

**THE RISKS AND BENEFITS OF SURGERY
FOR TEMPOROMANDIBULAR JOINT INTERNAL DERANGEMENTS**

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INTRODUCTION

Internal derangements of the temporomandibular joint (TMJ) have aroused the interest of surgeons since the nineteenth century and surgery continues to play a limited, but useful role in the management of patients with this condition.²¹

It has become increasingly evident that the primary indications for surgical intervention in patients with an internal derangement are the presence of pain that is localized specifically to the TMJ, and/or dysfunction that impairs the patient's ability to carry out his/her daily activities in relative comfort. This is predicated on the fact that the patient's condition has failed to improve with a reasonable course of appropriate non-surgical therapy, and that the condition is seemingly caused by a structural alteration that is amenable to surgical correction.^{29,15,41,76,103}

Undoubtedly, the rationale for each of the diverse operations that have been developed to treat these conditions is based on a specific understanding of the pathophysiology of these disorders. Consequently operations that include, but are not limited to, meniscectomy, meniscal repositioning, condylotomy, and more recently arthroscopic surgery and arthrocentesis have been devised.

While the risks associated with these operations have been well-documented, there is a paucity of information concerning any predictable resultant benefits. This paper will attempt to provide a critical review of the relevant scientific literature as it pertains to the risks and benefits of the surgical treatment of TMJ internal derangements.

The review is organized into the following sections:

RISKS AND BENEFITS OF SURGICAL APPROACHES TO THE TMJ

- I. Preauricular and Endaural
- II. Postauricular
- III. Intraoral Condylotomy Approach
- IV. Submandibular Retromandibular

RISKS AND BENEFITS OF SURGICAL PROCEDURES TO TREAT INTERNAL DERANGEMENTS OF THE TMJ

- I. (A) Meniscectomy (Discectomy)
- (B) Meniscectomy With Interpositional Implants
- II. Disc Repositioning
- III. Condylotomy
- IV. Arthroscopic Surgery and Arthrocentesis

A RISKS AND BENEFITS OF SURGICAL APPROACHES TO THE TMJ

I THE PREAURICULAR AND ENDAURAL APPROACH BENEFITS

These surgical approaches achieve an optimal lateral and anterior exposure of the TMJ. Modified by an anterior extension, they also permit better exposure of the articular eminence and zygomatic arch allowing for unrestricted access to the temporalis fascia and muscle for grafting. Moreover, the endaural approach is cosmetic, and shelters the scar within the confines of the tragus and helix of the ear.

RISKS

1. Facial Nerve Damage

Dolwick and Kretzschmar²⁷ found no significant difference in the incidence of nerve weakness when comparing the pre-auricular to the perimeatal approaches. The reported incidences of transient facial nerve paresis after arthrotomy range from 1 to 25%⁶³. Facial nerve paresis after TMJ surgery usually involves the temporal branch of the facial nerve, resulting in eyebrow lag and decreased function in the orbicularis oculi muscle. Dingman et al.²² reported an incidence of 55% of temporal branch paresis following surgery using the preauricular approach. Weinberg and Kryshtalskyj¹²⁷ reported that in 68 patients (83 temporomandibular joints) who had a variety of

temporomandibular joint operations using a preauricular approach, 10.84% showed signs of a transient facial nerve injury in which the temporal and zygomatic branches were involved. The incidence of facial nerve injury was greater in patients who had undergone previous TMJ surgery (17.64%) than in patients with previously unoperated joints (9%). Scarring of tissues as a result of previous TMJ surgery may significantly increase the risk of facial nerve injury during subsequent TMJ surgery.¹²⁷ Normal facial nerve function returned in 7 to 14 weeks, except in one patient who showed a persistent mild deficit of the zygomatic branch at 20 weeks. The nature and duration of the surgical procedure did not correlate with facial nerve injury.

2. Postoperative Paraesthesia involving the Auriculotemporal Nerve

This is usually a result of damage to the auriculotemporal nerve, and is very common after temporomandibular joint surgery. It is usually of little consequence; however, because it is temporary and resolves within 6 months. Dolwick and Kretzschmar²⁷, in their study of preauricular and perimeatal approaches to the TMJ, reported that 100% of patients had postoperative paraesthesia involving the auriculotemporal nerve.

3. Auriculotemporal Nerve Injury (Frey's Syndrome)

Frey's syndrome consists mainly of gustatory sweating, flushing, and warmth in the temporal and pre-auricular areas. The degree to which the syndrome is exhibited is variable. In their study of 20 patients tested for the auriculotemporal syndrome, Kryshatskyj and Weinberg⁶⁶ reported that 3 patients (15%) had a subclinical manifestation that consisted only of sweating over the distribution of the auriculotemporal and great auricular nerves in response to a gustatory stimulus. The response was variable from patient to patient.

4. Eighth Nerve Damage

This damage is rare.⁷¹

5. Damage to the Middle Ear

Loughner reported two cases, one after open surgery and the other after arthroscopic surgery, in which the patient had partial and total deafness respectively. The

mechanism proposed was tension placed on the malleus via the anterior malleolar ligament, which attaches to the sphenomandibular ligament. Damage may have occurred during the mobilization and distraction of the mandible, which produces tension in the sphenomandibular ligament that could potentially result in an auricular disruption.⁷¹

6. Hemorrhage

If bleeding occurs during surgery, it may result in a postsurgical hematoma, and increase the risk of infection and intracapsular adhesions. In order to minimize the occurrence of this complication it is important to meticulously close the wound and place a pressure dressing for 24 hours following the surgery. Husted⁵⁹, in a series of 150 arthrotomies, found it necessary to ligate the external carotid artery in two patients. The source of bleeding was probably from the maxillary artery.

7. Infection

This is usually the result of inadequate aseptic technique, or secondary to an infected hematoma. Dingman et al.²⁴ described four wound infections in 25 temporomandibular joints surgeries (16%). Eppley and Delfino³³ compared temporomandibular joint surgery with and without the use of prophylactic antibiotics, and found no significant difference in the incidence of infection. *Staphylococcus aureus*, *S. epidermidis*, and *Bacteroides fragilis* have been isolated from the wound infections.³³ Stitch abscesses were also common. Immediate preoperative prophylaxis with a penicillinase resistant antibiotic, such as a cephalosporin, may be indicated while performing open joint surgery. If TMJ implants are placed, antibiotic prophylaxis should be continued for a longer period of time.¹¹⁸

8. Sialocele and Parotid Fistula

Although a theoretical possibility, there are no case reports describing these complications arising from damage to the superficial lobe of the parotid gland as a result of TMJ surgery.

II POSTAURICULAR APPROACH

BENEFITS

Maximum esthetics and minimum risks of damage to the facial nerve are the major assets of this approach. It also permits the harvest of conchal cartilage for grafting.

RISKS

The potential risks are: postoperative infection, hematoma formation, cartilage necrosis, and stenosis of the external auditory meatus. Hall and Link¹³⁵ described 16 patients (25 joints) who were operated using this approach and noted that 5 patients had a wound infection in 5 joints (20 %) that manifested as a mild, but painful, cellulitis.

III INTRAORAL CONDYLOTOMY APPROACH

BENEFITS

Benefits include the absence of a visible scar, and adequate access to the lateral surface of the ramus, coronoid process, and condylar neck.

RISKS

Potential risks include damage to the long buccal, inferior alveolar, and lingual arteries, veins, and nerves and to the maxillary artery. Damage to the maxillary artery, in particular can result in significant intra or postoperative hemorrhage. There are no statistics to show the incidence of postoperative wound infection.

IV SUBMANDIBULAR (RISDON) APPROACH

BENEFITS

Adequate access to the lateral surface of ramus, condylar neck, and coronoid process.

RISKS

Dingman and Grabb²³ suggest that the submandibular incision should be made at least 2cm beneath the inferior border to avoid damaging the marginal mandibular branch of

facial nerve. The advantages of the retromandibular approach are improved access to the regions of the angle, ascending ramus, posterior mandible, and sigmoid notch.

B RISKS AND BENEFITS OF SURGICAL PROCEDURES TO TREAT INTERNAL DERANGEMENTS OF THE TEMPOROMANDIBULAR JOINT

I.(A) MENISCECTOMY (DISCECTOMY)

This procedure traditionally involves excision of the fibrous disc only. It is one of the oldest TMJ operations, having experienced periodic waves of popularity since its initial description by Lanz⁶⁸ in 1909. Meniscectomy was the dominant TMJ surgical procedure in the first three decades of the twentieth century,^{95,121} and then appeared to fade from the literature. It reappeared sporadically shortly after World War II, and with increasing frequency thereafter throughout the 1950's and 1960's.^{11,99,40,96,64}

In North America high condylectomy, and in the United Kingdom condylotomy, then began to steadily overtake and displace meniscectomy as the most favoured operations for the treatment of TMJ pain dysfunction.^{50,124} In fact, meniscectomy became the target of considerable criticism and, in spite of numerous reports of generally beneficial results and substantial data to warrant its use, was soundly denounced as a poor operation by a number of well-respected surgeons.^{111,94,51}

The prevailing perception that meniscectomy is a bad operation is currently being re-evaluated in light of the more recent publication of a number of studies that show favourable long-term results following disc removal.^{100,35,113,106}

1. Rationale for Meniscectomy

In some patients a displaced, damaged, or deformed disc may act as a joint irritant, producing symptoms of pain, dysfunction, and joint instability that can lead to secondary inflammatory changes within the joint. Removal of the disc and associated adhesions in these situations is felt to achieve joint debridement, indirectly reduce joint inflammation, and may protect the joint against degenerative joint disease.⁴⁴

2. Risks of Meniscectomy

Toller¹¹¹ in 1974 reported that the presence of an intact disc was essential for the

maintenance of normal joint function between an altered condylar surface and the upper part of the joint in the reparative phase of osteoarthritis. He felt that should the disc become damaged after the condyle had lost its fibrous articular surface that deformity and limitation of movement would probably result. Indeed, Toller¹¹¹ makes the statement that “there seems to be no justification at any time for the operation of meniscectomy”.

Experimental results in animal studies emphasized the importance of the disc in the repair of the surgically treated condylar head and in helping to determine the ultimate shape of the articulating surface of the condyle.⁹⁴ Poswillo⁹⁴ clearly stated his displeasure with meniscectomy: “the role of meniscectomy in the treatment of painful clicking temporomandibular joints should be relegated to that of an operative procedure of historical significance only.” He felt that pain and limitation of mandibular motion were late complications of this operation, and that this procedure was implicated as a potential cause of pain and dysfunction in the contralateral joint. No scientific studies were cited, however, to support this view.

Due to the presence of sensory nerve endings in the retrodiscal tissues, Henny⁵¹ and Poswillo⁹⁴ suggested that the immediate relief of pain experienced by patients after meniscectomy was readily explained by the cutting of these sensory nerves, rather than by removal of the disc. Henny⁵¹ felt that the late recurrence of pain following meniscectomy coincided with the regeneration of these sensory nerve fibers.

Based upon clinical and histologic observation, Yaillen et al¹³⁷ reported fibrous ankylosis in 3 of 4 monkeys (75%) who were evaluated at 4 and 12 months after meniscectomy. These joints, although appearing radiographically normal, showed histologic evidence of location dependent degenerative changes. Unlike Poswillo,⁹⁴ however, Yaillen et al¹³⁷ found that contralateral joints were not affected morphologically.

The presence of degenerative TMJ changes following diskectomy has also been confirmed by a number of clinical and experimental animal studies^{54,25,69,102,101,79}.

Indeed, Hinton⁵⁴ has shown in rats that some of the structural and metabolic changes that occur in the condylar cartilage after surgical removal of the articular disk include cartilage thickening, chondrocyte clones, clefts or tears in the matrix, increased hydration and a decrease in glycosaminoglycan (GAG) content and ¹⁰⁶S-sulfate uptake.

Stevenson et al¹⁰⁴, in an experimental study of 6 baboons, noted the valuable role of the meniscus in preventing TMJ ankylosis in the presence of intracapsular fractures. Two baboons had surgically induced intracapsular fractures with a meniscectomy and 6 weeks of intermaxillary fixation (IMF); two baboons had similar surgery plus IMF for 32 weeks, and two baboons had surgically induced fractures without meniscectomies and IMF for 32 weeks. Animals who underwent meniscectomy developed histologic evidence of fibrous ankylosis while those in whom the meniscus was retained did not. It was concluded therefore that the absence of the meniscus may be of critical significance in the development of ankylosis.¹⁰⁴

Although only one study is cited to support their view, Witsenburg and Freihofer¹³⁶ reported that a pathologic disc should not be left in place, but that meniscectomy without replacement leads to arthrosis. While some animal studies^{25,69,102,101,79} have shown that discectomy leads to degenerative joint disease (osteoarthrosis), Hall and others^{44,54,115} feel that these degenerative changes may be the result of failure to reduce joint loading, and to the lack of dietary modification during the adaptive phase of healing. Although, radiographic changes similar to those seen in DJD tend to occur in the condyle after discectomy, this flattening of the condyle may not be pathologic but may merely represent an adaptive change to establish a broader contact of articulating surfaces in order to decrease the joint load per unit area. Moreover, the pre-existence of osteoarthrosis when the disc was removed may also account for the presence of DJD after discectomy.⁴⁴

3. Benefits of Meniscectomy

The revival in the popularity of meniscectomy is primarily due to improvements in diagnostic techniques, and a clearer understanding of the pathophysiology of TMJ

disorders. Highlighting the successful outcomes of meniscectomy are reports indicating that 80 to 90 percent of patients experience relief from pain and dysfunction after this operation.^{44,32}

In a 1951 study at the University of Michigan, Dingman and Moorman²⁴ reported that 11 of 12 patients (91.6%) had excellent relief of symptoms following meniscectomy. The surgery was carried out using local anaesthesia and an endaural approach. Follow-up periods ranged from one month to three years. The patients were not randomized or consecutive, and an interesting finding was the preponderance of male patients (10) over females (2). This study was neither prospective nor controlled, and the follow-up periods were short. The preponderance of male patients is also unusual considering the natural history of TMJ dysfunction in which the incidence is generally higher in females.

In 1980 Brown¹³, in a retrospective, nonrandomized, or controlled study, reported his experiences with meniscectomy; 214 patients, of whom 180 were females, were followed-up with telephone interviews or office examinations. The lengths of follow-up periods were not specified, and pain score measurements were not available. Pre-operatively all patients had some form of “conservative therapy”, that could include sedation, muscle relaxants, diet restriction, splints, occlusal adjustments, hypnosis, and/or neurologic investigation for atypical facial pain. At surgery the most common vector of disc displacement was apparently posterior, occurring in 44% of patients, 11% had medial displacement, 16% had no discernible displacement, 14.5% had anterior displacement, 14.5% had lateral displacement, while 16% had no discernible displacement. Following meniscectomy 128 of these 214 patients (60%) had no joint pain or dysfunction, 73 patients (34%) had intermittent symptoms of mild pain and joint noises, and 13 patients (6%) had severe pain. Eleven of the patients who had persistent and severe pain subsequently underwent condylectomy for further management. Complications were not discussed. Brown¹³ concluded that meniscectomy was the surgery of choice for patients with persistent intermittent symptoms of internal derangement of the TMJ, and should be carried out before the

onset of degenerative arthritic changes.

Carlsson et al¹⁶ in 1981, in a review article, reported that of approximately 7000 patients seen in their TMJ clinic only 0.1 - 0.2% undergo surgery. The most common surgery was meniscectomy, and the results were good in the majority of cases. Specific objective criteria to support these results was not disclosed, however, meniscectomy was felt to be warranted if the disc was severely damaged. Six patients had meniscectomy between 1969 - 1978, and all were free of symptoms at 1-8 year follow-up examinations. All patients were women who had failed pre-operative conservative therapy, although the type and duration was not specified. Carlsson et al.¹⁶ commented that, due to the favourable results of surgery, some of the radiographic findings in postoperative patients should be interpreted as functional remodelling, rather than osteoarthritic changes.

In 1985, Westesson and Ericksson³⁵ reported a long-term retrospective follow-up study of meniscectomy, in 15 patients who had this procedure performed by Dr. Karl Boman between 1947 and 1960.¹¹ All patients considered the operation successful and would undergo the surgery again under similar circumstances. No post-operative complications were reported. One patient had occasional pain in the operated joint, while four patients had mild discomfort in the contralateral joint only and took analgesics occasionally. Crepitation was found to be greater in the temporomandibular joints that had been operated upon. Range of motion was within normal limits. All the temporomandibular joints showed radiologic changes, including flattening of the condyle and tubercles, osteophytes, and sclerosis, but these changes occurred most often on the operated side. After 35 years, however, post-meniscectomy patients were not found to get headaches as suggested by Myrhaug,⁸⁴ or develop pain and limitation of mandibular motion as proposed by Poswillo.⁹⁴ Westesson and Ericksson³⁵ concluded that meniscectomy relieved joint pain and eliminated functional disturbances in the long-term, despite the persistence of radiologic signs that could be interpreted as osteoarthrosis or functional remodelling changes. A proper controlled, prospective study, however, was felt to be necessary since it is known that many patients with

TMJ problems get better on their own, with or without conservative intervention.³⁵

In 1984, Silver¹⁰⁰ was the first to report the long-term results of 212 meniscectomies done between 1947 and 1979. This included a group of 69 patients reported upon in 1963, and 143 since then, including 113 women and 30 men, ranging in age from 12 to 66 years, with 91% being under 35 years of age. Conservative therapy was always attempted initially, which could include hydrocortisone injections, soft diet, bite adjustment, and/or splints. All patients had a minimum of a one year follow-up, 125 patients had at least a 2 year follow-up; 33 of these 125 patients were followed for at least 5 years, 22 patients for at least 10 years, and 10 patients were followed for at least 20 years. The interincisal opening in all patients was 30 mm or more. All patients were able to eat a normal diet, except for 8 patients with arthrotic changes; 10 patients had a clicking sensation in the ipsilateral joint. Silver's experience with bilateral meniscectomies in 10 patients showed poor results, due to the persistence of pain, and the presence of arthrotic x-ray changes. He therefore discouraged carrying out bilateral meniscectomies simultaneously. Silver's results showed that 8/212 patients (3.7%) developed arthritic changes within 2 years of the operation. These eight patients subsequently underwent a high condylectomy, with pain relief occurring in 6 patients (75%). A variety of complications were reported, including 2/212 patients (0.9%) who developed infections postoperatively which were successfully treated with antibiotics; 10/124 patients (8%) developed muscle paresis secondary to facial nerve injury, with 9 resolving within 6 to 8 weeks and one being permanent. Silver¹⁰⁰ believed that the most vulnerable region in the TMJ, and the area most subject to irritation, was the posterior attachment tissue. Unlike Brown,¹³ he found that most of the discs at surgery were displaced anteriorly.

In another long-term study of meniscectomy, Tolvanen et al.¹¹³ in 1988 reported the results of meniscectomies on eight patients who were operated between 1946 and 1957. Seven of the patients were women. Only 3 patients had conservative treatment prior to surgery. A limited range of mandibular motion had been noted pre-operatively in all cases, and other preoperative signs and symptoms included pain, locking, recurrent

dislocation, and crepitation. The mean preoperative duration of symptoms was 22 months. Five of the eight patients were examined 30 to 40 years postoperatively, with a mean follow-up of 33 years. All patients were satisfied with the surgery, and given the same circumstances would have the surgery again. All patients were free of pain on the operated side, while one patient had pain in the contralateral joint. Two patients had crepitus. There was no locking in the joints that had been operated upon, but two patients had locking on the unoperated side. The range of mandibular motion was normal. The jaw deviated to the operated side in all cases, however. The most common radiologic findings were condylar sclerosis, and flattening without evidence of erosion. Tolvanen et al.¹¹³ therefore concluded that their patients had good results and that meniscectomy should not be discarded as a treatment option.

In the most recent long term study of meniscectomy, Takaku and Toyoda¹⁰⁶ in 1994 reported on 39 patients, 36 of whom were female, who had undergone this procedure 18 to 27 years previously. Only 2 patients (5.1%) complained of occasional mild pain. All 39 patients were chewing a regular diet. The mean vertical opening was 43 mm, and only one patient (2.5%) opened less than 35 mm. The mean contralateral excursion was 7.6 mm. All patients showed osteosclerotic radiographic changes in the condyle and fossa, a condition also found in 41% of the contralateral unoperated joints. There were no reported surgical complications. Jaw exercises were initiated 3 days after surgery, and maintained for a period of 3 months. The authors concluded that if the disc had any form of pathologic alteration, it should be removed, and not repositioned or repaired.

In a well-designed prospective study, Holmlund et al.⁵⁸ evaluated 72 meniscectomy patients preoperatively and one year postoperatively; 40 patients were also examined 3 years post-operatively and 15 patients at 5 years after surgery. Standardized criteria were used for diagnosis and for defining successful outcomes. Criteria used for diagnosis included pain from the joint that was alleviated by diagnostic local anaesthesia of the joint, together with arthrographic or arthroscopic evidence of TMJ internal derangement. The arthrographic criterion for internal derangement was evidence of disc

deformation on the arthrotomograms. The arthroscopic criteria for internal derangement were pronounced folding of the posterior disc attachment with synovitis, and no clear boundary between the posterior band of the disc and the posterior disc attachment. The criteria for success were the following: the absence of pain or pain that is so mild, brief, and infrequent as to be of no concern to the patient; range of motion greater than 35 mm for maximum opening and greater than 5 mm for protrusive mandibular movements, regular diet that at worst avoids tough or hard foods, and absence of significant complications. At the one year follow-up, the success rate was 83% as in 60/72 patients pain was alleviated and chewing capacity was normalized. There was no TMJ clicking post-operatively whereas there had been in 13 patients (18%) pre-operatively. Crepitation occurred more frequently than it did pre-operatively, however. Maximal mouth opening increased. At 3 years there was even less joint pain, chewing had further improved, and there was less clicking. Two of forty patients (5%) were classified as unsuccessful. Fifteen patients were evaluated 5 years post-operatively. All patients had successful outcomes. They had less pain, less muscle soreness, and greater mouth opening, despite increased crepitus in the TMJ. Deviation of the mandible to the operated side did occur upon mouth opening, but in fewer patients as compared to the 3 year follow-up. Initially 12 of 72 patients (16.6%) had been classed as unsuccessful in the first year, primarily on the basis of residual muscle and joint pain. Seven of these patients underwent a second surgical procedure, two underwent a third, and of these two only one improved. Holmlund et al.⁵⁸ suggest not prolonging conservative therapy preoperatively if unsuccessful because increased muscle soreness preoperatively may lead to an unsuccessful surgical outcome. Overall, this study offers strong support for meniscectomy in the management of the painful TMJ with internal derangement.

4. Summary

Currently there are no prospective, controlled, long-term follow-up studies on humans to endorse the conviction that meniscectomy is an inferior operation. It appears that

those who denounced this procedure in the past have done so primarily on the basis of data derived from animal studies, and from retrospective non-randomized uncontrolled clinical studies in humans.^{111,94,51,137,104,136,54,115} Clearly the risks of meniscectomy, which include but are not limited to increased pain, decreased range of mandibular mobility, decreased chewing ability, osteoarthritis, and fibrous and/or bony ankylosis, have not been scientifically proven at the present time.

On the other hand, four long-term reports of outcomes after discectomy (meniscectomy) in general show consistently good results.^{100,35,113,106} These findings are reinforced by a number of shorter term outcome studies that show meniscectomy to be a highly effective operation accompanied by few complications.^{34,57,36} Unfortunately, most of the studies that endorse the benefits of meniscectomy are retrospective, uncontrolled, and non-randomized. The few prospective studies that exist usually involve small numbers of patients and short follow-up periods.^{34,57,36}

On the basis of the data currently available, it would appear that the pendulum is slowly swinging back in favour of meniscectomy as an effective operation for the treatment of the painful TMJ with late stage internal derangement. In the final analysis, however, only data derived from large, prospective, controlled, randomized long-term outcome studies will determine the ultimate status of meniscectomy.

I.(B) MENISCECTOMY WITH INTERPOSITIONAL IMPLANTS

Those who advocate the use of interpositional implants in the joint after discectomy cite the following reasons:^{78,39}

- it acts as a shock absorber and protects the articular surfaces from excessive load bearing
- it decreases the incidence and/or severity of osteoarthritis
- it reduces the formation of fibrous or bony ankylosis
- it reduces the chances for the development of an open bite

- it increases joint mobility
- it provides a gliding surface
- it prevents bone on bone contact
- it reduces crepitus
- it improves the incidence of pain relief

Because of the high incidence of destructive foreign body reactions associated with their use in the temporomandibular joint, alloplastic interpositional implants such as Proplast-Teflon and Silastic were removed from the market in 1988 and 1993 respectively.⁹⁷ Some surgeons, however, continue to use a variety of autogenous materials such as auricular cartilage,^{136,115} dermis⁷⁸ and temporalis muscle and fascia^{39,53} to replace the disc after its removal.

At the present time, because there are no studies to prove that discectomy with interpositional graft replacement gives superior results to discectomy alone, some surgeons recommend that the excised disc not be replaced with anything.^{44,37}

Until those who use interpositional grafts can show definite advantages for this method, the good long-term results reported with discectomy alone^{100,35,113,106} offer strong support for the continued use of this procedure when circumstances dictate.

II. DISC REPOSITIONING SURGERY

HISTORICAL PERSPECTIVES

Hippocrates 348 B.C. was the first to recognize internal derangement of the temporomandibular joint.¹¹⁸ In 1814, Hey defined internal derangement (ID) as a “mechanical fault interference that existed against providing a smooth articular function.” Cooper³⁸ in 1842 discussed ID describing it as a “snapping jaw” or subluxation of the TMJ. In 1887, Annandale² performed and reported the first reconstructive arthroplasty using a disc repositioning procedure through the preauricular approach. In 1918, Behan⁸ described a repositioning technique felt to be

more in harmony with the mandibular condyle.

In 1974, Toller¹¹² described a capsular rearrangement operation in which there would be an increase in freedom of movement of the meniscus due to the release of its lateral attachment to the temporomandibular ligament, and sectioning the sensory nerve supply to the joint. The procedure consisted of two horizontal incisions in both the inferior and superior joint spaces to completely free the lateral edge of the meniscus. A posterior based temporalis flap was developed and attached to the lower edge of the TM ligament only, with care not to include the freed meniscus. The operation, however, proved to be unsuccessful.

McCarty and Farrar⁷⁵ developed an operation that involved partial excision of the posterior attachment, meniscal plication, and high condylectomy for the correction of ID without significantly modifying the patients' existing occlusion. The technique consisted of excision of 3 to 4 mm of bone from the posterosuperior surface of the condyle, as well as 2 mm of posterior attachment tissue in the form of a wedge. The meniscus was then sutured to the remainder of the posterior attachment. The surgery was done only after clinical and arthrographic confirmation of disc displacement.

Dolwick and Sanders³⁰ described a similar technique, in which 3 to 5 mm of posterior attachment tissue was excised as a wedge. An eminectomy was carried out together with meniscal re-contouring if there was evidence of hypertrophic anterior or posterior bands, followed by plication of the disc to the posterior attachment and lateral capsular tissues. When there is a strong medial component in the anteromedial displacement of the disk, Sanders recommended an ellipsoid excision of the meniscus and posterior attachment tissue with plication.

Other modifications to these approaches have been documented and include: plication of the superior lamina of the posterior attachment tissue without violation of inferior joint space⁴⁷; eminectomy and plication of the fibrous disk to the articular capsule without excision of soft tissue (meniscorhaphy)¹²⁸, a suturing of the lateral border of meniscus to the periosteum/temporal fascia condensation above the glenoid fossa⁷⁰,

meniscocondylar plication in which the meniscus is sutured to the condylar head after eminoplasty and lateral condyloplasty¹²⁵, sliding capsular discopexy in which the disc is repositioned in an infero-lateral direction⁸⁵ and, finally, a high condylar shave in which 2 to 4 mm of the superior portion of the condyle is removed freeing the displaced disc, and the disc is then sutured to the condylar stump and the lateral capsule¹²². Piper⁹² has advocated the concept of disc preservation surgery in which intracapsular disk surgery is performed using a microscope.

BENEFITS

Most studies of disc repositioning surgery are qualitative, retrospective, non-randomized, and with small sample sizes. Although success rates of 70 to 90% are claimed, long-term studies are scarce and studies usually deal only with a limited follow-up postsurgery^{23,68,95,121,11,99,40,96,64}. Furthermore, postoperative rehabilitation regimens vary widely.

In 1985, Dolwick and Sanders³⁰ published their results on 78 cases of disk repositioning and condylar reduction procedures, with an average of a 3 year follow-up (18-60 months). They found excellent to good results were reported in 90% of patients, 4% of patients improved but had continuous symptoms, while 6% of patients had no improvement.⁶⁸ The disc repositioning groups (plication) without condylar reduction in 39 joints showed the following results: excellent 52%, good 33%, and failed or poor 15%.

Dolwick and Nitzan²⁸ studied 180 patients (225 TMJ's), aged 10 to 70 years, who underwent disc plication. The average length of follow-up was 26 months, with a range of 6 to 48 months. Disc repositioning procedures were performed using either a partial thickness or a full thickness plication. Osseous recontouring was carried out on the lateral third of the eminence. Some of the results of disk repositioning surgery were favorable, while others were disappointing; 90% of the patients reported a 70 to 80% improvement after disk repositioning surgery, which was maintained for 5 years. Excellent results were reported by 51.5% of patients and good results by 28%.

Disappointing results were reported in 4.5% of the patients, and 5.3% reported no change.

Anderson et al¹. studied 33 patients (39 joints) who underwent disc plication surgery. The mean postoperative follow-up was 18.5 months, with a range of 8 to 35 months. If the discs or retrodiscal tissues were found to be perforated or extremely compressed, the patients underwent meniscectomy and were excluded from the study. The investigators noted a decrease in head and shoulder pain, retro-orbital pain, temporal, occipital, frontal and submandibular pain. TMJ sounds were decreased or eliminated in 68% of the patients. Mandibular opening in general remained the same, although in some patients it decreased. In total, however, 22/33 (68%) of patients had a reduction in TMJ symptoms, and overall there was an 87% reduction in otological symptoms.

Wilkes¹³⁴ in 1991 published a classic paper, the only long term study of its kind, in which he evaluated 176 patients (210 joints) with internal derangement of the disk that were clinically and arthrographically confirmed. The follow-up ranged from 5 to 14 years (average 8.1 years). In this sample 40 patients (49 joints) served as a control group in that they refused surgical care and elected other conservative treatments. In 136 patients 162 joints were diagnostically staged using the Wilkes classification. Out of the 162 joints, 30.3% had reconstructive arthroplasty, primarily patients with early to intermediate disease stages. The surgery consisted of resection of stretched and redundant posterior attachment tissue followed by plication. The best surgical results occurred in early stage cases. Wilkes Stage 2 and 3 success rate was 96.9%, whereas Stage 4 and 5 success rate was 89.4%. Benefits attributed to the surgery were felt to be due to decreased mechanical signs and symptoms, and stability as far as continued progression of the disease process was concerned. A decrease was also reported in: headache, muscle contraction, temporalis tenderness, and muscle splinting secondary to joint inflammation. Some patients, even with fairly advanced disease, could adapt and live with their condition, but many suffered from a decrease in a quality of life with respect to function. As these patients age and enter their 6th, 7th, and 8th. decades of life, they tend to present in late stage status with significant overt TMJ symptoms and

disability. Wilkes¹³⁴ concluded that patients with early stage disease fare better than those with late stage disease as far as surgical correction is concerned.

In summary, the benefits achieved from disc repositioning surgery were reported as:

- 1/ A significant reduction in preauricular pain, otalgia, and masticatory headaches.
- 2/ An increase in the range of jaw motion and function that restores a patients' ability to eat a normal diet with few restrictions.
- 3/ Elimination and reduction of joint noises.

RISKS

1. Fibrous Adhesions and Ankylosis

According to Dolwick and Nitzan²⁸, the most common complications after TMJ disc-repositioning surgery have been continued pain and the development of fibrous adhesions. Although these occur together, there are no figures reported as to the incidence of these risks. Politis et al⁹³ describe one patient out of 8 (12.5%) who had a high condylectomy with disc plication who developed diminished TMJ function because of fibrous ankylosis. There was no mention of a postoperative physiotherapy regimen. Wilkes¹³⁴, however, did not indicate any incidence of fibrous adhesions/ankylosis in his series of 176 patients (211 joints) over an average of 8.1 year follow up.

In general, the more aggressive the procedure, and the greater the extent of the dissection and tissue manipulation, the greater the risk of hemarthrosis with the subsequent formation of fibrous adhesions.

2. Degenerative Joint Disease (Osteoarthrosis)

Politis et al.⁹³ have demonstrated that out of 22 patients in whom only a disc repositioning procedure was performed, 4 patients (18.1%) exhibited radiographic changes suggestive of osteoarthrosis postoperatively. Trumpy and Lyberg¹¹⁴ in their retrospective, non-randomized, uncontrolled and limited sample size study revealed

that 62% of the patients who had a discoplasty and eminectomy developed DJD after surgery.

Wilkes¹³⁴ documented and compared his series of 176 discoplasty patients with a control group of 40 patients with symptomatic TMJ disease who refused treatment, and were treated by conservative means. He found, over an average follow-up time of 8.1 years that the control group showed significant clinical and radiographic progression of DJD in 73.5% of the 40 control patients followed. Although in all cases of Wilke's stages of ID that were surgically treated, there was no evidence of worsening of DJD, reconstructive discoplasty was best in early stage cases (Wilke's Stages 2 and 3). Overall, progressive degenerative joint changes encountered prior to surgery were stabilized with surgical management, while the disease in untreated control patients tended to progress over time.

3. Relapse and Surgical Failure

In 1984, the AAOMS clinical congress and symposium on TMJ surgery reported that the surgical failure rate with disc repositioning surgery was between 10 and 20%.³ Politis et al⁹³ have stated that their rate of reoperation for the high condylectomy and plication group was 2/8 patients (25%), while the disc repositioning only group was also 6/24 patients (25%). Trumpy and Lyberg¹¹⁴ indicated that 3/13 patients (23%) who had eminectomy and posterior disc plication showed poor results and these patients were dissatisfied with treatment. Moreover 4/13 patients (30.7%) on postoperative MRI scans revealed anterior disc displacement, while 5/13 MRI's were inconclusive. Bronstein¹² has shown in postsurgical arthrograms after disc repositioning surgery that the disc was often still out of position, despite the fact that patients believed their condition was improved. Reoperation using the same surgical technique does not often yield good results, and the potential for success from any further surgery rapidly decreases as the number of operations increases.⁵² Overall, studies which have looked at figures on re-operation rates, the types, and the success from reoperation are lacking in the literature. The critical role of disc position in the genesis of TMJ pain-dysfunction has also been questioned with the introduction of

arthrocentesis and arthroscopy.^{31,26}

Dolwick and Nitzan²⁸, in their long-term follow-up of 153 patients (225 joints) that were operated by partial thickness plication or full thickness plication with eminoplasty, reported an 85% improvement in 90% of patients; 5.3% of patients, however, reported a worsening as a result of the surgery. The majority of those patients who reported an improvement still continued to experience symptoms of pain, joint noise, and decreased range of motion, although to a lesser extent than before surgery.

4. Chronic Pain

Sadly, there are no studies specifying the percentage of patients who may develop chronic pain as a result of one or more failed discoplasty procedures. Politis⁹³ has indicated several cases that were reoperated because the surgical result was poor. Dolwick³² commented that, in these patients who had undergone multiple TMJ surgeries, the problems facing the surgeon may not be due solely to the structural abnormalities of the multiply operated joint. These patients may also include long-term muscle dysfunction resulting from chronic pain, and limited jaw motion and abnormal illness behaviour created by chronic pain and multiple treatment failures. The literature is devoid of long-term solutions for the treatment of these patients, a deficiency that reinforces the need for careful planning and case selection before embarking on any surgical procedure.

5. Malocclusion

A malocclusion is usually rare after a discoplasty procedure, but there may be a slight temporary posterior open bite that usually resolves in several weeks. Aggressive discoplasty with eminectomy and/or high condylectomy or shave has the potential to lead to heavy posterior contacts with an anterior open bite. There are no studies to show the number and types of patients who are at risk for this occurrence.

In summary, the risks of disc repositioning surgery are:

1. Fibrous Adhesions and Ankylosis
2. Degenerative Joint Disease (Osteoarthritis)
3. Relapse and Surgical Failure
4. Chronic Pain
5. Malocclusion

III. CONDYLOTOMY

HISTORICAL PERSPECTIVE

Condylotomy, as initially communicated by Ward et al.¹²³ in 1957, and further described in 1961,¹²⁴ is defined as an oblique osteotomy of the condylar process starting near the level of the sigmoid notch and ending high on the ramus, well above the angle of the mandible. The rationale for this approach was first presented by Campbell,¹⁴ a radiologist, who noted that some patients who had suffered condylar fractures and who had previously experienced TMJ clicking and locking, had lessening or disappearance of the TMJ symptoms following treatment and rehabilitation of the fractured condyle. Disc displacement in symptomatic patients could be verified arthro-graphically and Campbell postulated that fracture or osteotomy of the condyle might improve the disc-condyle relationship. Campbell's review of the condylotomy procedure on 80 patients showed 84% were clinically improved by surgery and 31.2% were completely cured.¹⁴ Results were based on a simple questionnaire with the patients categorizing themselves as cured, improved, no better or worse. Banks and MacKenzie^{6,5} reported longer-term follow-up results, which included patients from Campbell's study, as being 92% successful using similar, subjective criteria. Tasanen and Von Konow¹¹⁰ and Tasanen and Jokinen¹⁰⁸ showed similar success rates, while slightly lower successes were reported by James.⁶² Recurrent luxation has also been treated with closed condylotomy, with impressive results even on the contralateral side.¹⁰⁹

The original technique as described by Ward et al.¹²³, called for a percutaneous approach utilizing a Gigli saw for osseous sectioning, but this technique is rarely used anymore. A modified technique, using the now more popular intraoral vertical ramus osteotomy, showed a similar high success rate of approximately 93%.^{86,77,9,116,45,129} In spite of

reported excellent results, including improvement of the disc-condyle relationship in anterior disc displacement with reduction,^{9,116,45,129,87} the procedure remains seldom used in North America. The original, closed condylotomy procedure is of historical interest only, and will not be discussed further. The modified condylotomy, however, continues to be used.

BENEFITS AND / OR ADVANTAGES OF CONDYLOTOMY

Nickerson and Veaco⁸⁶ first reported the modified procedure in a retrospective study of 29 patients, followed for 59-72 months postoperatively. All patients answered a questionnaire, while 21 were also examined by one of the authors. Preoperative and postoperative symptoms were compared, but the means of obtaining the preoperative information, whether from a questionnaire vs. chart audit, was not specified. The accuracy of patients' recollection of symptoms 5 years prior could be questioned, if that was the way the information was collected. The questionnaire used was not reproduced. All five symptoms reviewed (joint pain, headache, acute lock, mechanical dysfunction, recurrent luxation) showed excellent subjective improvement in those patients that responded, but no control group was employed. Of the 29 respondents to the questionnaire, 24% felt they needed further treatment, in contrast to 14% of 21 patients examined whom the surgeon felt might benefit from further treatment. It was not stated how many of the patients who felt they required further care were in the group who presented for re-examination.

Upton and Sullivan¹¹⁶ reported on 44 patients after modified condylotomy, with an average follow up of 33.8 months. Excellent improvement in signs and symptoms, such as clicking, locking, pain, and headache was reported, but the criteria utilized in grading the degree of improvement were not specified. No control group was utilized. The results were not compared to other forms of treatment.

The modified condylotomy appears to be the only surgical technique currently available that can reliably improve the disc-condyle relationship in cases of anterior disc displacement with reduction.^{86, 45,129,87} The long-term stability and value of this are yet to

be determined. Disc plication procedures are generally not successful in improving disc position in the long-term, even though symptoms may be improved. Relief of pain following modified condylotomy is consistently high in all reported studies, and is considered greater than the relief offered by arthrotomy and even arthroscopic surgery.⁴⁵ The lack of adequate controls in virtually all studies, however, prevents truly valid conclusions being drawn.

The modified condylotomy procedure itself is extra-articular. There seems to be less risk of intra-articular osseous degeneration, and the postoperative morbidity is reported as less than that of an arthrotomy.⁴⁵ Long-term mobility postoperatively is reportedly better than that following intra-articular procedure. Nickerson⁸⁷ states that he knows of no failed condylotomy that has resulted in the need for total joint replacement, as has been reported for other arthrotomy-based procedures. It is still possible to employ an arthrotomy-based procedure should the situation demand additional surgery in the future. The modified condylotomy procedure can be done on an outpatient basis and recovery is usually rapid and uneventful.

RISKS AND / OR DISADVANTAGES OF CONDYLOTOMY

The original, closed condylotomy technique was associated with a significant incidence (50%) of postoperative occlusal change requiring equilibration, as intermaxillary fixation was not routinely used. There was also the risk of hemorrhage (8%), facial nerve injury (2.5%), and inferior alveolar paresthesia (12%).¹¹⁷ These risks prompted development of the modified technique.

Reported complications of the modified condylotomy include infection, inferior alveolar and long buccal nerve paresthesias that are usually temporary, and malocclusion.⁴⁵ The reported incidence of each of these is 1-2%.⁴⁵ There is also a risk of hemorrhage, particularly from the masseteric vessels and the maxillary artery, but this has not been reported when this technique has been used for the purposes described here, but has been recognized in association with orthognathic surgery.⁶⁷ The risk of significant malocclusion with retrusion of the mandible and anterior open bite is greatest with

bilateral procedures. Nickerson⁸⁷ advises against simultaneous bilateral surgery. Major malocclusions, although rare, may require orthognathic surgical correction. Short-term intermaxillary fixation is used to minimize occlusal change, but some consider this itself to be a disadvantage of the procedure. Careful control of the proximal segment is also important. The production of a centric relation to centric occlusion (CR-CO) discrepancy, likely due to “condylar sag”, occurs in most patients, but this does not appear to present a significant clinical problem in most cases.⁸⁷ A controlled downward and forward movement of the condyle is desirable to reduce joint loading, but this does alter the CR-CO relationship. Degenerative changes of the condylar head have rarely been observed.⁸⁶ Although the modified condylotomy appears to be a promising treatment in specific situations, continued evaluation and research are warranted as with all current therapeutic procedures. The mechanisms by which this and other procedures actually result in symptom improvement need to be identified in carefully controlled studies with very limited variables, and measured against the results of an appropriate control group.

DISCUSSION

Upton¹¹⁷ and Banks⁷ have recently discussed their opposing views concerning the condylotomy procedure. Upton,¹¹⁷ in addition to reviewing the results of papers previously published,^{86,77,9,116,45,129,87} reviewed his personal experience with the condylotomy technique. A retrospective comparison was performed between a group of patients who had undergone condylotomy versus a matched group of patients who had undergone disc plication. Follow-up periods ranged from 2-11 years for the condylotomy group, and from 4-11 years for the disc-repositioning group. Interincisal opening was seen to be similar postoperatively in the two groups. Malocclusion was a more common complication in the condylotomy group. Two patients later required orthognathic surgery to correct their malocclusions. Although it was stated that the differences in treatment results between the two groups were nonsignificant, there were definitely more cases of postoperative malocclusion in the condylotomy group. A second study was therefore performed involving a questionnaire to evaluate postoperative symptoms

between the two groups in the study above. Preoperative symptoms were of similar incidence in the two groups but symptom severity was not evaluated. Responses were received from approximately 75% of the patients in the first study. Long-term follow-up, averaging 6-7 years, revealed significant differences in postsurgical symptoms. Improvements in joint clicking, catching, and locking were significantly greater in the condylotomy group versus the disc plication group. A somewhat lesser improvement was shown regarding joint, muscle, and temporal pain in the condylotomy group versus the disc plication group. Upton concluded that the modified condylotomy procedure demonstrated efficacy in the surgical management of various painful disorders of the temporomandibular joint, as well as low overall morbidity. The condylotomy procedure appears to improve the anatomic relationship of the disc/condyle complex, thus enhancing function. It increases joint space and reduces joint loading, which are very desirable results, while at the same time avoiding certain complications of intra-articular surgery such as scarring, adhesions, removal of natural interpositional tissue, and reduction in the amount of synovium. There are, none the less, some concerns regarding these studies that promote the modified condylotomy, despite the impressive results and low overall complication rates reported.^{117,46} None of the studies used any kind of acceptable scientific control group⁷. Most studies have compared results to other surgical techniques, such as disc plication, but have not looked at long-term results as compared to patients who have not had surgical or even non-surgical treatment. Banks,⁷ in his paper presenting the case against condylotomy, questions the validity of any surgical approach for the treatment of a condition that may have up to a 90% chance of spontaneous resolution. Banks emphasizes that painful temporomandibular joint dysfunction has a natural history of spontaneous fluctuation and placebo response. This makes true, objective evaluation of responses to surgery very difficult to evaluate. What is critical, whenever elective surgery is to be considered, is that the procedure not leave the patient worse off than before the operation. There is no real evidence, however, that any surgical procedure for temporomandibular joint problems, including the modified condylotomy, can fit this criteria.

The other area of concern is the exact purpose of treatment with a condylotomy. Banks⁷ and Israel⁶¹ both raise the issue that disc displacement is an extremely common condition in the general population and may, in fact, not be a disease at all. If the goal of procedure is to reposition the disc to a normal relationship with the condyle, there should be scientific evidence that this malrelationship is indeed a major cause of patient symptoms.

This has not been proven and, in fact, several studies have shown that disc displacement is common in asymptomatic populations.⁶⁵ Chemical mediators, joint loading, and lack of disc mobility may be more important factors in joint symptoms and pathology. Although it remains yet to be proven, it may be that beneficial changes in joint loading have more to do with the apparent success of the condylotomy procedure than a change in disc position.

CONCLUSIONS

Although adequate controls are lacking, the studies evaluating the results of the modified condylotomy procedure appear favorable. Overall, the ability of this procedure to reduce signs and symptoms in certain TMD patients, with fewer serious complications and less need for reoperation, appears quite good when compared to some other procedures including open intra-articular procedures. The underlying mechanism that results in symptom improvement following condylotomy, however, remains to be proven. The rationale with regard to the indications for this procedure should be revisited.

Banks⁷ has questioned the Wilke's classification¹³³ often used as an indication for a surgical procedure of the temporomandibular joint and which presumes a spectrum of disease for which there is no hard evidence. It does appear that temporomandibular joint disease involves an inflammatory response and that the inflammation itself can lead to adhesions and disc problems. If a disease entity is nonprogressive, or even ill defined, significant surgical intervention cannot be justified.

Surgery should be able to improve upon the natural history of a disease with minimal, or ideally no morbidity. No surgical procedure to date has proven itself in this regard.

IV. ARTHROSCOPY AND ARTHROCENTESIS OF THE TMJ

HISTORICAL BACKGROUND OF ARTHROSCOPY

Although arthroscopy has become a standard method of diagnosis and treatment in the orthopaedic literature, with the initial investigative studies completed by Takagi¹⁰⁵ in 1918, arthroscopy of the human temporomandibular joint was first described by Ohnishi⁹⁰ as recently as 1975. The level of sophistication and success that has been attained with arthroscopic surgery applied to the small joints by orthopaedic surgeons has been directed to the temporomandibular joint. The objectives of temporomandibular joint arthroscopy are to provide an accurate diagnosis of symptomatic temporomandibular joint intracapsular disorders by direct visualization, and to provide minimally invasive surgical treatment of the abnormalities observed at diagnostic arthroscopy. Gynther and Holmlund⁴³, in 1994, observed a high correlation between the arthroscopic diagnosis and histologic interpretation of synovitis.

The diagnostic capability of arthroscopy of the temporomandibular joint, as compared to tomography and arthrography, would indicate that arthroscopy should not replace standard imaging techniques. Arthroscopy provides a three dimensional, but narrow, view which clinically is limited to the upper joint space. Bibb et al¹⁰ confirmed that each imaging technique had diagnostic strengths, but none were comprehensive. The criteria for the selection of TMJ imaging should depend on the working diagnosis based on the clinical findings.

BENEFITS

Arthroscopic surgery, as applied to the TMJ, has been popularized by many surgeons. Published reports indicate a short term success rate of 85% or higher, based largely on subjective criteria and retrospective analysis.^{60,131,81,55}

Tarro¹⁰⁷ looked at 152 arthroscopic surgical procedures over two and one half years, including 77 patients, 66 females and 11 males, ranging in age from 13 years to 76

years. All TMJs were symptomatic, including pain and dysfunction, and had failed to respond to conservative treatment. Disc repositioning and anterior release was carried out arthroscopically. Disc repositioning was performed in the belief that disc position was important, and that disc mobility was a desired surgical result. Arthroscopic surgery should improve disc mobility by removal of adhesions and fibrillated fibrocartilage, and by performing an anterior and lateral capsular release. After disc mobilization, posterior repositioning of the disc and stabilization are performed. The primary reason for disc repositioning is based on the supposition that the avascular fibrocartilaginous tissue in the joint is nourished by synovial fluid. Synovial fluid movement is thought to occur by compression of this fluid against the properly aligned cartilaginous articulating surfaces of the disc condyle complex and temporal bone. If the disc is displaced optimal fluid movement, and therefore optimal nourishment of the cartilage, will not occur and future degenerative changes may result.

In 1992 McCain⁷³ conducted a multicenter review of 4,831 TMJ arthroscopic surgeries. The age range was 10 years to 83 years with a female:male ratio of 9:1. Average age was 32.6 years and average duration of symptoms 22.6 months. The preoperative diagnosis consisted of six clinical categories; internal derangement-closed lock, internal derangement with painful clicking; osteoarthritis; hypermobility; fibrous ankylosis and arthralgia. Surgical treatment for internal derangement-close lock were lysis and lavage, 73%, or anterior release, posterior cauterization with sutures, 2%, or anterior release, posterior cauterization without sutures, 25%. Internal derangement with painful click was 51%, 3% and 46% respectively. Osteoarthritis was treated by lysis and lavage, 44%, or debridement with hand or motorised equipment, 56%. Hypermobility was treated by posterior cauterization or sclerosis of retrodiscal tissue. Fibrous ankylosis was treated by lysis and lavage, 6%, or debridement, 94%. Arthralgia was treated by lysis and lavage, 77%, or synovial cauterization, 23%.

About 1% of all patients had a repeat arthroscopy and about 3% had open arthrotomy. Results showed 70% of patients with range of movement greater than 40mm, 71% showed no pain on palpation. Diet alteration evaluation showed 10% of patients

having significant diet alteration and 50% of patients reporting excellent diet. Subjectively, 58% of patients had a good result and 8.3% reported a poor result.

This study reported on a large number of arthroscopic interventions (4800) with a follow-up of six months (16%) to more than two years (31%). The results conclude TMJ arthroscopy is a highly effective, minimally invasive, safe surgical technique for the diagnosis and treatment of intra-articular pathology.

Moses⁸², in a retrospective study evaluated 419 temporomandibular joints in 237 patients, with a mean follow-up of 10.5 months; 63% of patients were reported to have an increased jaw opening by one month postoperatively, while 73% of patients had an increased opening after one year, with a greater than 40 millimeter average opening. At surgery lysis of adhesions, lavage, and lateral ligament release was carried out. Anterior release or disc suturing was not performed. Moses⁸² did not feel that disc repositioning was achievable. The success of the arthroscopic procedure has been attributed to a removal of inflammatory substances within the joint, an increased disc mobility which prevents adverse load distribution, a reduction of synovial inflammation, and a release of abnormal restraints within the joint which cause capsular strain and muscle fatigue.⁸¹

In 1993, a prospective study by Moore⁸⁰ evaluated restrictive TMJ disease confirmed by MRI and arthrotomography. Sixty-three consecutive patients, ranging in age from 17 to 68 years, were admitted to the study over a three year period; 92% of patients were female and 8% were male. All had complaints of painful, limited opening and their TMD was refractory to conservative treatment. The average duration of non-surgical treatment was 12.2 months, and consisted of behaviour modification, occlusal appliances, and physical therapy in all cases. Visual analogue scales were used in the pre-operative and post-operative periods to assess pain and dysfunction levels. The range of motion improved rapidly after arthroscopy, and peaked at 10 weeks. The average net gain in opening was 12.2 millimeters. Pain decreased rapidly after surgery, and continued to improve after six months. Subjective dysfunction scores also continued to improve after six months. By one year following treatment, 55/63 (87%)

had successful results. The patients who failed to improve demonstrated no significant differences in terms of age, sex, or duration of symptoms, but were more likely to have disc perforation and degenerative joint disease. Only 8% of the discs were perforated in this study, but this accounted for 50% of the patients who failed to respond. Degenerative bony changes were noted in 15% of the group overall, but in 75% of the failures. These figures were not statistically significant, however. Of the 63 patients in this study with restrictive TMJ disease, 55 patients (87%) showed a statistically significant improvement in their range of motion and a reduction in pain and dysfunction after arthroscopy. The results have been stable up to four years of follow-up. The patients in this study who failed to improve following arthroscopy were more likely to have advanced internal derangements and more severe degenerative joint disease.⁸⁰ The literature clearly indicates that an alteration in disc position does not occur following standard methods of arthroscopic lysis, lavage, and lateral ligament release.^{60,131,81,55} A well controlled study has not been done to determine the long-term value of disc repositioning procedures in association with arthroscopy in order to confirm that an improvement in disc position occurs, and whether it is maintained long-term.

In a light microscopic evaluation of synovial membranes in osteoarthritic joints, Dijkgraaf et al.²⁰ reported the benefits of arthroscopy to be related to the lavage of degradation products and related pain and inflammatory mediators in the synovial fluid. The classification of TMJ disorders has been primarily based on the presence of signs and symptoms related to disc displacement. Osteoarthritis, however, plays an important and likely initiating role in TMJ signs and symptoms, and is directly related to the health of the synovial membrane.

ARTHROCENTESIS

In light of the generally successful outcomes with arthroscopic lysis and lavage, arthrocentesis has been evaluated as a potentially effective treatment for restrictive TMJ intracapsular problems. The work of Nitzan et al.^{89,88}, and Murakami et al.⁸³ has evaluated acute closed lock and its management by arthrocentesis. Arthrocentesis is

traditionally defined as a procedure in which fluid in a joint cavity is aspirated and a therapeutic substance is injected into the joint. Arthrocentesis of the temporomandibular joint is a modification of this method in that two needles, instead of one, are introduced into the upper joint space, which allows for passive lavage of fluid. Murakami et al's⁸³ initial description of arthrocentesis for relief of acute closed lock used a single injection of a local anaesthetic followed by manipulation. Nitzan et al.⁸⁸ followed with the double needle modification. The techniques offer similar benefits as compared with arthroscopy of the TMJS for the treatment of closed lock. An 87% to 90% success rate has been reported with long-term follow-up.^{89, 88}

The morbidity of arthroscopy is similar to the morbidity associated with major joint surgery. When comparing arthrocentesis to arthroscopy, Nitzan et al.⁸⁸ found intra-articular scar formation to be more prevalent following arthroscopy. This may explain why there is less long-term maximal increase in mouth opening after arthroscopy as compared to arthrocentesis.

RISKS OF ARTHROSCOPIC SURGERY

Some specific, although exceedingly rare, intra-operative and post-operative complications/risks have been reported with arthroscopy, including perforation of the middle ear, external auditory canal, tympanic membrane and middle cranial fossa; as well as pulmonary edema. Arthroscopy, as well, carries some risk as compared to arthrocentesis for scuffing of articular cartilage surfaces with sharp trocars, perforation into the lower joint space, and damage to the articular cartilage of the condylar head.

1. Vascular Injury and Hemorrhage

The distribution of vascular structures around the TMJ increases the risk of hemorrhage during arthroscopy. Operative arthroscopy usually involves multiple punctures so that vessel penetrations, punctures, or lacerations are possible. The correct rotational movement of the trochar may prevent this problem. The superficial temporal artery is the vessel most at risk, but careful palpation of landmarks and vessels prior to the insertion of the trochar can help prevent arterial bleeding. A

landmark study by Holmlund and Hellsing⁵⁶, in 1985, has made the puncture technique safe and predictable. If arterial bleeding is encountered, it can be controlled by pressure and wound suturing. If this fails to stop the bleeding, open exploration and ligation is warranted. The need for the use of arteriography and embolization technique has not been reported. Venous bleeding may be more predictably controlled by pressure and suturing.

Intracapsular bleeding may occur at the lateral pterygoid muscle during an anterior release, or in the posterior attachment tissue. Electrocautery and/or the injection of a local anaesthetic with epinephrine may be used to control bleeding.

2. Neurologic Injury

McCain⁷⁴ has reported a middle cranial fossa perforation during arthroscopy. A middle cranial fossa perforation is possible due to the thinness of the temporal bone in the articular fossa. A tear in the dura may result in a CSF leak, and a neurosurgical consultation should be sought if this complication occurs. Usually the dura will self-seal and the CSF leak will cease spontaneously. A pressure dressing should be applied and the head should be kept elevated.

Patients who are obese, with landmarks that are difficult or impossible to palpate, or who have a history of previous multiple open procedures and have a diminished superior joint space, may not be the best candidates for arthroscopy.

3. Nerve Injury

Cadaver studies by Westesson et al¹³⁰ showed that the puncture sites during arthroscopy may come within three millimeters of the temporal branch of the facial nerve. Predetermined measurements, as described by McCain⁷⁴, can be used to minimize the risk of these injuries. Studies by McCain⁷⁴ and by Green⁴² show nerve injury rates of approximately 1% which usually result in eyebrow lag and, occasionally, weakness in the orbicularis oculi preventing complete eyelid closure. Eyelid taping and use of artificial tears is useful. An ophthalmological consultation is obviously warranted in these circumstances.

Indresano⁶⁰ reported a transient temporal nerve branch contusion abnormality after extravasation of irrigation fluid. The use of a long-acting anaesthetic, or the extravasation of irrigation fluid, can mimic more significant neurological injuries.

4. Inferior Alveolar and Lingual Nerve Injuries

Nerve injury can result from extravasation of fluid. This injury is generally transient and resolution is usually complete. Extravasation of irrigation fluids through the medial capsule can cause lingual nerve paraesthesia. The use of a distraction clamp at the angle of the mandible can result in an injury to the inferior alveolar or lingual nerves. Either careful placement of the clamp to avoid these nerves, or the use of intraoral distraction can avoid this sequelae.

5. Auriculotemporal Nerve Injury

Weinberg and Kryshchalskyj¹²⁶ evaluated auriculotemporal nerve injuries and found fewer nerve injuries with arthroscopy than arthrotomy. A 15% incidence with arthrotomy was noted.

6. Otologic Complications

The close proximity of the ear to the TMJ increases the risk for potential ear involvement leading to complications during surgical procedures in the TMJ. Sanders⁹⁸ has reported otitis media, Van Sickels et al¹²⁰ reported ear drum perforations, and Applebaum et al⁴ reported two cases of sensory neural hearing loss.

McCain⁷⁴ and Van Sickels et al¹²⁰ suggest that avoidance of these problems is best achieved with strict adherence to the following:

- a) Maintenance of proper horizontal patient head position.
- b) Attention to anatomic landmarks.
- c) Maintenance of anterior inclination of trochar.
- d) Use of blunt trochar to penetrate the lateral capsule and enter the superior joint space.
- e) Attention to an average puncture depth of 25mm from skin to lateral aspect of the

joint; perforation of the medial capsule can occur at 50mm +/- 5mm.

7. Extravasation of Fluid

Irrigation fluid extravasation into the temporal, parotid, and masseteric spaces can lead to premature termination of the operative procedure. Attention to inflow pressures and unrestricted outflow will generally alleviate this problem.⁷⁴ Following fluid extravasation there is generally resolution of swelling within 24 to 48 hours, and no irreversible sequelae have been reported.

Upper airway obstruction has been reported with difficult cases where procedures were lengthy and large amounts of irrigation fluid were used. Extravasation of fluid into the medial tissues can lead to edema in the medial masticatory space and lateral pharyngeal space, producing an acute upper airway obstruction if there is rapid extubation. This situation can be avoided by inspecting the pharynx for symmetry, and by examining the neck for swelling or tracheal deviation before extubation. Extubation should be avoided until symmetry returns. Lateral edema will usually resolve within two to four hours. Hendler and Levin⁴⁹ have reported pulmonary edema secondary to just such a lateral pharyngeal extravasation.

8. Iatrogenic Intra-articular Injury

Westesson et al¹³⁰ reported scuffing of articular cartilage during arthroscopy, while McCain⁷⁴ reported at least one case of disc perforation. Careful puncture technique, and the use of blunt trochars, are recommended to minimize iatrogenic injury.

9. Complications from Electrocautery

High flow irrigation to control generated heat is required when electrocautery is used in arthroscopic surgical procedures. Carter and Tesla^{17,18} have reported permanent seventh nerve injury associated with electrocautery. Soft tissue and skin thermal injury can occur during arcing into the working cannula.

Holmium/Yag Laser

Hendler et al in 1992 commented favourably on the use of this laser as it easily sculpts cartilage and rapidly ablates adhesions and fibrillations.⁴⁸ Rapid coagulation is obtained

in areas of hemorrhage. Operating time is also reduced as compared to conventional arthroscopic techniques.

In conclusion, arthroscopy can be recommended for:

- 1 Internal derangements.
- 2 Hypomobility secondary to intracapsular adhesions.
- 3 Synovitis.
- 4 Degenerative joint disease.
- 5 Hypermobility resulting in painful subluxation or dislocation.

Arthroscopy is most commonly used for hypomobility secondary to a persistent closed lock, or in patients with degenerative joint disease and/or adhesive capsulitis.

Although a greater complication rate has been reported with arthroscopic surgery versus arthrocentesis, it does present certain advantages. Arthroscopy allows for direct visualization of the joint for a more complete diagnosis. The diagnostic benefits include information about disc position and morphology, and evaluation of articular surfaces. It allows for visualization of synovitis and adhesions that arthrocentesis cannot provide. Arthrocentesis has proven its effectiveness as a beneficial treatment for sudden acute closed lock of the mandible. Although the therapeutic goals of each procedure may be similar, as they both involve irrigation of the superior joint space to reduce pain and inflammation, arthrocentesis is not a comparable substitute for arthroscopic lysis and lavage in all cases.

It is clear that arthroscopy of the temporomandibular joint is a useful diagnostic and surgical procedure for internal derangements, degenerative joint diseases, synovitis, and mandibular hypo- and hyper-mobility within the parameters previously outlined. Arthroscopy should not, however, be the automatic treatment alternative for all patients who fail conservative management. Careful patient selection is critical to a

successful outcome. Similarly, open joint arthrotomy should not be offered to all patients who fail to have successful arthroscopic outcomes.^{119, 132} Currently, the significance of disc position and the requirement for disc repositioning in a dysfunctional joint is undetermined. Further prospective, controlled, long-term research studies should help to shed some light upon this perplexing problem.^{72,19,91}

SUMMARY

While there are some studies that show an unsuccessful outcome following surgery for TMJ internal derangements, there are others that show distinct benefits after joints surgery. What is clear is the obvious deficiency of scientific proof to validate the risks and/or benefits associated with TMJ internal derangement surgery as typified by the demonstrable lack of prospective controlled and randomized long-term studies.

Until the results of such studies are known, the decision on whether or not to treat the internally deranged TM joint surgically needs to be based on sound clinical judgement and reasonable expectations of the surgical outcome.