

The Temporomandibular Joint and Related Orofacial Disorders

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Surgery of the Temporomandibular Joint

Surgery of the TMJ plays a small but significant role in the management of TMD. The most undisputed application of surgery is found in management of the least common TMJ disorders, such as ankylosis, growth disorders, recurrent dislocation, and neoplasia. Indications are less clear for more common disorders, such as internal derangements. Experience suggests that about 5% of all patients undergoing treatment for TMD require some surgical intervention.

A wide spectrum of surgical procedures is used for treatment of TMJ disorders. The procedures range from simple irrigation of the joint to complex open joint procedures. Surgical success depends on the appropriate selection of cases.

This chapter presents the indications, outcomes, and complications associated with some common surgical procedures. Extensive detail is beyond the scope of this chapter. Some procedures are briefly described to improve the reader's comprehension of problems faced by patients and by the practitioners who treat them.

Indications for Surgery

Individuals with genuine TMJ disorders suffer various afflictions. Surgery may be necessary if the symptoms are resistant to conservative, nonsurgical treatment. Most surgeries are performed for the following reasons:

- Internal derangements.
- Osteoarthrosis (osteoarthritis).
- Ankylosis (fibrous and bony).
- Hypermobility, dislocation.
- Growth disorders (hyperplastic versus hypoplastic).
- Condylar trauma.
- Infections.
- Neoplasia.

Terminology of Surgical Techniques

Arthrotomy involves open surgery to expose and dissect structures of the joint.

Debridement concerns the removal of devitalized tissue by mechanical means.

Perforations imply holes in the disk or junction of the disk with the posterior

attachment.

Disk repair involves procedures used to repair perforations or tears in the disk.

Disk repositioning is a procedure to move a displaced disk into a normal anatomic relation with respect to the condyle and fossa.

Discectomy (sometimes inappropriately termed meniscectomy) refers to surgical removal of the disk.

Eminectomy involves removal of the eminence; *eminoplasty*, recontouring of the eminence.

Condylectomy involves total removal of the condyle.

Modified condylotomy is a variation of the vertical ramus osteotomy, whereby the condylar process is detached from the mandibular ramus. It is used in the treatment of internal derangement.

High condylectomy refers to limited bony recontouring of the head of the condyle. This procedure is sometimes called a "condylar shave". It is used to removed the diseased articular surface of the condylar head.

Arthroscopic surgery refers to operative procedures performed with fine instruments during telescopic penetration of a joint cavity for diagnostic and therapeutic reasons. The surgery is performed using a rigid endoscope (arthroscope). Arthroscopic surgery is less invasive than arthrotomy.

The scopes have an average external diameter of 2.5 mm and a lens diameter of about 2.0 mm. The image is magnified from 1 to 15 times. The joint anatomy can be visualized, surgically altered if needed, and the procedure recorded by an attached cinecamera or videorecorder.

Anatomic details seen after insertion of the arthroscope into the healthy joint are the position of the disk, the articular surfaces, and the synovial membrane of the upper joint space. Arthroscopy permits a viewing of pathologic changes in the joint, including degree of inflammation (eg, hyperemia, edema, synovitis), adhesion, fibrillation, fibrosis, disk displacement and rupture, and perforations. Bony irregularities may be visible.

Arthrocentesis refers to needle puncture of the joint space. Usually, this procedure is combined with lavage. *Lavage* involves irrigation of the joint. After lavage, the mandible is gently manipulated to evaluate motion.

Lysis refers to mechanical or hydraulic techniques designed to loosen adhesions.

Anterior release (anterior band release) is a procedure used for freeing up fibrous tissue anterior to the disk. It helps to increase the mobility of the disk and may be

accomplished with arthroscopic scissors or by electrocautery.

Posterior cauterization refers to electrocautery of the posterior attachment. The procedure is used primarily for symptomatic hypermobility with chronic condylar dislocation and hypertrophied synovial tissue. Proof is lacking for its value in retaining the posterior positioning of a disk freed by anterior release. *Synovial cauterization* is used if control of oozing and hemorrhage is required. Some surgeons use sutures to reposition the disk.

Plication involves folding or taking a tuck to reduce the size of the disk. It consists of removing a wedge from the redundant posterior attachment of an anteriorly displaced disk. The segments are sutured together. *Partial-thickness plication* involves repositioning the disk without violating the lower joint space. *Full-thickness plication* means repositioning the disk by surgically exposing the lower joint space.

Arthroplasty generally involves recontouring the articular surface of the mandibular condyle or articular eminence. Another material may be inserted after surgical excision to replace some part of the joint.

This replacement may be made with either with an *autogenous* or *homogenous* tissue or with an *alloplastic* material. Autogenous tissue is obtained from the same individual and may include dermis, temporal fascia, or cartilage of the ear. Homogenous tissue is derived from another animal, such as collagen or lyophilized cartilage. An alloplast is a prosthesis made from a nonbiologic substance.

Complications that may arise after surgery and require management mostly fall into the following categories:

- Neurologic dysfunction of nerves V and VII.
- Auditory dysfunction.
- Infections.
- Limited mandibular movement from scarring and fibrosis.
- Pain.
- Hemorrhage.

Rationale for Surgery

The patient with TMJ arthropathy may present to the surgeon with a generalized complaint of chronic joint pain that has been present for 6 months or longer. There may be hypo- or hypermobility of the mandible. No other jaw pathology is evident.

Experience has shown that most TMD patients benefit from appropriate nonsurgical treatment. Thus, TMJ surgery should rarely be performed before nonsurgical treatment has

been attempted and found to be ineffective.

Criteria for Successful Outcome

The patient considering TMJ surgery should understand that the surgery is an optional treatment. Details of each procedure should be thoroughly discussed between the surgeon and the patient and an agreement reached on what is interpreted as a "successful outcome". The patient or surgeon may interpret either improved motion or loss of pain as successful. There remains the possibility that the surgery may make the patient worse. Thus, specific treatment goals must be well defined and accepted by both parties before surgery.

Most surgical outcomes have been judged by their short-term results. Little information exists about long-term outcome for specific procedures. Most findings have been based on testimonials, either from patients' written reports or from verbal patient judgments interpreted by surgeons. Few surgical criteria have been identified that would serve as a "gold standard" for success or failure of treatment. Recent attempts have been made to establish some measure of assessment. These criteria can be summarized as follows:

1. Patient's sense of improvement
 - a. Improvement in chewing and talking.
 - b. Reduction in pain.
 - c. Reduction in joint sounds.
2. Surgeon's sense of improvement
 - a. Improved range of motion, greater than 35 mm vertical opening and 5 mm protrusively and laterally.
 - b. Avoidance of postoperative complications.
 - c. Imaging or radiographic appearance of TMJs within normal limits.

Patient's Interpretation of Pain

A Committee on TMJ Arthroscopy formed by the American Association of Oral and Maxillofacial Surgeons in 1988 has published the surgical findings from 12 multicenters across the USA. Among the findings were degree of success or failure and outcome with different procedures employed.

Summary of patients' interpretations showed that 91% rated **pain response on palpation** as excellent to good. An excellent response was rated as minimal to no pain, good as minimal pain, and poor as significant pain. An excellent to good **sense of improvement** was found in 90% of patients. An excellent rating meant a significant sense of improvement; good, a moderate improvement; and poor, a persistent disability. Similar findings were found for eating and dietary habits.

These data compare favorably with findings from another study of TMDF patients treated with arthroscopic surgery who were followed for up to 3 years. Procedures included lysis, lavage, debridement of the superior joint space, and mobilization of the joint. Treatment of the 109 TMD patients (150 arthroscopies) showed that three fourths rated the level of pain at 2 postoperatively, compared with 7 to 10 preoperatively. Ninety-three percent of the patients with pain managed it easily. Headache decreased from 83% preoperatively to 40%

postoperatively. Chewing was significantly improved, and 90% reported that they could eat a regular diet after the surgery.

In studies concerned with arthrotomy, 80% of 83 patients considered the status of their TMJ as better. About 70% reported being free of pain. Comparable success of 84% was claimed for 27 open surgical cases. Ten percent of patients reported no relief of pain, and 6% described it as worse. Among 14 patients treated arthroscopically, one half reported less frequent and reduced pain intensity and one half had little to no change.

Questionnaires returned from 150 to 237 patients treated by different surgical procedures revealed that 146 had improved significantly. The failure rate was highest in the few patients treated by diskectomy. Overall, most stated that they would have the surgery again if needed.

Computation of results from another study of 77 patients (152 joints) treated arthroscopically found that 71% achieved excellent to very good results. These patients had no pain and followed a diet without restrictions. Twenty-four percent were judged as good to fair because of occasional to slight discomfort. The treatment was considered to have failed in the remaining 5% of patients with unrelenting pain. The patients were followed for 2 to 31 months.

Significance: Collectively, the studies support the view that surgery is a meaningful option for management of patient's pain or dysfunction.

Surgeon's Interpretation of Range of Motion and Tenderness

The findings obtained from the multicenter study revealed that a high percentage of surgeons were satisfied with the surgical outcome. A summary of the surgeons' interpretations showed that 92% rated patients' range of motion as excellent or good. This decision was based on an excellent rating of maximal vertical opening as 40 mm or more, good as 30 to 40 mm, and poor as less than 30 mm.

These data compare favorably with findings from another study of patients treated with arthroscopic surgery. Seventy-five percent of 109 patients had a maximal voluntary opening of 40 mm or more and similar improvement in lateral motions after surgery, where 47% had opening less than 35 mm prior to treatment. Additionally, muscular tenderness on palpation dropped from about 50% preoperatively to 29% postoperatively, and the discomfort was described as less severe.

Another study of 237 patients treated with different surgical procedures produced 83% success. The author assessed the success from clinical and radiologic findings. The level of pain was determined by patient response to treatment. Absence of major complication was considered a surgical criterion. Success was judged by the specific procedure performed: bone reduction, 85%; disk repositioning and repair, 81%; and diskectomy, 89%. Length of follow-up was not stated.

Based on studies of 77 patients treated arthroscopically, another surgeon judged excellent to very good results as an interincisal opening of 35 mm or more and good

mandibular function as an absence of joint noises. Good to fair success was judged as minimal joint sounds, interincisal opening of 35 mm or more, and good mandibular function. Such patients had close follow-up, stress management, or physical therapy. Outcomes were judged as failures in patients who required further surgery because of pain or dysfunction.

Significance. Collectively, these studies support the view that surgeons interpret surgeries as worthwhile options for patients with chronic TMJ pain or dysfunction resistant to conservative therapy.

Diagnosis

Successful TMJ surgery depends on accurate diagnosis. The diagnosis is derived after evaluation of the patient's chief complaint, history of the complaint, and the clinical findings.

The chief complaint must be severe or bothersome enough to constantly interfere with activities of daily living. The history should include some prior conservative therapies resulting in unfavorable outcomes.

Clinical examination relies on finding pain localized to the TMJ that is tender to palpation and painful when the joint is loaded. Mechanical interference of mandibular movement (locking, clicking, or popping) may be present.

Osseous changes may be visible by radiographic analysis. TMJ arthrographic or magnetic resonance imaging (MRI) evaluations of soft tissues help identify some deranged structures, but these evaluations should not be considered definitive diagnostically.

Surgical Dilemmas: Selected Opinions About TMJ Surgery

The surgeon should select operative procedures with the greatest potential for success and lowest possibility of complication. However, there is controversy within the profession about definitions of and need for TMJ surgery. Sampling by postal questionnaire of 100 international "experts on temporomandibular joint surgery" revealed some degree of consensus for certain questions but disagreement for others.

Length of Conservative Therapy

Opinions differed on the minimal time conservative therapy should be judged ineffective before surgery is attempted. Fifty-one percent of the surgeons designated as "experts" agreed on 6 months, and 34% agreed on 2 months.

Definitions

Support among the "experts" was lowest for the statement that internal derangement led to arthrosis. Thirty-nine percent disagreed with this statement. The statement with the next to lowest support was the definition of internal derangement as a localized mechanical fault.

Surgery and Stage of Derangement

Five stages of progressively worsening internal derangement were defined, and 87% of the surgeons accepted them. Just 30% agreed that surgery should be performed in the earliest stage. Nearly complete agreement was found for performing surgery on patients in the early-intermediate to intermediate-late stages, and complete agreement for the latest stage. The preference for specific treatments at each of the five stages is outlined below:

Early: none.

Early-intermediate: lysis and lavage with arthroscopy or disk repositioning with arthrotomy.

Intermediate: disk repositioning or diskectomy with arthrotomy or lysis and lavage with arthroscopy.

Late-intermediate: disk repositioning, diskectomy, or condylar shave with arthrotomy or lysis and lavage with arthroscopy. (Few surgeons recommended lysis and lavage, but if arthroscopy was performed, some bony recontouring and repair were recommended.)

Late: diskectomy primarily with or without replacement during arthrotomy.

Relief of Pain

Eighty surgeons estimated surgical success for relief of pain at 70%. Other successes included relief from locking (60%), clicking (63%), and limitation of opening (77%).

But when the experts were questioned about failures, the ratings did not match the reciprocal percentages. Ratings for failures were estimated as continued pain (14%), locking (35%), clicking (10%), and limitation of opening (16%).

Postoperative Complications

Little difference was found in postoperative complications for surgery performed by arthroscopy or by arthrotomy. For as many as 10% of patients presenting with complications, surgical estimates for complications with arthroscopy were 65% for persistent pain and 82% for temporary facial weakness. For arthrotomy, the estimate was 61% for each, respectively.

Significance: A major criticism of the survey is that few oral surgeons were sampled from North America. The response rate was highest for surgeons from Asia, with 87% responding.

The relation of pain to stages of diskal disorder, particularly in light of the absence of neural tissue within the disk, is unclear.

For internal derangements, arthroscopic surgery was preferred by experts for its diagnostic and therapeutic values. Clinicians interested in arthroscopic surgery may review the excellent photographs of intra-articular morphology in *Diagnostic Arthroscopy of the TMJ*

by Murakami and colleagues.

History of TMJ Surgery and Related Procedures

Internal Derangement and Treatment

Since the introduction of surgery for disk repositioning, surgical treatment of internal derangement has undergone major changes. Until the middle of the 1980s, most TMJ pain and dysfunction was attributed to diskal displacement and deformity. Displaced, deformed disks were reshaped and repositioned after arthrotomy. Discectomy and condylotomy were alternative procedures used then and later.

Because open joint procedures failed to achieve expected results, surgeons sought alternative procedures. The surgical management of internal derangement was revolutionized by the introduction of TMJ arthroscopy. The observation that lavage and lysis of adhesions done only within the upper joint compartment resulted in less pain and improved function raised important questions about the need to reposition the disk. Recent observations after arthrocentesis with lavage makes the significance of diskal displacement as a cause of TMJ pain and dysfunction even more doubtful.

Most internal derangements in North America are managed arthroscopically. Others require arthrotomy, and still others may be performed with either procedure. In most cases of arthrotomy, this decision is not made until the condition of the disk is inspected at the time of the operation. This difference in management is demonstrated by a review of the findings from patients treated at 12 multicenters across the USA.

Differences between the diagnosis and severity of the disorders explain the variation in the procedures elected. Lysis and lavage have been the preferred treatment for patients suffering from arthralgia and disk disorder without reduction. Nearly three fourths of the surgeons applied this modality if pain was present, or if there was disk disorder without reduction. The next most often selected modality was anterior release, posterior cauterization without sutures for disk disorder without reduction and for painful clicking. Synovial cauterization was preferred for arthralgia. Debridement was chosen for the treatment of fibrous ankylosis. Debridement and then lysis and lavage were applied for osteoarthritis.

About 6.1% (194/3146) of the patients developed complications. A temporary fifth nerve deficit accounted for 3.6% of the problems, followed by temporary seventh nerve paresis, and then partial hearing loss, respectively.

The frequencies of the follow-ups conducted were as follows: 6 months, 18%; 6 to 12 months, 18%; 12 to 18 months, 16%; 18 to 24 months, 19%; and more than 24 months, 29%.

Rationale for Treatment

There are several options for surgery of internal derangements. Because randomized prospective studies have not been conducted, a procedure should be selected based on available clinical data and the surgeon's experience. The prudent surgeon selects the procedure with the highest probability for success and the lowest probability of morbidity for each

patient.

Surgeons should inform patients that although the derangement may progress anatomically, pain and dysfunction frequently diminish in the absence of treatment.

The decision to perform surgery should be predicated on severity of the patient's symptoms, not on the degree of anatomic derangement. Because little is known about whether surgery is better than the natural course of the disorder, it should not be performed for preventive reasons.

Indication

Surgical treatment is indicated for the patient who presents with severe TMJ pain and dysfunction that has proved refractory to nonsurgical management.

Diagnostic Criteria

The best surgical candidate localizes the pain and dysfunction specifically in the TMJ, has a TMJ tender to palpation, and experiences increased TMJ pain when the joint is loaded. Mechanical interference such as locking or clicking may be demonstrable.

TMJ arthrography or magnetic resonance imaging may prove helpful in identifying certain deranged structures, but the lack of correlation between imaging findings and pain lessens their usefulness. Although arthrography and imaging provide accurate images of the anatomy, they have proved disappointing for differentiating patients with TMJ pain from non-TMJ individuals.

Further evidence confirms that MRI findings would be an inaccurate "gold standard" for predicting the presence of internal derangements. Comparison of MRI findings with symptoms observed for right-side and left-side joints showed that the sensitivity was 68% and specificity was 82% for right-side joints. For left-side joints, these symptoms were 47% and 64%, respectively. Thus, over-reliance on the diagnostic value of imaging may lead to overdiagnosis and overtreatment.

Risks

Physical risks accompany surgery for internal derangements. It is not known whether the progression of anatomic derangement is altered by surgery.

Procedures

Arthroscopy. TMJ arthroscopy was popularized in the late 1980s. It allowed observation of internal anatomy of the joint, led to improvement in diagnosis, and reduced the maneuvers required to perform surgery of the joint, particularly internal derangements. Clinical experience with arthroscopy raised serious questions as to whether it was necessary to reposition the disk to resolve pain and treat dysfunction.

TMJ arthroscopy usually is performed with the patient under general anaesthesia. The cannula attached to the rigid arthroscope is inserted into the upper joint compartment, and the arthroscope is connected to a television camera equipped with a video monitor. The upper joint compartment is thoroughly examined either directly through the ocular or indirectly from the monitor.

The most common procedures performed by arthroscopy are lavage and lysis of adhesions. Lavage of the compartment makes exploration easier and more effective. Probing at this time permits determination of tissue characteristics. Adhesions are lysed with instruments manipulated through a second cannula inserted in the compartment. Biopsy forceps or motorized devices fitted with different blades may be used to resect excess tissue.

Results with arthroscopy have been good. Improvement in range of mandibular motion and decreased pain have been judged successful in 79% to 93% of cases. Retrospective studies confirmed that lavage and lysis of adhesions performed during arthroscopy are as effective as arthrotomy for treatment of chronic painful limited hypomobility.

Some complications may develop during and after arthroscopy. Breaking of instruments within the compartment is a complication unique to arthroscopy. Mobility of the joint may be reduced after arthroscopy, which often requires an aggressive regimen of physical therapy.

Significance: Arthroscopy has both diagnostic and therapeutic value. Surgery can be performed for all stages of internal derangement and has proved most effective in treating painful diskal disorders without reduction. Presumably, the disk adheres to the fossa, eminence, or both and fails to reduce. The immobility of the disk apparently results from changes in the synovial fluid or articular connective tissue, or is caused by a vacuum effect that develops between the disk and fossa.

Arthrocentesis. Arthrocentesis coupled with lavage and manipulation has become the procedure of choice for many surgeons. Once the joint is anesthetized by local anesthesia, and the patient is under conscious sedation, a 20-gauge needle is placed in the upper joint compartment about 1 cm in front of the ear. Hydraulic pressure is created by injecting about 2 mL of lactated Ringer's solution into the upper compartment. A second 20-gauge needle is placed about 1 cm anterior to the first needle, and the joint is irrigated with 50 to 100 mL of the Ringer's solution.

The outflow needle is intermittently occluded to create hydraulic pressure within the compartment. The mandible is gently manipulated to evaluate motion.

Arthrocentesis with irrigation has been used successfully without the need to reposition the disk. These steps proved effective in "unlocking" eight patients with diskal displacement without reduction.

The mean interincisal opening was 22 mm preoperatively and 38 mm postoperatively. Furthermore, the procedure improved the range of mandibular motion and reduced pain in 17 patients with severely limited mouth opening. Comparison of preoperative and postoperative measures showed that pain as measured by the visual analogue scale decreased from 9 to 2,

and the frequency of clicking decreased from 12 to 4 patients. Mean voluntary opening increased from 24 to 43 mm and mean lateral motions from 4 to 11 mm. Overall success was 91% in patients followed for 4 to 14 months.

Significance: Surgeons can treat sudden, severely limited opening with arthrocentesis and lavage in patients with diskal displacement without reduction. Patients can expect low morbidity and few complications. Postoperative therapy requires repetitive opening and excursive exercises to maintain and improve function.

Arthrotomy. Arthrotomy may be indicated for all stages of internal derangement. Disk repositioning and diskectomy have been the most frequent procedures managed by open joint surgery.

The skin incision requires a preauricular, endaural, or postauricular approach. The decision of where to locate the incision is based on the surgeon's experience. Once the incision is made, the underlying soft tissue is dissected with care to avoid cutting the facial nerve. Internal components of the joint are evaluated after reflection of the capsule. Either disk repositioning or diskectomy is performed depending on clinical presentation of the joint.

Disk Repositioning. The healthy disk is free of tension and can be repositioned to a normal anatomic relation with the condyle and the fossa. During surgical exposure, the healthy disk is white and glistens. It is firm when manipulated.

Surgical management may entail a partial-thickness plication procedure, which does not require entrance into the lower synovial compartment. A full-thickness plication is needed if entry is required to the lower compartment.

Osseous recontouring of the condyle, achieved by high condylectomy, may be done to remove any bony irregularity or impingement. Usually this surgery is performed in the lateral third of the joint. Another option is eminoplasty to remove additional mechanical interference.

Surgery to reposition the disk was first used in 1979. Studies concerned with success of disk repositioning have been mixed. Of 152 patients treated between 1980 and 1988, excellent results were reported by 52% and good results by 28%. Nonetheless, about 5% to 10% of the patients reported no improvement or described their dysfunction as worse after the procedure. These findings confirmed the results of other studies.

A serious complication after repair has been the formation of fibrous adhesions between the disks and regions of osseous reduction, particularly the condyle. Relief of pain may occur. Some complaints, including joint sounds or reduced jaw motion, may remain. Temporary weakness of the facial nerve occurs in less than 5% of patients and is usually limited to temporal branches. Many patients experience occlusal changes. Infection develops in less than 1% of cases.

Significance: Disk repositioning is a conservative joint surgery because joint structures are preserved. This procedure is the most technically precise and requires careful postoperative management, especially attention to the occlusion. Long-term prognosis is

considered excellent because joint structures are maintained.

Diskectomy. The decision to remove the disk is made in situations in which the disk is so deranged that few options exist. Instability of the disk because of perforation, fragmentation, loss of elasticity, or persistent pain after disk repositioning may require diskectomy.

Once the joint is exposed, the disk is excised, leaving as much synovium as possible. The articular surfaces are then recontoured conservatively if irregularities exist.

Diskectomy is an old procedure. Many surgeons have been reluctant to perform diskectomy and the procedure remains controversial. In a review of historical perspectives, excision without replacement was common between 1900 to 1960. The trend in North America then shifted to replacement with an interpositional implant, although presently most surgeons do not use implants.

Outcomes with diskectomy have been equivocal. A comprehensive review described successful relief of pain in some cases, but long-term osseous changes and significant loss of motion were sequelae. Histopathologic changes have been found after experimental diskectomy was performed in the joints of rabbits and baboons.

Favorable results have been reported. No replacement proved effective in the hands of one orthopedic surgeon. A total of 212 diskectomies performed without replacement and conducted over 32 years showed only 4% of the patients developed significant arthropathy. Evaluation of another 15 patients treated by diskectomy between 1947 and 1960 revealed all were pain free and just 1 opened less than 39 mm. Radiographic changes have been observed, primarily in the condyle. They tend to stabilize after 18 months. Presumably, these changes represent adaptation between the condyle and fossa.

Significant risks exist with diskectomy. Paresis of the facial nerve may occur in up to 5% of cases after diskectomy. Heterotopic bone formation may cause ankylosis, which tends to follow extensive osseous recontouring. Condylar resorption may occur if multiple operations have been done. Significant malocclusion may develop and can be managed by occlusal adjustment.

Significance: Diskectomy is a valid surgical option. Nonetheless, surgeons have been reluctant to accept it because of perceived complications.

Modified Condylotomy. Condylotomy originated in 1957 as a procedure for treatment of painful TMJ. A closed subcondylar incision was made through the neck of the condyle. Because of potential for hemorrhage and injury of the facial nerve, the original procedure was modified. A current indication is for treatment of chronic refractory TMJ pain associated with a reducing disk.

The procedure is performed under general anaesthesia on an outpatient basis. The lateral aspect of the mandibular ramus is exposed through a transoral incision. A vertical cut extending from the sigmoid notch to the angle is made parallel to the posterior border of the mandible. The osteotomized border of the proximal segment is smoothed and then is placed

next to the distal segment. The incision is closed once the teeth are placed in maxillomandibular fixation. The mandible is immobilized for 2 to 6 weeks. Trainning elastics are used to avoid significant malocclusion.

Surgical results have been reported as excellent. About 92% of 207 patients (251 joints) treated in this manner have been considered successful. These patients had little or no pain and an improved range of motion. A retrospective study of 400 patients followed over 9 years showed that 90% received pain relief from this procedure. The authors claimed that clicking and locking were mostly eliminated.

Significance: Apparently, favorable outcome results because the condyle sags after surgery. This sag increases the space between the condyle, disk, and fossa. An unfavorable malocclusion may follow if the sag is excessive. Minor occlusal changes have been observed in 1% to 2% of patients. There is some possibility of injury to the inferior alveolar nerve during the surgery.

Interpositional Implants. After diskectomy, many kinds of interpositional implants have been inserted to improve joint function. Implants used since 1960 include polycaps for the condyle, dermal or ear cartilage grafts, silicone (Silastic), polytef (Teflon), and Proplast implants, and chrome-cobalt (Vitallium) eminence prostheses.

Replacement by alloplastic materials has been uniformly bad, although some studies reported short-term success. Improvement has been reported by patients treated with Vitallium and Vitallium-and-Silastic implants; a success rate of 85% was claimed in eliminating or significantly improving symptoms.

Some alloplasts have produced severe consequences. Foreign body reaction and synovitis were observed initially after Silastic implantation. Other significant changes have included increased pain, bony resorption, and malocclusion. Clinical and radiographic studies were conducted on 43 patients who had diskectomies for chronic pain. Twenty-two received a silicone implant, and 21 received no implant. Condylar erosion was found in 8 patients with implants. The outcome was judged poor in 5 patients; all had implants. Condylar erosion was found in 8 patients with implants. Recent evidence supports the negative long-term effects of these implants. Postinsertional symptoms developed about 4 years after surgery in 12 of 15 patients who received 23 implants.

Proplast-Teflon implants were introduced as interpositional materials in 1976. Short-term results demonstrated favorable outcomes in about 90% of cases, and thousands of patients subsequently received these implants. However, deleterious side effects arguing against their use continued to emerge. Severe condylar and fossa degeneration developed in 90% of cases. The implants have been unable to withstand functional loading and gradually disintegrated. A foreign body giant cell reaction with subsequent bony erosion and lymphadenopathy appeared within a few years. Anterior open bite developed in some cases.

Some measure of success has been accomplished with dermal grafts and grafts consisting of cartilage procured from the ear. Twenty patients (26 joints) with irreparable disks unsuitable for posterior plication were treated by diskectomy. These disks were replaced with a 2x2x3 cm piece of autogenous auricular cartilage sutured against the fossa. Seventeen

patients had significant or total resolution of pain. Based on a scale of 0 to 3 (no pain to severe pain), the preoperative level of pain dropped from 2.8 to 0.4 postoperatively. An 85% success rate was claimed for increased range of motion. Maximum voluntary opening averaged 31 mm preoperatively and was 39 mm postoperatively with a follow-up of about 2 years.

Studies involving disk replacement with temporalis muscle pericranial flaps have been limited. The average preoperative opening increased from about 21 mm to 35 mm in 13 patients treated in this manner and followed for 15 months.

Significance: Diskectomy without replacement is recommended over diskectomy with replacement. Long-term studies have not been evaluated in the small number of patients treated with dermal grafts, auricular cartilage grafts, and muscle flaps.

An implant alert concerning Proplast was issued by the Federal Drug Administration (FDA) in 1991. Since then, production for this purpose has ceased. Patients or clinicians concerned about individuals with Silastic or Teflon implants should consult an oral surgeon to see if the removal of implants is necessary. The consensus for symptomatic patients with Proplast-Teflon implants still in situ is for immediate removal. Radiographic follow-up is recommended every 6 months for asymptomatic patients. Information about alloplastic interpositional implants can be obtained from a special registry at the Medic Alert Foundation. To report problems with these implants, notify the FDA.

Hypermobility, Subluxation, and Dislocation

Hypermobility, dislocation, and subluxation represent a spectrum of disorders with various etiologies. Among TMD patients treated nonsurgically, 3% or less have a history of dislocation.

The asymptomatic individual with a hypermobile mandible may lack the true pathology of the TMJ. Some hypermobile patients can smoothly translate the condyles horizontally and vertically beyond the peak of the eminence. Usually clicking, locking, and pain are absent as the condyles move to and from this extreme position.

Certain patients with hypermobility may not experience progressive osteoarthritis with advancing age. Thirteen subjects with bilateral hypermobility who were treated non-surgically were matched for gender and age against 13 patients who received routine dental care. The hypermobile group was evaluated 30 years after treatment. Clinical and functional evaluation showed no significant difference between the two groups. Examination of transpharyngeal radiographs disclosed some sclerosis in the joints of the hypermobile patients, which was absent in the dental patients. The authors concluded that some hypermobile joints may degenerate and others may not.

Subluxation is an incomplete condylar translation and should be considered a pathologic condition. The condyle is briefly trapped in a forward position by diskal obstruction or an irregular articular surface. It may spontaneously return to the fossa or the patient may self-reduce the affected joint. Generally, subluxation and ultimate reduction are irregular motions, characterized by sudden popping and some intermittent pain.

Dislocation (luxation) results when contact is absent between normal articulating surfaces. The condyle is locked forward to the anterior slope of the eminence. The individual is unable to reduce the lock because the condylar displacement is too severe. Frequently, tension and pain develop within the lateral pterygoid muscle. The dislocated condyle is characterized by a depression anterior to the tragus. The point of the chin deviates toward the contralateral side on unilateral dislocation.

Radiographs should be obtained to rule out possible mandibular fracture before attempts are made to manipulate the dislocated mandible. Local anesthesia of the TMJ, auricular nerve, and lateral pterygoid muscle has proved helpful before manipulation. Intravenous injection with diazepam (5 to 10 mg intravenously, adult dose given incrementally) may help after unsuccessful attempts. In patients with closed head injury and long-standing bilateral dislocation, arthrotomy may be required. Occasionally, patients may present with dislocation secondary to acute dystonic phenothiazine reaction. Injection with diphenhydramine (25 mg intravenously, adult dose) minimizes extrapyramidal effects and should be given before manual reduction is attempted.

Dislocations that become recurrent are a nuisance for the patient. Procedures for correction are designed to limit condylar translation, eliminate mechanical blocking, or both.

Correction for recurrent dislocation may be accomplished by eminoplasty. A 1.5-cm preauricular incision allows exposure of the eminence. The tubercle and eminence are excised with an osteotome and mallet. The procedure may be done unilaterally or bilaterally. A modified Myrhaug operation has proved successful. Care is taken to avoid opening into the upper joint compartment. A horizontal groove made in the lateral part of the tubercle allows resection of the tubercle and eminence without damaging the articular cartilage.

Retrospective study of 11 patients treated for chronic dislocation and followed for up to 27 months found that all improved with or were satisfied by eminectomy. Satisfactory results were obtained for another 16 patients (31 joints) treated with the modified Myrhaug operation. Nine patients had no recurrence of dislocation, 5 showed improvement, and 1 required a second operation. Ten patients were 100% satisfied, 4 were 90% satisfied, 1 was 50% satisfied, and 1 was dissatisfied. The patients were followed for 8 months to just over 9 years.

Condylar translation can be limited by tightening the laxity associated with the capsule or posterior attachment, tethering the condyle to an adjacent structure, detaching the lateral pterygoid muscle, or forming an anterior block (supraeminence).

In patients with redundant posterior attachment, a partial- or full-thickness plication can be performed. Modest reduction in the height of the eminence improves the chance for success. Sclerosing agents can be injected into the prominent oblique protuberance found in the posteromedial recess of the superior joint compartment. The patient's teeth should be placed in maxillomandibular fixation for 1 month to limit mandibular movement when these procedures are performed.

Chronic dislocation can be prevented by performing an osteotomy of the zygomatic arch. A slanted osteotomy is made in the posterior arch, and the anterior arch is distracted

laterally and partially fractured into place below the intact posterior edge. This surgery creates a large bony eminence.

Another procedure is insertion of a free autogenous bone graft or homologous graft to build up the eminence. The technique has an important advantage because the graft is secured to the eminence with metal plates and screws. Thus, immediate postoperative forces are resisted. This fixation allows long-term healing of the graft to the eminence.

Significance: Eminoplasty appears to be a useful procedure for habitual dislocation. There is no interference with the articular or condylar surfaces or the capsule of the joint. The procedure most likely prevents dislocation because of fibrosis between the roughened surface of the eminence and the internal joint structures. Other modalities, such as injection of sclerosing solution, scarification of the temporalis tendon, or plication, require further study involving larger samples of patients to prove their long-term value.

Hypomobility Unrelated to Internal Derangement

Limited mandibular opening caused by ankylosis of the joint can be debilitating. Individuals experience problems with mastication, speech, and oral hygiene that make management difficult. Hypomobility arises from either extracapsular or intracapsular origins.

Extracapsular Origin

Limited opening of extracapsular origin is termed *pseudoankylosis*. These patients often present with a history of soft tissue injury and scarring related to trauma. Some cases of hypomobility result from enlargement of the coronoid process. The patient typically presents with a gradual loss of opening with advancing age and has no history of trauma, orofacial pain, or TMJ disorder.

The treatment for extracapsular limited opening is generally scar release or coronoidectomy. Once the incision is made over the coronoid, part of the coronoid process is excised to prevent reattachment of the bony ends.

Intracapsular Origin

Limited opening of intracapsular origin is termed *true ankylosis*. Some are bony, others are fibrous, and combinations of the two are termed *fibro-osseous ankylosis*. The primary cause of fibrous ankylosis is trauma. Less common causes are infection, neoplasia, and, rarely, growth disorders.

The procedure for correction of ankylosis is referred to as *gap arthroplasty*. An autogenous graft of temporal muscle or dermis may be positioned between the dissected surfaces to fill the gap.

Significance: Pain is rarely a feature of ankylosis, yet hypomobility may require extensive surgery. Frequent, aggressive physical therapy is required to restore and maintain the normal range of motion.

Skeletal and Dental Malocclusion

Severe cases of dental and skeletal malocclusion are correctable by means of orthognathic surgery. Beneficial effects include correction of the malocclusion, improvement in aesthetics, and reduction of the load on the TMJs. Few studies have assessed the effect of this surgery in TMD patients.

A retrospective study of 75 symptomatic and asymptomatic subjects who had undergone orthognathic surgery showed that 36 had preoperative TMD symptoms. Among treated TMD patients, 89% improved, 8% developed more symptoms, and 3% remained unchanged. About 8% of patients who were asymptomatic before surgery developed some dysfunction postoperatively. The prevalence of dysfunction was greater in patients with class II than class III relations, but function improved in both groups after surgery.

Comparison of 53 retrognathic patients with class II, division I malocclusion treated by mandibular advancement showed that the surgery neither increased nor reduced the risk for TMD. Findings obtained by means of a craniomandibular index confirmed that the signs and symptoms did not differ significantly between the preoperative condition and the condition 1 year after the surgery.

Significance: These limited outcome studies suggest that the surgery led to improvement in symptomatic individuals. Little to no short-term disability resulted.