. Temporomandibular joint arthrocentesis: a simplified treatment for severe, limited mouth opening. *J Oral Maxillofac Surg*. 1991;49:1163–7.
8. Koslin MG, Martin JA. TMJ arthroscopic surgery. Clinical results in 79 cases. *J Ala Dent Assoc*. 1990;74(1):26–31.
9. McCain JP, Hossameldin RH. Advanced arthroscopy of the temporomandibular joint. *Atlas Oral Maxillofac Surg Clin North Am*. 2011;19:145–67.
10. Srouji S, Oren D, Zoabi A, Ronen O, Zraik H. Temporomandibular joint arthroscopy technique using a single working cannula. *Int J Oral Maxillofac Surg*. 2016;45:1490–4.
11. González-García R, Gil-Díez Usandizaga JL, Rodríguez-Campo FJ. Arthroscopic anatomy and lysis and lavage of the temporomandibular joint. *Atlas Oral Maxillofac Surg Clin North Am*. 2011;19:131–44.

12. Wilkes CH. Internal derangements of the temporomandibular joint: pathological variations. *Arch Otolaryngol Head Neck Surg.* 1989;115:469–77.
13. Barkin S, Weinberg S. Internal derangements of the temporomandibular joint: the role of arthroscopic surgery and arthrocentesis. *J Can Dent Assoc.* 2000;66:199–203.
14. American Association of Oral and Maxillofacial Surgeons. Position paper on TMJ arthroscopy 1988. In: Thomas M, Bronstein S, editors. *Arthroscopy of the temporomandibular joint.* Philadelphia: WB Saunders; 1991. p. 347–50.
15. Israel H. Arthroscopy of the temporomandibular joint. In: Peterson L, Indresano T, Marciani R, et al., editors. *Principles of oral and maxillofacial surgery.* Philadelphia: JB Lippincott; 1992. p. 2015–40.
16. Murakami K, Ono T. Temporomandibular joint arthroscopy by inferolateral approach. *J Oral Maxillofac Surg.* 1986;15:410.
17. Fernández Sanromán J, Fernández Ferro M, Costas López A, Arenaz Bua J, López A. Does injection of plasma rich in growth factors after temporomandibular joint arthroscopy improve outcomes in patients with Wilkes stage IV internal derangement? A randomized prospective clinical study. *Int J Oral Maxillofac Surg.* 2016;45:828–35.
18. Everts PAM, Knape JTA, Weibrich G, et al. Platelet-rich plasma and platelet gel: a review. *J Extra Corpor Technol.* 2006;38:174.
19. Chang KV, Hung CY, Aliwarga F, Wang TG, Han DS, Chen WS. Comparative effectiveness of platelet-rich plasma injections for treating knee joint cartilage degenerative pathology: a systematic review and meta-analysis. *Arch Phys Med Rehabil.* 2014;95:562–75.
20. Khoshbin A, Leroux T, Wasserstein D, Marks P, Theodoropoulos J, Ogilvie-Harris D, et al. The efficacy of platelet-rich plasma in the treatment of symptomatic knee osteoarthritis: a systematic review with quantitative synthesis. *Arthroscopy.* 2013;29:2037–48.
21. Sánchez M, Fiz N, Azofra J, Usabiaga J, Aduriz Recalled E, Garcia Gutierrez A, et al. A randomized clinical trial evaluating plasma rich in growth factors (PRGF-Endoret) versus hyaluronic acid in the short-term treatment of symptomatic knee osteoarthritis. *Arthroscopy.* 2012;28:1070–8.
22. Vaquerizo V, Plasencia MÁ, Arribas I, Sei-jas R, Padilla S, Orive G, et al. Comparison of intra-articular injections of plasma rich in growth factors (PRGF-Endoret) versus Durolane hyaluronic acid in the treatment of patients with symptomatic osteoarthritis: a randomized controlled trial. *Arthroscopy.* 2013;29:1635–43.
23. Park H, Hong SN, Kim HS, et al. Determinants of conductive hearing loss in tympanic membrane perforation. *Clin Exp Otorhinolaryngol.* 2015;8(2):92–6.

Minimally Invasive Oral and Maxillofacial Surgery

Nahlieli, O. (Ed.)

2018, XII, 203 p. 174 illus., 150 illus. in color.,

Hardcover

ISBN: 978-3-662-54590-4