A long-term evaluation of arthroscopy of the temporomandibular joint using holmium YAG laser

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Abstract:

The aim of this in vivo study was report the long-term results of arthroscopic laser surgery for treatment of TMJ internal derangements (Wilkes class II-III).

This report included 45 patients (42 women and 03 men) with an average age of 36.7 years old (14 to 66 years). There were 69 joints involved. The criteria for inclusion were patients who had complained of TMJ pain and dysfunction and had remained refractory to nonsurgical treatment for at least 3 months without resolution of the problem. All patients filled out a questionnaire preoperatively and postoperatively for assessment of their signs and symptoms. The range of interincisal opening was measured preoperatively and at 1, 7, 30, and 60 days after the surgery. The postoperative questionnaire, radiographic evaluation, and the last measure of range of motion were performed with one year or more after the surgical procedures. The preoperatively and postoperatively scores were compared and tested for statistically significant differences by the paired t-test (P>0.05).

Forty-five patients (69 joints) have been followed postoperatively for an average of 28.6 months. Maximal interincisal opening improved from a mean of 25.95mm to 35.91mm (+9.96mm) in seven days after the surgery; to 39.86mm (+3.95mm) after thirty day and; to 40.92mm (+1.06mm) after 60 days. The last measurement of maximal interincisal opening made after one year or more showed a mean of 42.15mm. All postoperative VAS pain scores showed a statistical significant improvement (p<0.05). The overall success rate for arthroscopy arthroplasty with Holmium YAG laser was 93.3% (42 of 45 patients) in a mean follow-up of 28.6 months. No complications were observed.

Based on the results we can conclude that arthroscopic arthroplasty with Holmium laser is a safe and effective tool for the treatment of TMJ internal derangements.

Key Words:
Temporomandibular Joint, Internal Derangements of the Temporomandibular Joint, Arthroscopy, Holmium YAG Laser.
Introduction
With the development of arthroscopy and the direct visualization of components of joint compartment, the prominent role of arthritic cartilage degeneration, clinically known as osteoarthritis, in temporomandibular joint (TMJ) signs and symptoms was increasingly appreciated. New studies show that osteoarthritis and synovitis are major pathoses of TMJ that lead to joint dysfunction. Patients usually respond to nonsurgical treatment but some are refractory. In such cases, surgical procedure is necessary, and in this aspect arthroscopy has been effective.

Many surgical procedures previously performed by arthrotomy now may be performed by arthroscopy. Further, relatively conservative arthroscopic procedures may be sufficiently effective to eliminate the need for more complex arthroscopic and surgical arthrotomy procedures, especially when treating internal derangements.

The major advantage of arthroscopic surgery is that it is a minimally invasive surgical procedure and results in less periarticular tissue disruption and preservation of vascular and lymphatic drainage of the joint. Other advantages include direct visualization of pathologic tissue; biopsy; removal of adhesions; direct injection of steroid into inflamed synovial tissues; removal of osteoarthritic fibrillation tissue; and correlation of clinical findings with the actual joint pathology.

Many procedures of operative arthroscopy have been reported in the literature. In spite of the significant variability in the arthroscopic technique used, the clinical results are remarkably consistent. Success rates for TMJ arthroscopy, as determined by decreased pain and improved range of motion, have varied from 79% to 93%.

Murakami et al. in 1995 compared the efficacy of nonsurgical therapy, arthrocentesis, and arthroscopy in 108 patients with TMJ internal derangements and closed-lock. The nonsurgical therapy group had a success rate of 55.6%, the arthrocentesis group had a success rate of 70%, and the arthroscopy group who underwent lysis and lavage had a success rate of 91%. Because statistical comparison of the arthrocentesis group and arthroscopy group did not indicate any significant differences, the authors concluded that both therapies are effective modality in treating patients with acute limitation of mandibular opening refractory to medical management.

Hori et al. in 1999 studied the efficacy of a combined treatment using hydraulic lavage, arthroscopy surgery and rehabilitative therapy in the releasing of severe adhesions around the eminence and the synovial portion of the TMJ. The results demonstrated an improvement in condylar head movement in adhesions concentrated in the posterior and/or the anterior synovial portion of the upper TMJ compartment or around the eminence.

The first laser used in TMJ arthroscopy was the neodymium-yttrium-garnet laser (Nd: YAG) but most recently Holmium: YAG laser has been used. Like others kind of lasers, Holmium Laser has affinity for water, and this property allows to be absorbed by aqueous tissue, which then converts its energy to heat with subsequent ablation of tissue. Although not being a “cold laser”, the technically Ho: YAG laser produced almost no heat in the TMJ. The average intra-articular increase in temperature recorded is 10°F. Because of Holmium’s ability to pass through water and its ability to coagulate, it becomes an excellent laser for the surgeon in arthroscopic TMJ surgery.

Although the long-term outcome of arthroscopic surgery has been reported, few are the studies in the literature using the Holmium Laser as a surgical tool to perform a different number of arthroscopic procedures. In this paper, we report the long-term results of arthroscopic laser surgery for treatment of TMJ internal derangements.

Material and Methods
Casuistic
This report includes 45 patients (42 women and 03 men) with an average age of 36.7 years old (14 to 66 years). There were 69 joints involved.

The criteria for inclusion were patients who had complained of TMJ pain and dysfunction (Wilkes class II-III) (Table 1) and had remained refractory to nonsurgical treatment (splint therapy, nonsteroids inflammatory drugs, physical therapy, and others) for at least 3 months without resolution of the problem (Table 2). A probable etiology of the TMJ internal derangement was also investigated. Exclusion criteria included compromised present illness, and physical or mental handicap that would preclude the patient’s ability to answer verbal or written question.

Table 1 – Preoperative Symptoms (69 joints, 45 patients)

<table>
<thead>
<tr>
<th>SYMPTOMS</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint pain with mandibular movement</td>
<td>100</td>
</tr>
<tr>
<td>Pain at palpation of the capsule</td>
<td>97.11</td>
</tr>
<tr>
<td>Limitation of Range of Motion</td>
<td>91.12</td>
</tr>
<tr>
<td>Clicking</td>
<td>66.6</td>
</tr>
<tr>
<td>Locking</td>
<td>43.47</td>
</tr>
<tr>
<td>Crepitation</td>
<td>36.23</td>
</tr>
</tbody>
</table>

The diagnosis of class II-III of internal derangement was determined by a patient evaluation and imaging modalities. The patient evaluation consisted of a pre visit questionnaire for assessment of their signs and symptoms, history of present illness, clinical examination, and clinical differential diagnosis. The imaging modalities included panoramic radiographs and magnetic resonance imaging (MRI).
Patient evaluation was not blinded. The same surgeon (DBS) performed preoperative evaluation and the arthroscopic surgery in all patients.

All patients filled out a self-assessment questionnaire preoperatively and postoperatively. The questionnaire consisted of a visual analogue scale (VAS), with one item on level of pain most of time, one item about the effect of pain on normal diet, and one item about the effect of pain on daily living. One final question about their perception of tolerability of the surgery was also applied. The ROM was measured preoperatively, and seven, thirty, sixty days, and 18 months or more postoperatively. The postoperative questionnaire and radiographic evaluation were performed 18 months or more after the surgical procedures. The preoperatively and postoperatively scores were compared and tested for statistically significant differences by the paired t-test (P>0.05). Postoperative radiographic evaluation was done in all patients.

Arthroscopic Surgery

All the arthroscopic surgeries were procedures made under general anesthesia with nasoendotracheal intubation, using the same type of instruments. A double portal arthroscopic technique using a TMJ 2.3mm Set (Stryker Corp., Kalamazoo, MI, USA) was used for all cases. The landmarks for arthroscopic surgery including the Holmlund & Hellsing line, the 10-2 point and the 25-10 point were drawn in the face. Local anesthetic with Xylocaine with epinephrine was placed into the skin at these points and then the superior joint space was insufflated using an 18-gauge catheter with normal saline. Following insufflation and a small skin incision at the 10-2 point with a number 15 blade, a sharp trocar and cannula were introduced into the superior joint space. The arthroscope was then placed for joint inspection.

The surgical procedures were performed according to five (5) diagnostic categories, alone or associated (Table 3). In presence of closed lock and disc dislocation with reduction (painful clicking), the surgical technique used were lysis and lavage associated with release of adhesions and posterior cauterization with Holmium YAG Laser, followed by injection of steroids.

In presence of osteoarthritis, debridement with motorized shaver and vaporization with Holmium YAG Laser in order to remove the fibrillated or degenerated fibrocartilage was performed.

In presence of synovitis, the redundant synovial tissue was removed with Holmium YAG laser.

In presence of hypermobility, the arthroscopic technique of choice was posterior cauterization or sclerosis of the retrodiscal tissue with Holmium YAG Laser.

In cases of small disc perforations, laser discoplasty and disc mobilizations were performed.

In all patients after the indicated procedure, a completely and thoroughly irrigation of the joint with saline solution to be free of any loose debris was performed, and 1cc of betametezone, 1cc of bupivacaine with epinephrine 1:200.000 and 1cc of sodium hyaluronate were placed in the superior joint space. Both cannulas were removed and a suture of 5-0 nylon was placed in each cannula site. A stabilization occlusal appliance (splint) was placed in the mouth in all patients at the end of the surgery.

Results

Forty-five patients (69 joints) have been followed postoperatively for an average of 28.6 months. In general, there were no disparities between the clinical findings, MRI and arthroscopy findings. Regarding the probable etiologies for TMJ internal derangements 71.1% had positive history for microtrauma (grinding, clenching, jaw posturing, nail biting, and gun chewing), 26.6% had history of macrotrauma, and 8.8% of unknown causes (Table 4).

Maximal interincisal opening improved from a mean of 25.95mm to 35.91mm (+9.96mm) in seven days after the surgery; to 39.86mm (+3.95mm) after thirty days; to 40.92mm (+1.06mm) after 60 days. The last measurement of maximal interincisal opening made after one year or more showed a mean of 42.15mm (Table 5).
Table 4 – Probably Etiology (45 patients)

<table>
<thead>
<tr>
<th></th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microtrauma</td>
<td>71.11</td>
</tr>
<tr>
<td>Clenching</td>
<td>46.6</td>
</tr>
<tr>
<td>Grinding</td>
<td>43.3</td>
</tr>
<tr>
<td>Gum Chewing</td>
<td>15.0</td>
</tr>
<tr>
<td>Nail Biting</td>
<td>15.0</td>
</tr>
<tr>
<td>Jaw Posturing</td>
<td>10.0</td>
</tr>
<tr>
<td>Macrotrauma</td>
<td>26.6</td>
</tr>
<tr>
<td>Unknown</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Table 5 – Range of Interincisal Opening

<table>
<thead>
<tr>
<th></th>
<th>Pre Operation</th>
<th>7 days</th>
<th>30 days</th>
<th>60 days</th>
<th>1 year or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximal Opening</td>
<td>25.95</td>
<td>35.91</td>
<td>39.86</td>
<td>40.92</td>
<td>42.15</td>
</tr>
<tr>
<td>Opening without pain</td>
<td>+9.96</td>
<td>+3.95</td>
<td>+1.06</td>
<td>+1.23</td>
<td></td>
</tr>
<tr>
<td>Values expressed as mean (Range)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

All postoperative VAS pain scores showed a statistical significant improvement (p<0.05). Pain and dysfunction scores were reduced significantly (Table 6).

Table 6 – Comparison of baseline and postoperative measurements in 45 patients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Preoperative</th>
<th>Postoperative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain Score</td>
<td>43.66 a</td>
<td>4.66 b</td>
</tr>
<tr>
<td>Interference with the normal diet</td>
<td>43.44 a</td>
<td>9.11 b</td>
</tr>
<tr>
<td>Effect in life</td>
<td>39.88 a</td>
<td>7.22 b</td>
</tr>
</tbody>
</table>

Means followed by different character were significantly different (p<0.05)

A success categorization of a particular subject was based primarily on whether the subject showed statistically significant improvement in both range of interincisal opening and pain scores. Given these criteria, the overall success rate for arthroscopy arthroplasty with Holmium YAG laser was 93.3 % (42 of 45 patients) in a mean follow-up of 28.6 months. Two patients classified in a success group showed a significant improvement in pain scores. They showed no pain most of the time and a slight pain, less than before surgery occasionally. Their range of interincisal opening showed an improvement after surgery. In failure patients, two still remain in pain and one, even not showing no pain, his range of interincisal opening didn’t improved with the treatment.

Discussion

In our study, all patients who underwent arthroscopic surgery with Holmium YAG laser had a preoperative diagnosis of pain secondary to stage II-III of internal derangement (Wilkes19) who had not responded to conventional nonsurgical treatment (splint therapy, nonsteroidal inflammatory drugs, physical therapy). Our indication for arthroscopy was the same as those found in the literature3,4,5,6,7,10,11.

The probable etiologic factors described in the literature1,2,9 such as trauma to face (macrotrauma) and joint overloading (microtrauma) were also found in our study as major factors contributing to TMJ internal derangement.

According to the literature, the most common arthroscopic procedure was lysis and lavage. However, lateral capsular release, posterior cauterization, debridement, abrasion arthroplasty, suturing, or laser techniques were also described12,18. The techniques performed in our study were used according to the surgical findings. In presence of closed lock and disc dislocation with reduction (painful clicking), the surgical technique used was lysis and lavage associated with release of adhesions and posterior cauterization with Holmium YAG Laser, followed by injection of steroids. In presence of osteoarthritis, debridement with motorized shaver and vaporization with Holmium Laser in order to remove the fibrillated or degenerated fibrocartilage was performed. In presence of synovitis, the redundant synovial tissue was removed with Holmium YAG laser. In presence of hypermobility, the arthroscopic technique of choice was posterior cauterization or sclerosis of the retrodiscal tissue with Holmium YAG Laser. In cases of small disc perforations, laser discoplasty and disc mobilizations were performed. All techniques were well described for arthroscopic surgery in the literature.

Holmium YAG laser vastly improves the ability to remove and sculpt diseased tissues when compared to mechanical instrumentation9. Operating time is reduced owing to the small size of the delivered tip and the ability to manipulate...
the fiberoptic handpiece, which allowed easy access to all recesses of the TMJ. No oozing or debris exist because there is only minimal tissue damage. Clinical studies have demonstrated that the Holmium YAG laser is a safe and effective modality for the delivery of energy in the TMJ. When the laser surgery has been employed the benefits include the following: decreased operating time, increased precision, expanded accessibility, minimized blood loss, decreased hemarthrosis, non contact ability to vaporize pathology, reduced postoperative pain, and recovery time. Several success rates for TMJ arthroscopic surgery have been shown in the literature. In a multicenter retrospective study of 4,831 joints, after arthroscopic surgery 91.6% of all patients had good or excellent motion and 91.3% had good or excellent pain reduction. Others reports in the literature showed success rates ranging from 76% to 83% for different arthroscopic procedures such as lysis and lavage or arthroplasty with disc repositioning. In our study we found a success rate of 93.3% with a significant improvement in pain reduction according with the VAS scores. The maximal interincisal opening improved from a mean of 25.95mm to 42.15mm after one year or more. No progressive changes were found on postoperative radiographs. Among the failed patients, two still showed significant pain after 24 and 27 months, respectively, and one did not show improvement in the range of motion, even though no pain was described. All three patients had diagnostic of osteoarthritis and synovitis. The mean of complications rate described in previous studies was 3.8%, and included 5th nerve deficit, 7th nerve paresis, hearing loss, infections, and broken instruments. No complications were found in all patients who underwent arthroscopic surgery in our study. Recurrence or persistence of symptoms after arthroscopic surgery is usually caused by failure to control the etiologic factors. Causative factors such as stress, muscle disorders, grinding, and clenching contribute to excessive joint loading, inflammation, and cartilage breakdown. The patient compliance for the treatment is one of the most important factors for success. Decreasing joint loading with splint therapy and soft diet, controlling the inflammatory process in the joints with appropriate anti-inflammatory drugs, and rehabilitation immediate with physical therapy seems to be an important factor for success. The understanding of the disease process is another important factor for patient’s success. Patient education and treatment aimed for the system and not just for the joint is imperative to reach long-term success.

Arthroscopy is a minimally invasive procedure and all patients were treated as outpatient and no hospitalization was needed. On the basis of this follow-up study, arthroscopy using Holmium YAG laser for management of internal derangements is an effective therapy for TMJ pain and restricted ROM. Patient acceptance of this procedure is high. The rate of recovering is excellent. Holmium YAG laser a safe and effective tool for the treatment of TMJ internal derangements.

References
17. Quinn JH, Stover DS. Arthroscopic management of temporomandibular joint disc perforations and associated advanced chondromalacia by discoplasty and abrasion
