



Matthews device arthroplasty presents superior long-term mouth opening than interpositional arthroplasty in the management of temporomandibular joint ankylosis

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KEYWORDS

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Summary *Background:* The aim of this study is to describe the surgical outcomes of a single-institution experience in the surgical management of temporomandibular joint ankylosis, comparing interpositional arthroplasty with autogenous tissue and Matthews device arthroplasty.

Methods: A retrospective analysis of temporomandibular joint ankylosis patients ($n = 15$), who underwent interpositional arthroplasty or Matthews device arthroplasty, was conducted. The surgical outcomes (preoperative, recent [4–6 weeks], intermediate [1 year], and late [3 years] postoperative maximal incisal opening, hospital stay, and complication, relapse, and reoperation rates) were compared.

Results: Significant (all $p < 0.05$) differences were recorded in temporomandibular joint ankylosis patients treated with interpositional arthroplasty with autogenous tissue (53.3%) versus Matthews device arthroplasty (46.7%) according to intermediate (25 ± 7 vs. 34 ± 5 mm) and late (19 ± 8 vs. 33 ± 5 mm) postoperative maximal incisal opening, intermediate (31% vs. 7%) and late (47% vs. 12%) postoperative relapse, and reoperation rate (38% vs. 0%). There was similarity (all $p > 0.05$) in preoperative (4.8 ± 2.9 vs. 4.9 ± 2.9 mm) and recent (35 ± 4 vs. 37 ± 4 mm) postoperative maximal incisal opening, hospital stay (3.5 ± 0.8 vs. 3.6 ± 0.8 days), and surgery-related complications (13% vs. 14%).

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Conclusion: Both surgical procedures evaluated were successful in initial management of temporomandibular joint ankylosis, but the Matthews device arthroplasty avoided postoperative relapse.

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Introduction

Temporomandibular joint (TMJ) ankylosis is a debilitating and distressing condition that severely restricts mouth opening and causes psychological stress, malocclusion, facial disfigurement, and airway, speech, and nutrition dysfunction.¹ Therefore, the target of surgical management in TMJ ankylosis should be releasing the joint ankylosis and lengthening the hypoplastic mandible (if present), with the aim of restoring and maintaining normal TMJ movement and mandibular function and prevent reankylosis.^{2–17}

Multiple surgical modalities have been proposed to treat TMJ ankylosis, including gap arthroplasty, interpositional arthroplasty with autogenous or alloplastic materials, and total TMJ reconstruction with autogenous or alloplastic replacement.^{2–17} However, there is no consensus regarding the ideal surgical approach, and distinct therapeutic algorithms with variable success and relapse rates have been described.^{2–17}

Furthermore, although the UCLA group¹¹ has verified that the Matthews device (KLS Martin, Jacksonville, FL, USA) arthroplasty could avoid 1 year relapse, peer-reviewed literature showed only limited data¹⁸ addressing the surgical outcomes of the craniomandibular external fixation device designed by Dr David C. Matthews.^{19,20} Thus, the purpose of this study was to describe the surgical outcomes of a single-institution experience in the management of TMJ ankylosis, comparing interpositional arthroplasty with autogenous tissue and Matthews device arthroplasty. We hypothesized that the late postoperative maximal incisal opening (MIO) would be better in the Matthews device arthroplasty group due to intrinsic characteristic of the device that maintains the surgically created space between the roof of glenoid fossa and the mandible and simulates TMJ movement during the postoperative physiotherapy process.

Methods

An observational retrospective study was performed on consecutive patients clinically and radiographically diagnosed with TMJ ankylosis by our craniofacial multidisciplinary team, and who underwent TMJ surgical intervention between 2003 and 2012. Demographic data, disease-related data (e.g., etiology, side involvement, facial asymmetry, micrognathia, and mandibular hypoplasia), surgery-related data (e.g., previous TMJ operation and interpositional arthroplasty with autogenous tissue vs. Matthews device arthroplasty), and outcome data (preoperative and

postoperative MIO, days of hospitalization, and complication, relapse, and reoperation rates) were verified through medical records, standardized facial photographs (frontal, basal, lateral, and intraoral views),^{21,22} radiographic TMJ images, and patient interviews. All patients were stratified according to the New York University classification (congenital or acquired ankylosis; soft tissue or skeletal ankylosis; and intracapsular or extracapsular ankylosis).²³ Patients with incomplete medical records and/or incomplete postoperative follow-ups (<36 months) were excluded from the study.

Written consent was obtained from all patients, in accordance with the Helsinki Declaration of 1975, as amended in 1983. Approval from a local institutional research ethics board was obtained for this study.

Surgical approach

In our center, TMJ ankylosis patients were managed with interpositional arthroplasty or Matthews device arthroplasty between 2003 and 2007 and between 2008 and 2012, respectively. Similar steps of both arthroplasty procedures were included^{2,6,10,11,15,16}: the affected TMJ was exposed with preauricular incision with a temporal extension; uni- or bilateral excision of the ankylotic mass was performed resulting in a gap of at least 15 mm between the roof of the glenoid fossa and the mandible; followed by interposition of autogenous tissue (the pedicled temporoparietal fascial flap or the costochondral graft [particularly in patients with inadequate mandibular ramus height]); further ipsilateral and contralateral coronoidectomy was performed if the intraoperative MIO was not more than 35 mm.

The interpositional arthroplasty procedure was finalized with a drain placed before layered closure. In Matthews device arthroplasty, the cranial arm was fixed on temporal bone with subperiosteal dissection cephalad to the external auditory canal. The mandibular arm was fixed by two percutaneous pins to the ramus, and the adjusting screw was set for 15–17 mm of TMJ space displacement between the roof of the glenoid fossa and the mandible ([Figure 1](#)). The procedure was finalized with a drain and closure in layers. The external craniomandibular device was advanced 1 mm daily postoperatively to increase the TMJ space according to the individual need, and the device was removed after 4–5 months.¹¹ Additional surgical technical details have been previously reported.^{2,6,10,11,15,16}

All patients received early (at 24 h postoperatively) mobilization and TMJ physiotherapy (three repetitions of 10 jaw-stretching exercises [mouth opening–closing exercises with an increasing number of tongue spatulas, active hinge opening, and lateral excursions combined with manual finger

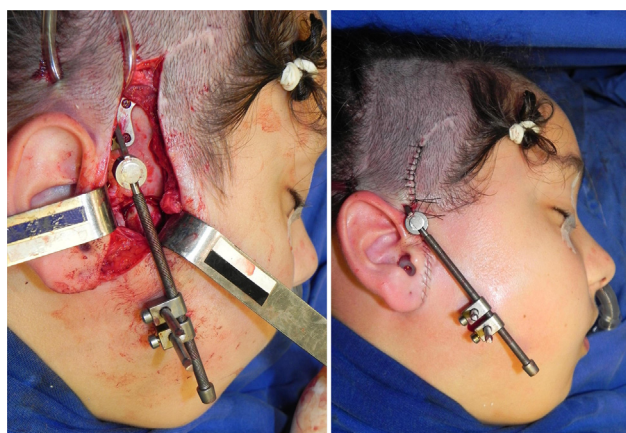


Figure 1 Intraoperative photograph of Matthews Device. Cranial arm fixed to temporal bone cephalad to the external auditory canal, and mandibular arm fixed by percutaneous pins to ramus.

stretching in front of a mirror] $\geq$ four times per day) for at least 6 months.^{6,10,11} In this context, it is noteworthy that our craniofacial multidisciplinary team has accompanied all TMJ ankylosis patients. Psychologists prepared patients for better compliance with prolonged surgical treatment and intensive postoperative TMJ physiotherapy, and orthodontic interventions were applied according to individual needs. All patients received regular postoperative follow-up because of the risk of TMJ ankylosis relapse.

Surgical outcome assessment

Outcome analysis was based on MIO measured by a millimeter caliper for preoperative, recent postoperative (4–6 weeks), intermediate postoperative (1 year), and late postoperative (3 years) time points. Relapse of TMJ ankylosis was defined as the change in MIO distance at late evaluation compared with the MIO at recent evaluation.¹¹

Statistical analysis

For the descriptive analysis, the mean $\pm$ standard errors were used as metric for variables, and percentages were given for categorical variables. Intra- and intergroup (interpositional arthroplasty with autogenous tissue vs. Matthews device arthroplasty) comparisons (hospital stay, MIO measurements, and complication, relapse, and reoperation rates) were performed with the aid of the Mann–Whitney, Friedman, Wilcoxon, and Confidence Interval for the mean tests. All *p* values were corrected by Bonferroni's method due to multiple testing. All data were analyzed using the software program Statistical Package for Social Science (SPSS version 20.0 for Windows, Chicago, IL, USA), and values were considered significant with a confidence interval of 95% ($p < 0.05$).

Results

A total of 15 patients (10 [66.7%] males and five [33.3%] females, with age 23.1 ± 8.4 years [range 14–46 years] at surgery) with TMJ ankylosis were included in this study. The most common complaint presented was limited mouth opening; in addition, facial contour asymmetry (including micrognathia and mandibular hypoplasia), TMJ pain, headaches, malocclusion, difficulty in mastication, speech, and oral hygiene, and dyspnea were reported. Of the 15 patients, seven (46.7%) had left-sided and six (40%) right-sided unilateral TMJ ankylosis (86.67%). Patients were classified as congenital TMJ ankylosis (86.67%), skeletal TMJ ankylosis (100%), and intracapsular TMJ ankylosis (100%). Most patients (73.3%) underwent previous unsuccessful TMJ ankylosis surgical intervention. The mean postoperative follow-up was 5.2 ± 1.3 years (range 3–7 years), and all patients had at least 3 years of follow-up (Table 1).

Eight (53.3%) patients underwent interpositional arthroplasty with autogenous tissue, and seven (46.7%)

Table 1 Distribution of patients with temporomandibular joint ankylosis ($n = 15$).

Characteristics	TMJ ankylosis groups		<i>p</i> value
	Interpositional arthroplasty ($n = 8$)	Matthews device arthroplasty ($n = 7$)	
Male/Female n (%)	5 (62.5)/3 (37.5)	5 (71.4)/2 (28.6)	>0.05
Age at surgery (years) $M \pm SD$ (V) ^a	23.3 ± 6.5 (15–36)	22.9 ± 10.7 (14–46)	>0.05
Unilateral/Bilateral n (%)	7 (87.5)/1 (12.5)	6 (85.7)/1 (14.3)	>0.05
NYU classification n (%)			
Congenital/Acquired ^b	7 (87.5)/1 (12.5)	6 (85.7)/1 (14.3)	>0.05
Soft tissue/Skeletal	—/8 (100)	—/7 (100)	>0.05
Intracapsular/Extracapsular	8 (100)/—	7 (100)/—	>0.05
Previous MDO n (%)			
Yes/No	5 (62.5)/3 (37.5)	4 (57.1)/3 (42.9)	>0.05
Previous TMJ ankylosis surgery n (%)			
Yes ^c /No	6 (75)/2 (25)	5 (71.4)/2 (28.6)	>0.05
Follow-up time (years) $M \pm SD$ (V)	5.5 ± 0.9 (3–7)	4.9 ± 1.6 (3–7)	>0.05

n, number of patients; *M*, mean; *SD*, standard deviation; *V*, variation; TMJ, temporomandibular joint; NYU, New York University; MDO, mandibular distraction osteogenesis; —, absent.

^a Only 1 patient in each group was younger than 18 years at surgery.

^b All acquired TMJ ankylosis were posttraumatic.

^c Gap arthroplasty (86.7%) or interpositional arthroplasty with native disk or auricular cartilage (13.3%).



Figure 2 (Left) Preoperative frontal photograph of a 14-year-old patient with right temporomandibular joint ankylosis. (Right) Three-year postoperative maximal incisal opening photograph after Matthews device arthroplasty.



Figure 3 (Left) Preoperative frontal photograph of a 17-year-old patient with left temporomandibular joint ankylosis. (Left, bottom) Preoperative maximal incisal opening photograph. (Right) Three-year postoperative maximal incisal opening photograph after Matthews device arthroplasty.



Figure 4 (Left) Preoperative frontal photograph of a 23-year-old patient with right temporomandibular joint ankylosis and lower facial asymmetry. (Left, bottom) Preoperative maximal incisal opening photograph. (Center) Three-month postoperative frontal photograph following Matthews device arthroplasty and reconstruction of the ramus height with costochondral graft showing improved facial symmetry. (Right) Three-year postoperative maximal incisal opening photograph.

underwent Matthews device arthroplasty. No bone and/or soft tissue surgical reconstruction was performed in the included patients for at least 36 months after TMJ ankylosis surgical interventions. The Matthews device arthroplasty group presented significantly (all $p < 0.05$) higher intermediate (1 year) and late (3 years) postoperative MIO measurements than the interpositional arthroplasty group, which in turn resulted in significantly (all $p < 0.05$) higher relapse and reoperation rates than the Matthews device arthroplasty group (Figures 2–4). There was similarity (all $p > 0.05$) in preoperative and recent postoperative (4–6 weeks) MIO measurements, hospital stay, and surgery-related complications (two [13.3%] TMJ surgery-related infections were successfully managed with antibiotic therapy) (Table 2). All of these patients are still being followed at our craniofacial plastic surgery center.

Discussion

Treatment of TMJ ankylosis to restore full-mouth opening and normal oral functions is one of the most difficult and complex challenges managed by craniofacial plastic surgeons.^{2–17} Different craniofacial surgery groups^{2–17} have published their experiences, trying to define the optimal surgical treatment of TMJ ankylosis. However, there was no uniformly accepted guideline, and hence TMJ ankylosis surgery-based therapy has always been controversial.^{2–17}

In the TMJ ankylosis surgery literature, only gap arthroplasty has been shown to be inadequate with a high rate of recurrent ankylosis.^{2–17,24–26} Therefore, different autogenous (e.g., native disk, buccal fat pad, auricular cartilage, sternoclavicular joint, and temporalis myofascial flap) and alloplastic (e.g., titanium foil, stainless steel, Vitallium, acrylic, teflon-proplast, and silicone) interposition materials have been adopted worldwide.^{2–17,24–26} Alloplastic materials have been associated with mixed results and numerous postoperative complications such as foreign body granuloma, infection, extrusion, and displacement.^{3,24–26} We therefore are in favor of using autogenous tissue in the vast majority of craniofacial surgical reconstructions^{27,28}; and particularly in the TMJ

Table 2 Outcome comparison of interpositional arthroplasty with autogenous tissue versus Matthews device arthroplasty.

Characteristics	Interpositional arthroplasty (n = 8)	p value ^a	Matthews device arthroplasty (n = 7)	p value ^a	p value ^b
Hospital stay (days) M ± SD (V)	3.5 ± 0.8 (3–5)	—	3.6 ± 0.8 (3–5)	—	>0.05
Surgery-related complications n (%)	1 (12.5)	—	1 (14.3)	—	>0.05
MIO M ± SD (V)					
Preoperative	4.8 ± 2.9 (1–9)	<0.001	4.9 ± 2.9 (1–8)	<0.001	>0.05
Recent postoperative (4–6 weeks)	35.3 ± 4.3 (30–41)		36.7 ± 4.4 (29–42)		>0.05
Intermediate postoperative (1 year)	24.9 ± 6.8 (16–34)		34.1 ± 4.7 (26–40)		0.013
Late postoperative (3 years)	19.3 ± 8.2 (10–29)		32.6 ± 5.1 (24–40)		0.005
Relapse (%)					
Intermediate postoperative (1 year)	30.5 ± 11.1	0.012	7.1 ± 4.7	0.028	0.002
Late postoperative (3 years)	47.0 ± 16.6		11.6 ± 5.0		0.001
Reoperation n (%)	4 (50)	—	0 (0)	—	0.014

n, number of patients; M, mean; SD, standard deviation; V, variation; MIO, maximal incisal opening in millimeters; Pre, preoperative; Post, postoperative; —, not applied.

Note: Significance persisted after Bonferroni correction for multiple testing.

^a Intragroup comparisons.

^b Intergroup comparisons.

ankylosis surgical management, we, as in some studies,^{3,15,29} adopted the temporoparietal facial flap as the interpositional material of choice because of the following features: autogenous tissue with adequate blood supply, proximity to the TMJ, and resilience.^{3,15,29} In addition, reconstruction of the ramus height with costochondral grafts fixed to the mandibular ramus with titanium miniplates combined with interpositional arthroplasty^{6,16} has also been performed in our TMJ ankylosis patients with a short mandibular ramus.

In this context, recent meta-analyses^{24–26} evaluating the clinical outcomes for various TMJ ankylosis surgical approaches (e.g., gap arthroplasty, interpositional arthroplasty, total reconstruction arthroplasty) were in favor of interpositional arthroplasty. However, data on the Matthews device arthroplasty were not compiled in these evidence-based reports.^{24–26} Interestingly, the data on this particular device have been scarce,^{11,18} although the results reported by the UCLA group¹¹ using the Matthews device arthroplasty are encouraging.

In 2008, Dr Matthews visited our center and operated on an adult patient with Pruzansky III craniofacial microsomia previously operated by Dr Paul Tessier, and who developed a TMJ ankylosis refractory to successive operations by our group. The surgical devices were donated by Matthews and since then, our group has applied the Matthews arthroplasty in the TMJ ankylosis surgical management. Before 2007, our patients with TMJ ankylosis were systematically treated with interpositional arthroplasty with autogenous tissue. As the Matthews device arthroplasty data are scarce^{11,18} and interpositional arthroplasty appears to produce the best results in evidence-based reports,^{24–26} we assessed our surgical outcomes using both TMJ ankylosis surgical procedures.

Our intragroup comparisons showed that the interpositional arthroplasty with autogenous tissue and the Matthews device arthroplasty were successful in increasing MIO at postoperative evaluations, whereas the intergroup comparisons showed that both TMJ ankylosis surgical

procedures present similar MIO measurements at 4–6 weeks postoperatively, with no significant difference in length of hospital stay and complication rate. In addition, our initial hypothesis proved right as the Matthews device arthroplasty had significantly higher MIO at 1 and 3 years postoperatively, with significantly lower relapse and reoperation rates. The Matthews device allows TMJ motion by the hinged device arm while maintaining the surgically created TMJ space during physical therapy in the postoperative period, allowing for “pseudo-joint” formation and prevention of reankylosis.¹¹

This “pseudo-joint” formation hypothesis is based on the transport distraction osteogenesis for TMJ reconstruction literature.^{30,31} In transport distraction osteogenesis, the fibrocartilaginous cap that develops on the leading edge of the mandibular segment obtained following osteotomy (the transport disk) acts as a “neocondyle” as it comes into contact with the reshaped glenoid fossa.^{30–32} In the Matthews device arthroplasty literature,^{11,18} there is no formal evidence for the formation of a “neocondyle” or “pseudo-joint” (collagenous or fibrous structure) over the edge of the mandibular ramus. Therefore, further research with computed tomographic and magnetic resonance imaging scans should be carried out to confirm this assumption, namely the formation of a “pseudo-joint” structure.

We and other groups^{2–17} evaluated the MIO after different surgical approaches. The UCLA group¹¹ achieved similar initial (6 weeks) MIO measurements, with differences in the late (~1 year) postoperative MIO data. We also showed similar trends and include a longer follow-up (3 years) period. In this context, it is important to recognize that there are limitations in the comparative discussion among the results obtained in different studies,^{2–17,24–26,29} because the types of surgical techniques adopted in TMJ ankylosis surgical treatments, the types of TMJ ankylosis, the postoperative times, and the methodologies adopted (if used) to evaluate outcomes vary widely. Therefore, the differences between our postoperative MIO measurements and the MIO data reported in other studies can probably be

explained by some of these differences. In addition, in the UCLA experience,¹¹ mainly pediatric patients with bilateral, congenital, and skeletal ankylosis of the TMJ, who underwent the transport distraction osteogenesis or the Matthews device arthroplasty, were evaluated. We analyzed the results of the interpositional arthroplasty versus the Matthews device arthroplasty in a particular subset of TMJ ankylosis patients composed primarily of adults with unilateral, congenital, intracapsular, and skeletal ankylosis and who underwent previous unsuccessful TMJ ankylosis surgical treatment. Therefore, our data are complementary to those previously presented ones,¹¹ because we show that the interesting device delineated by the Dr Matthews is also effective in the management of difficult and challenging patients with prior unsuccessful attempts to correct the TMJ ankylosis.

The importance of immediate and continuous postoperative physiotherapy as a key element in the success of TMJ ankylosis management is noteworthy.^{6,10,11,13,16} Besides the reduction in the rate of reankylosis, vigorous immediate postoperative mouth opening exercises helped the patients regain or exceed the MIO measurements recorded intraoperatively.^{6,10,11,13,16} As in previous reports,^{6,10,11,13,16} our patients received the same orientations and were rigorously evaluated at predetermined postoperative periods. Therefore, we believe that the variable physiotherapy was not a confounding factor in the results, although we cannot quantify the actual patient compliance with rigorous mouth opening physiotherapy process carried out outside the hospital (i.e., at home).

Potential caveats of our study should be addressed. We did not adopt advanced technologies (e.g., computer-assisted templates, and computerized navigation systems, which allow preoperative simulation and intraoperative visualization)^{33,34} in the TMJ ankylosis management that can potentially affect the surgical results, although our surgical approach was grounded in previously published cohorts.^{2,6,10,11,15,16} In addition, it is important to confirm that our data are restricted to a subpopulation of TMJ ankylosis patients, and any generalizations must be cautioned. We also have not included a comparative analysis with other surgical approaches such as transport distraction osteogenesis and total reconstruction arthroplasty. Although MIO has been considered the main indicator of the success of the TMJ ankylosis surgery, it is also significant to recognize the limitations of the variable (i.e., MIO) adopted for the characterization of our and previous^{2–17} surgical results. As MIO measurements assess the surgical results at a specific time (static evaluation), and TMJ ankylosis can be progressive (dynamic process),^{1,23} our and other^{2–17} results may change as the time of postoperative follow-up increases. Thus, our patients have been regularly monitored, because of risks of relapse and the need for additional TMJ surgical interventions. Further longitudinal research may confront or confirm our data and also try to solve these drawbacks.

Conclusion

In this retrospective study, we presented an overview of a single-institution, 13-year experience with surgical

management of TMJ ankylosis and showed that both interpositional arthroplasty with autogenous tissue and Matthews device arthroplasty procedures with intensive postoperative physiotherapy were successful in initial management of TMJ ankylosis. However, the Matthews device arthroplasty showed better long-term results, that is, higher mouth opening and lower relapse. [Figures 1–4](#)

Conflict of interest

None.

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