Risk Factors Associated With Poor Outcomes Following Temporomandibular Joint Discectomy and Fat Graft

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Purpose: Temporomandibular joint (TMJ) discectomy is performed for patients with degenerative joint disease with an unsalvageable disc, but with a salvageable condylar head and glenoid fossa. The purpose of this study was to estimate the incidence and risk factors associated with poor postoperative outcomes following TMJ discectomy and abdominal fat grafting.

Methods: A retrospective cohort study was conducted on patients who underwent TMJ discectomy. Included in this study were patients who had complete data sets with a minimum of 1-year follow-up. Potential risk factors included demographics, preoperative findings (mouth opening, pain levels, previous TMJ surgery), operative findings (disc degeneration, state of TMJ components), and postoperative outcomes (pain levels, mouth opening). Failed outcomes were those who had return of pain postoperatively, no improvement in mouth opening following TMJ discectomy, and/or those who progressed to TMJ total joint replacement (TJR).

Statistical methods included Kaplan-Meier curves and Cox proportional hazards regression time to event analyses.

Results: This study included 129 patients who had undergone 132 TMJ discectomies. Most patients were female (89.9%), with a mean age of 43.2 years, standard deviation 14.2. The success rate for discectomy was 75.2% and the conversion rate of TMJ discectomy to TJR was 11.7%. A total of 32 patients (24.8%) experienced return of pain. The median time to return of pain or second surgery was 94.4 months (95% CI = 88.3 to 101.8). No risk factors were statistically significant, although mouth opening improvement of less than 10% was associated with higher risk of poor outcome (P = .77).

Conclusion: The findings of this study suggest that lower improvement in mouth opening at 1 year following surgery is likely to result in failure of the TMJ discectomy procedure although the result was not statistically significant. This outcome may ultimately necessitate a TJR.

J Oral Maxillofac Surg 000:1−7, 2021

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Conflict of Interest Disclosures: None declared.

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Received April 8, 2020

Accepted May 12, 2021.

0278-2391

https://doi.org/10.1016/j.joms.2021.05.018

Introduction

From a surgical standpoint, a temporomandibular disorder (TMD) is defined as a musculoskeletal disorder that adversely affects the smooth, pain-free function of the mandible resulting in reduced oral function and poor quality of life. TMD is a common problem, affecting up to 10 to 25% of the population, and most patients are initially managed conservatively.[1-3] Approximately 5 to 10% of all TMD patients may require surgical intervention.[4] Indications for temporomandibular joint (TMJ) surgery can be divided broadly into absolute and relative indications.[5] Absolute indications include: tumors, growth anomalies and ankylosis. Relative indications include: TMJ internal derangement and degenerative disorders such as osteoarthritis.

Degeneration within the TMJ can affect all components, including the disc, condyle and glenoid fossa.[5] The Dimitroulis surgical classification of TMJ disorders separates the degree of joint pathology into 5 categories.[6] A category 4 joint is when major joint components such as the disc cannot be salvaged due to advanced disease or severe trauma. In this scenario, the disc demonstrates severe internal derangement in the form of significant disc displacement and deformity, and the articular surfaces may be normal or show early signs of osteoarthritis. A TMJ discectomy, with or without debridement of the condylar head and glenoid fossa, is indicated for category 4 joints that have failed to respond to lesser measures such as disc repair and repositioning, arthroscopy, arthrocentesis as well as conservative measures, such as occlusal splint therapy, physiotherapy and medications.[5,6]

Discectomy is a well-recognized surgical intervention, with many long term follow-up studies demonstrating high success rates.[7-12] However, there remains a paucity of evidence with regards to the outcomes of that subset of patients who fail to respond to TMJ discectomy surgery. The purpose of this study was to determine what risk factors govern the outcomes of TMJ discectomy, thereby predicting risk of failure of the surgery, and to determine the conversion rate of discectomy to total joint replacement (TJR).

Materials and Methods

STUDY DESIGN

To address the research aims, a retrospective cohort study was conducted. The study included patients who underwent TMJ discectomy between January 1, 2009 and December 31, 2014 by a single surgeon, GD, at a single hospital, Epworth HealthCare -Freemasons, Melbourne, Australia. Eligible patients were identified from electronic records and data gathered from the patient's digital medical file using the operative report, preoperative and postoperative consultation notes. The study's inclusion criteria were: a minimum of 1-year follow-up data; adult patients older than 18 years; MRI evidence of Cat 4 TMJ internal derangement; the patient reporting symptoms of severe joint pain, which they consider intolerable; and clinical evidence of joint dysfunction that had failed to respond to at least 6 months of conservative treatment (medication, splints, physiotherapy, etc.). Patients were excluded from the study if they had previous or concurrent surgeries other than discectomy such as condylectomy or removal of associated pathology such as synovial cyst or tumor. The Epworth HealthCare Human Research Ethics Committee granted formal approval for this research project (Reference Number EH2017-231).

The TMJ was accessed via a preauricular incision and dissection continued in layers until the capsule was reached. An incision parallel to the zygomatic arch was made through the TMJ capsule to expose the superior joint space, and the diseased disc was removed. The condition of the disc, condyle and glenoid fossa were documented at the time of the disc removal. If osteoarthritis was noted with the presence of a roughened articular surface, a high condylar shave and/or glenoid fossa recontouring was undertaken. An abdominal dermis fat graft was harvested, ensuring the overlying epidermis was carefully dissected off the specimen. This was used as an interpositional graft and carefully placed over the condylar head and sealed within the repaired joint capsule without any anchorage. The preauricular wound was repaired with sutures in a layered closure.

Each patient followed a standard peri-operative protocol. All procedures were undertaken under naso-endotracheal intubation and all received a 24-hour prophylactic course of intravenous cephazolin and a standardized analgesia regime (paracetamol 1g QID, ibuprofen 400mg TDS and oxycodone 5mg PRN for up to 7 days). A barrel-head pressure bandage was applied for 24 hours and the patient was discharged the next morning from hospital. A soft diet was maintained for 4 weeks. All patients were seen 1 week postoperatively as outpatients, at which point sutures were removed and jaw physiotherapy commenced and continued for a period of 6 weeks depending on progress. Splint therapy was only recommenced postoperatively in those patients with an ongoing habit of clenching and bruxism. Patients were reviewed at 3, 6 and 12 months after TMJ discectomy. Patients with successful outcomes ie. little or no pain and good mandibular function, were discharged after 12 months. Patients who failed to make significant progress after 12 months were monitored for further management.

STUDY VARIABLES

The primary outcome variable of this study was time to failure. Failure was defined as return of pain and/or progression to further TMJ surgery.

Clinically meaningful potential risk factors were identified from the patient's medical information and analyzed for association with the primary outcome variable. Risk factors consisted of demographic, preoperative, intraoperative, and postoperative variables.

The demographic information recorded was patient age at the time of surgery and gender. The preoperative predictor variable was previous TMJ surgery. Previous TMJ surgery included TMJ arthrocentesis, arthroscopy and disc repair before undergoing TMJ discectomy, and was recorded in a binary fashion.

The intraoperative surgical predictor variables were disc degeneration (including non-reducing disc displacement and deformity); condyle and/or glenoid fossa (joint) osteoarthritic (OA) degeneration. The degree of degeneration was also determined intraoperatively by the operating surgeon, GD. Degeneration, displacement and deformity of the disc was documented as a categorical variable: mild degeneration, moderate degeneration, and severe degeneration. OA degeneration of the joint was recorded as a binary variable: normal or OA present. All patients underwent discectomy and abdominal dermis fat graft in keeping with previous surgical approaches utilized by the author.[13]

The postoperative predictor variables were change in maximal mouth opening (ΔMMO), postoperative pain levels (VAS) and progression to further surgery. A preoperative and postoperative MMO were recorded as a continuous variable in millimetres, and the difference noted as ΔMMO. A comparison between preoperative and postoperative pain was measured with and recorded as: nil, improved, same or worse pain based on a VAS score 0 to 10. The postoperative recording of pain was taken as the longest interval after surgery that the patient had been followed, with a minimum of 12 months. The time between TMJ discectomy and further surgery such as condylectomy, rib graft and TJR was also documented. For statistical analysis, TJR, costochondral rib graft, and condylectomy were grouped together under the term further surgery and coded in a binary fashion. Similarly, change in ΔMMO was dichotomized at less than or equal to 10% increase from baseline versus greater than 10% increase from baseline. Finally, age was categorized at 18 to 30, 31 to 44, 45 to 54, and 55 and over years.

DATA COLLECTION AND ANALYSIS

The data was de-identified and collated into a single Microsoft Excel spreadsheet. Analyses including 95% confidence intervals (CIs) for means and proportions, and paired samples *t* tests, were conducted using Minitab, version 18 (Minitab, LLC, State College, Pennsylvania, 2017), with the exception of Kaplan-Meier curves and Cox proportional hazards regression time to event analyses[14] which were conducted using Stata, version 16 (Stata Corporation, College Station, Texas, 2019). The Cox regression models were checked for any violation of the proportional hazards assumption.[15]

A P value of <.05 was considered to be statistically significant. Ninety-five percent CIs were reported wherever appropriate.

Results

PARTICIPANTS AND DEMOGRAPHICS

During the study period, 148 patients underwent discectomy, and were screened for eligibility. Nineteen patients were excluded from the study as they had less than a 1-year follow-up period. In total, 129 patients with 132 TMJ discectomy procedures were included in the final sample. Due to the small number of repeat operations, only the 129 first operations were statistically analyzed. The mean age of the 129 patients was 43.2 years (standard deviation [SD] = 14.2 years, range = 18 to 76 years) and 89.9% (n = 116) of the patients were female (Table 1).

OUTCOME DATA AND ANALYSES

Previous TMJ surgery had occurred for 36 (27.9%) patients (Table 1). Intraoperatively it was noted that all joints had some form of disc degeneration, with 7 (5.4%) being mild, 79 (61.2%) moderate, and 43 (33.3%) having severe disc degeneration (Table 1). Osteoarthritis was also noted at the time of the operation in 79 (61.2%) of the joints (Table 1).

At 12 months postoperatively maximum mouth opening had increased from a mean of 31.6 (SD=6.7) to a mean of 37.3 (SD=5.7), an overall increase of 5.7 mm (95% CI = 4.4 to 7.1), which was statistically significant ($t(128)=8.7$, $P < .001$).

Pain remained the same or improved in 95 (75.2%) (95% CI = 66.8% to 82.4%) of the patients, 1 (1.0%) (95% CI = 0.03% to 5.5%) of whom went on to undergo TJR. Sixty-three patients within the above 95 (48.8% of the total sample) (95% CI = 39.9% to 57.8%) did not experience any pain. None (0%) (95% CI = 0.0% to 5.7%) of the patients without pain went on to undergo TJR.

Of the 32 (24.8%) (95% CI = 17.6% to 33.2%) patients for whom pain returned, 14 (43.7%) (95% CI = 26.4% to 62.3%) went on to undergo TJR. Of these 14 patients, 12 were part of the 20 patients that experienced an initial decrease in pain, followed by a

Table 1. SUMMARY OF THE DEMOGRAPHIC, PRE-, INTRA-, AND POST-OPERATIVE FINDINGS OF THIS COHORT.

Cohort Size, n	129
Demographics:	
Age (years), mean (SD)	43.2 (14.2)
Gender: female, n (%)	116 (89.9)
Preoperative:	
Previous TMJ surgery: yes, n (%)	36 (27.9)
Intraoperative:	
Disc degeneration, n (%)	
Mild	7 (5.4)
Mod	79 (61.2)
Severe	43 (33.3)
Joint OA present, n (%)	79 (61.2)
Postoperative:	
MMO (preoperative) (mm), mean (SD)	31.56 (6.7)
MMO2 (postoperative) (mm), mean (SD)	37.30 (5.7)
Change (MMO2-MMO), mean (SD)	5.75 (7.5)
Change (MMO2-MMO)/MMO (preoperative) * 100 greater than 10%: yes, n (%)	81 (62.8)
Further Surgery: yes, n (%)	34 (26.4)
Total joint replacement	15 (11.6)
Costochondral rib graft	1 (0.9)
Condylectomy	1 (0.9)
Pain Returned (worsened or remained the same)	32 (24.8%)

Abbreviations: OA, osteoarthritis; SD, standard deviation; Δ MMO, change in maximal mouth opening.

Ellis et al.. Risk Factors Associated With Poor Outcomes. J Oral Maxillofac Surg 2021.

later increase. In other words, 60% (95% CI = 36.1 to 81%) of the above 20 patients went on to undergo TJR.

The 95 patients who reported an improvement in their pain had greater increases in maximum mouth opening, with a mean ΔMMO of 6.2 mm (95% CI = 4.6 to 7.8 mm), compared with a mean ΔMMO of 4.1 mm (95% CI = 1.8 to 6.4 mm) for the 32 patients who did not.

A Kaplan-Meier curve showing time in months to return of pain or second surgery is shown in Figure 1. Most of those (25 out of 32 or 78.1%, 95% CI = 60.0% to 90.7%) experiencing a return to pain did so within the first 12 months. The median to return of pain was 94.4 months, 95% CI = 88.3 to 101.8.

The results of the individual Cox regressions shown in Table 2 indicated that past medical history (hazard ratio (HR) = 0.6, 95% CI = 0.2 to 2.1, P = .463) and change in MMO greater than 10% (HR = 0.5, 95% CI = 0.3 to 1.04, P = .066) were protective factors for return of pain. In other words, the presence of each factor is associated with a reduced risk of returning to

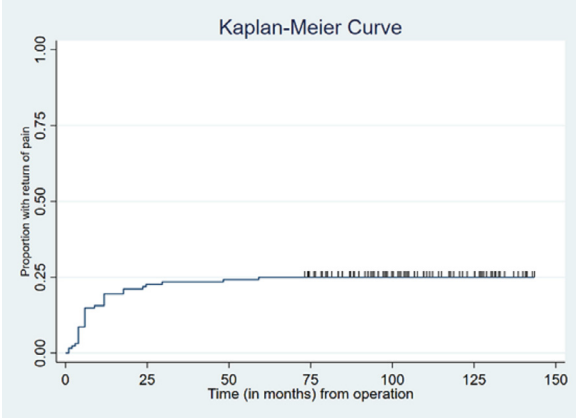

FIGURE 1. Kaplan-Meier curve showing time in months to return of pain or second surgery following discectomy. Black vertical lines denote censoring (no return of pain by end of study, December 31, 2020).

Ellis et al.. Risk Factors Associated With Poor Outcomes. J Oral Maxillofac Surg 2021.

pain. Neither individual factor was significantly significant, although change in MMO narrowly failed to achieve statistical significance (P = .066). All of the other factors were risk factors (HRs greater than 1), with the highest HRs being observed for severe disk degradation (HR = 1.9, 95% CI = 0.2 to 15.0, P = .527) compared with mild, and female gender (HR = 1.7, 95% CI = 0.4 to 7.3, P = .446), but these and other factors shown in Table 2 were clearly not statistically significant.

Table 2. INDIVIDUAL COX PROPORTIONAL HAZARDS REGRESSIONS (EACH PREDICTOR VARIABLE ENTERED INTO A SEPARATE REGRESSION MODEL) FOR PREDICTING RETURN OF PAIN OR SECOND SURGERY FOLLOWING DISCECTOMY.

Predictor Variable	HR	95% CI	P value
Age category (years)			
18-30	(reference category)		
31-44	1.4	0.5 to 4.3	.496
45-54	1.8	0.6 to 5.2	.311
55+	1.4	0.5 to 4.3	.547
Female	1.7	0.4 to 7.3	.446
Past surgical history	1.5	0.7 to 3.0	.312
Past medical history	0.6	0.2 to 2.1	.463
Disc Degeneration			
Mild/normal	(reference category)		
Moderate	1.8	0.2 to 13.8	.547
Severe	1.9	0.2 to 15.0	.527
Joint OA present	1.1	0.5 to 2.1	.903
MMO change > 10%	0.5	0.3 to 1.0	.066

Abbreviations: Δ MMO, change in maximal mouth opening; CI, confidence interval; HR, hazard ratio.

Ellis et al.. Risk Factors Associated With Poor Outcomes. J Oral Maxillofac Surg 2021.

A very similar pattern to the above was observed for the multivariable (all factors entered simultaneously) Cox regression shown in Table 3. Change in MMO greater than 10% remained the strongest predictor, but it did not reach statistical significance (HR = 0.5, 95% CI = 0.3 to 1.1, P = .077).

Discussion

The primary aim of this study was to determine the risk factors involved with TMJ discectomy that would negatively impact on the postoperative outcome. The authors looked at variables associated with the patient's demographic profile, preoperative history, or operative findings, which might predict positive or negative outcomes. While most studies have focused on successful outcomes of surgical interventions, particularly in terms of pain improvement, this study focused on what factors contribute to worsening pain and progression to further surgery.

ΔMMO following TMJ discectomy has been documented in the literature with improvements ranging from 6.7 to 14 mm.[9-11,16,17,18,19] This study demonstrated a mean increase of 5.7 mm. Furthermore, the results showed a statistically significant difference in ΔMMO for those patients who had improvement in pain (6.2mm) compared to those who did not (4.1 mm). To the best of the authors' knowledge this is the first time this association has been established. ΔMMO could be used as a potential predictor of post-operative pain. In the clinical setting the authors have used an improved mouth opening measurement of 2 mm or less as a sign of failure of TMJ discectomy. Greater than 10% improvement in MMA was found to be associated with lower risk of return of pain, although the result narrowly failed to reach statistical significance (P = .077).

Table 3. MULTIVARIABLE COX PROPORTIONAL HAZARDS REGRESSIONS (ALL PREDICTOR VARIABLES INCLUDED IN A SINGLE REGRESSION MODEL) FOR PREDICTING RETURN OF PAIN OR SECOND SURGERY FOLLOWING DISCECTOMY.

Predictor Variable	HR	95% CI	*P* value
Age category (years)			
18-30	(reference category)		
31-44	2.0	0.6 to 6.3	.242
45-54	2.1	0.7 to 6.5	.208
55+	1.7	0.5 to 5.5	.369
Female	2.1	0.5 to 9.0	.337
Past surgical history	1.9	0.9 to 4.2	.117
Past medical history	0.7	0.2 to 2.4	.515
Disc Degeneration			
Mild/normal	(reference category)		
Moderate	2.5	0.3 to 20.6	.394
Severe	2.9	0.3 to 25.2	.335
Joint OA present	1.0	0.5 to 2.1	.959
MMO change > 10%	0.5	0.3 to 1.1	.077

Abbreviations: Δ MMO, change in maximal mouth opening; CI, confidence interval; HR, hazard ratio.

Ellis et al.. Risk Factors Associated With Poor Outcomes. J Oral Maxillofac Surg 2021.

In keeping with previous literature, more severe disc degeneration is associated with OA degeneration of the joint.[20]

The success of TMJ discectomy is defined in this study as improvement in postoperative pain and joint function not requiring further TMJ surgery. The success rate of the cohort in this study was 75.2%. No previous study has used this as a definition of TMJ discectomy success. When focusing solely on postoperative pain, multiple studies have reported improvement post-discectomy with results ranging from 73 to 96%.[7,9-11,16-19] The results of this study are consistent with the international literature when focusing only on postoperative pain improvement; which was 88% of patients following TMJ discectomy. Few studies have included data on the percentage of patients who were completely pain free. Brown[21] reported 60% and Bjornland[10] 69%, respectively. This study found 48.8% of the cohort to be completely pain free a year after TMJ discectomy surgery.

In reviewing the primary outcome variable, change in pain postoperatively, we have proposed the following hypotheses for our results. The 63 (48.8%%) patients who had no pain following discectomy and whose symptoms were resolved had no further treatment.

Of the 20 (15.5%) patients who reported pain improvement, but not complete pain resolution, at 1 year, 12 (60%) progressed on to TJR. This suggests that pain improvement alone, is not the only factor affecting their likelihood to undergo further surgery. Other factors could include: a greater diversity of pain experiences within this sub-cohort than were able to be defined by this study; previous positive surgical experience; and the individual biopsychosocial factors which affects patients' willingness to engage in further surgical treatments.

The study highlights the diversity of treatment choices made by patients, which does not necessarily reflect the surgical treatment ladder available to them. This may include financial constraints and further time off work that may well impact on their decision not to proceed with further surgery during the time frame of this study.

Another goal of this clinical study was to identify the conversion rate of TMJ discectomy to TJR. During the 6-year study interval, 17 of the 112 patients underwent condylectomy and glenoid fossa recontouring, with various methods of reconstruction: 15 patients

had a TJR, 1 patient underwent a costochondral rib graft, and an edentulous patient had a condylectomy without any reconstruction. The costochondral rib graft and condylectomy were performed at the beginning of the study interval. Today, with an increased understanding of treatment options, all patients would have been likely offered TJR as the method of reconstruction.[22] Therefore, we consider the conversion rate of discectomy to TJR to be 14.7%. An earlier study by Breik et al (2016) from the same center showed a conversion rate of 22% from TMJ arthroscopy to open TMJ surgery.[23] In that study, the authors also reported that patients with more advanced disease (Categories 4 and 5) often progressed onto TJR.

Possible indications for conversion from discectomy to TJR reported in the literature are either end stage category 5 joints or multiply-operated TMJ treatment failure cases.[24-26] Despite these indications, the physiological mechanism by which discectomy provides success or failure is not known.[5] Some authors have proposed that the fundamental cause is an imbalance between anabolic and catabolic molecular events within the joint.[27] Without further studies into the role of molecular factors, it is not possible to comment fully on their impact on surgical outcomes. However, it should be considered that these factors may contribute to worsening disease symptoms and possibly result in patients opting for further surgery, including TJR.

A number of studies have been published discussing the success of TMJ arthroscopy, as well as progression rates to TJR.[22,28] However, multiple authors have published results on the long-term satisfactory outcomes of TMJ discectomy, but have not disclosed unsatisfactory outcomes.[9-11,19] This is the first study to document failures associated with the procedure, and thus, has demonstrated a conversion rate from TMJ discectomy to TJR of 14.7%. The results of this study provide essential evidence with respect to informed consent of patients when discussing the risks and limitations of TMJ discectomy surgery, and in particular, the likelihood of further surgery.

The main areas of weakness in this study were the retrospective collection of data, the single surgeon, and also the single center experience, which may not necessarily reflect the experience of other centers. Late failures may also be missed, if they occur after the data collection period closed. Prior literature on TMJ discectomy surgery is predominantly composed of retrospective papers reporting only positive outcomes with cohort sizes of less than 40 patients.[3,8,10,11,16, 19,29] This research represents 1 of the largest cohorts in the literature on TMJ discectomy surgery, with 129 patients.

In conclusion, the success rate of TMJ discectomy in this study was 75.2% where patients reported significant improvement in joint pain and function that required no further treatment. The conversion rate from TMJ discectomy to TJR was 11.7%, with a median of 94.4 months to return of pain or second surgery. ΔMMO of less than 10% at the 1-year review point following surgery narrowly failed to each statistical significance ($P = .077$, when included in the multivariable Cox regression) as a predictor of poor outcomes associated with TMJ discectomy. Further research activities in this field, with larger sample sizes, could investigate the specific nature of the relationship between change in MMO and return of pain, as well as explore the predictive value of preoperative CT in determining the presence of OA in the joint, which may influence the decision to proceed straight to TJR rather than TMJ discectomy. The findings of this study provide clinicians with valuable evidence-based information when discussing the risks, benefits and limitations of TMJ discectomy with their patients.

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