# ORIGINAL ARTICLE

# Modified condylotomy versus conventional conservative treatment in painful reciprocal clicking—a preliminary prospective study in eight patients

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Abstract Modified condylotomy may be relevant in severe painful reciprocal clicking of the temporomandibular joint (TMJ) where conservative treatment is insufficient. The effect of the modified condylotomy was analyzed and compared with conventional nonsurgical treatment in a randomized pilot study of eight patients, 19-44 years of age, with severe painful reciprocal clicking. Before and after treatment, assessments were performed by subjective reports, clinical recordings, and blinded evaluations of radiography and magnetic resonance imaging (MRI). Based on the clinical evaluations before treatment, all conditions were disc displacements with reduction and arthralgia (Research diagnostic criteria for temporomandibular disorders), but based on MRI, one patient had disc displacement without reduction and another had normal disc position. The treatment effect was significantly better and the disorders were significantly more reduced with condylotomy than with conventional nonsurgical treatment (P < 0.05, Mann–Whitney U test). In the surgical group, the clicking and locking had

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L. Eriksson Department of Oral and Maxillofacial Surgery, University Hospital, Malmö, Sweden disappeared, the pain during function was significantly reduced (P<0.05, Friedman ANOVA), and in two patients the disc position was normalized. The clicking still persisted in the nonsurgical patients and the disc position was unchanged. Our conclusion is that modified condylotomy is a promising option to reduce symptoms and signs in severe painful reciprocal clicking.

Keywords Disc displacement with reduction  $\cdot$ Orofacial pain  $\cdot$  RCT  $\cdot$  Surgery  $\cdot$  TMJ

#### Introduction

The frequency of clicking and popping in the temporomandibular joint (TMJ) is high in the population and a common finding in temporomandibular disorders [10, 19]. Clicking is considered to be associated with disc-interference disorders in the TMJ. There is, however, doubt about the

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A. Wagner Department of Neuroradiology, Copenhagen University Hospital, Copenhagen, Denmark significance of disc position in TMJ joint pathology [25], and in most cases, clicking is not associated with TMJ pain [11]. If TMJ symptoms from disc-interference disorders occur, treatment should be directed at pain management, reduction of inflammation, decrease of adverse joint loading, and restoration of normal range of motion, rather than repositioning the disc [6].

Reciprocal clicking has been recorded clinically in 7% of an adult Scandinavian population [18]. Reciprocal clicking with a click in the first half of the jaw opening and another click shortly before full closure is generally termed disc displacement with reduction (DDR) in the clinic. In addition, according to the Research diagnostic criteria for temporomandibular disorders (RDC/TMD) [8], DDR must also be characterized by at least 5 mm between the clicking during opening and the clicking during closing. It is supposed that the disc in this condition is displaced from its position between the condyle and the eminence to an anterior and medial or lateral position with the teeth in intercuspidation, and that the displacement grows smaller during jaw opening.

The symptoms from DDR are generally weak to moderate and only require reassurance and observation. When untreated, DDR tends to persist [19], and the clicking sound and the maximum jaw opening remain, most often, unchanged [18, 24]. With more severe symptoms and signs, including loud joint sounds and pain on jaw movements, conventional treatment has included intraoral splints, jaw exercises, and nonsteroid anti-inflammatory drugs (NSAID), as well as arthroscopy and surgical procedures [9, 23, 31]. Stabilization splints and NSAID reduce TMJ pain [4], but often, the joint clicking does not change considerably with conservative treatment [28], and arthroscopy and conventional surgical treatments are not always successful [7, 23].

According to Banks [2], all procedures that reduce the interference during movement between condyle and disc are likely to be beneficial for reduction of reciprocal clicking. Because correction with direct surgical intervention of the TMJ is traumatic for the joint structures, an indirect approach may be preferred. Nickerson and Veaco introduced modified condylotomy of the mandible in 1989 [21]. This method differs from conventional condylotomy and should more correctly be described as vertical ramus osteotomy [2, 29]. Postoperatively, the pull from the lateral pterygoid muscle is supposed to place the condyle segment in a more anterior and medial position, allowing the possibility of a reduction of the disc displacement. The intraoral modified condylotomy has been reported to be a safe procedure [14], reducing popping and clicking of the TMJ by 91% and pain by 85% reduction [27]. Similar findings have been observed by Hall et al. [15], Werther et al. [30], and Upton [26]. To our knowledge, the only prospective study on modified condylotomy for treatment of painful temporomandibular TMJ with reducing disc displacement has shown a high rate of favorable outcome, but no kind of control was included in the design [13].

The aim of our preliminary study was to compare the effect of modified condylotomy with conventional conservative treatment of painful reciprocal TMJ clicking in a randomized, controlled design. The study was approved by the scientific, ethical committee for Copenhagen and Frederiksberg (No. 03-002/00).

# Patients and methods

#### Patients

Inclusion criteria for the study were (1) reciprocal clicking assessed by palpation and stethoscopic auscultation at less than a 30-mm-opening between the incisors in at least two out of three recordings; (2) present TMJ pain during jaw function above 40 mm on a 100-mm visual analog scale (VAS) with the left endpoint of the scale (0 mm) indicating "no pain during jaw function" and the right endpoint (100 mm) "the worst imaginable pain during jaw function"; (3) no erosions on transpharyngeal or transmaxillary radiographs and normal translation of the condylar head on oblique, lateral transcranial radiographs; and (4) no sign of overgrowth of condylar heads or jaw asymmetry on orthopantomographic radiographs. Exclusion criteria were (1) age less than 18 years, (2) systemic joint conditions, and (3) diseases and conditions that could implicate contraindications for ethical reasons or towards methods and treatments used in the study.

Eight consecutive patients, three males and five females, 19–44 years of age, referred for treatment to the School of Dentistry, University of Copenhagen, were included in the preliminary study. Each patient had a long-lasting, severe unilateral painful reciprocal clicking of the TMJ and participated after written, informed consent was obtained (Table 1). The patients were randomly assigned to either treatment with modified condylotomy or conventional, conservative treatment, but they were promised that they could try the other treatment modality afterwards if needed.

At admittance, seven right TMJs and one left TMJ in the eight patients were diagnosed clinically as both DDR (IIa) and arthralgia (IIIa), according to the RDC/TMD [8]. The contralateral TMJs were classified clinically as nonpainful disc displacements with reduction (IIa) in two of the patients having modified condylotomy and in one having conservative treatment. The rest had no clinical diagnosis. No parafunctional behavior was reported, and the patients had complete dental arches (number of teeth present; M 28.3, SD 2.4) without significant malocclusion and occlusal

	Duration of TMJ	Clicking	Clicking	Intermitter	nt locking c	of the jaw	MRI diagr	losis	MRI reduction of disc	Radiographic	Radiographic
	clicking (months) at stage 1: before treatment	present at stage 2: after treatment	present at stage 3: after treatment	Stage 1: before treatment	Stage 2: after treatment	Stage 3: after treatment	Stage 1: before treatment	Stage 2: after treatment	displacement atter treatment: stage 2 vs stage 1	condylar appearance at stage 1: before treatment	changes in maximum condylar translation after treatment: stage 2 vs stage 1
Modified condylotor	ny										
Male, 44 years	132	Z	Z	Z	Z	Z	DDNR	DDNR	N	Slight deviations <sup>a</sup>	-1 mm
Male, 24 years	60	Z	Z	Z	Z	Z	DDR	Normal	Υ	Normal	-1 mm
Female, 40 years	60	Z	Z	Υ	Z	Z	DDR	Normal	Υ	Normal	-5 mm
Female, 19 years	70	Z	Z	Υ	Z	Z	DDR	DDNR	Ν	Normal	9 mm
Conservative treatm	ant										
Female, 42 years	120	Υ	I	Υ	Υ	Ι	DDR	DDR	Ν	Normal	3 mm
Male, 27 years	36	Υ	I	Υ	Υ	I	DDR	DDR	N	Normal	12 mm
Female, 29 years	18	Υ	I	Υ	Z	Ι	DDR	DDR	Ν	Normal	0 mm
Female, 44 years	360	Υ	I	Z	Z	Ι	Normal	Normal	Ν	Normal	2 mm

support on premolars and molars (number of posterior teeth with occlusal contact: M 15.8, SD 2.3). Clinical recording, radiography, and magnetic resonance (MR) scanning were performed shortly before (stage 1) and approximately 1/2 year after treatment (stage 2). The patients with modified condylotomy were also reexamined clinically 1 year after surgery (stage 3). No systematic recalls were performed in patients with conservative treatment.

# Methods

# Treatment

Slight flattening before treatment and small erosion after treatment

Unilateral intraoral modified condylotomy [15] with additional modification according to Hall [12] was performed under general anesthesia in the Department of Oral and Maxillofacial Surgery, Copenhagen University Hospital (author LE and SH). No complications occurred during surgery. Postoperatively, the patients had an intermaxillary fixation with elastics sustained for 2 weeks, and the following 2 weeks, soft diet was prescribed. Benzyl penicillin sodium (Leo Pharma Nordic, Malmö, Sweden) 3 g intravenously ×3 and Betametason (Betapred; Swedish Orphan, Stockholm, Sweden) 4 mg intravenously ×3 were administered on the day of surgery, and 2 mg Betametason ×3 was administered intravenously the following day as antibiotic coverage. NSAID and paracetamol were used postoperatively for pain as needed during the first week.

Conventional, conservative treatment for a period of 2 months was administered at the School of Dentistry (author NMT). It consisted of a combination of the use of an intraoral flat-plane stabilization splint at night, retruded jaw opening exercises,  $20 \times 2$  daily, NSAID (Brufen, ibuprofen; Abbott, Gentofte, Denmark), 400 g ×3 daily, and control visits including splint correction after 1 week, 3 weeks, and 2 months.

# Subjective assessment and clinical recording

Before (stage 1) and after (stage 2) the treatments, all patients were seen at the School of Dentistry (author MB). In addition, the patients in the surgical group were seen at stage 3, 1 year after the condylotomy to confirm the status after treatment. The patients rated the intensity of their TMJ disorder on a scale from 0 (no disorder) to 3 (severe disorder). The experienced severity of TMJ clicking and the intensity of TMJ pain during jaw function and pain with the jaw at rest were marked by the patient on VASs, with the left endpoint (0 mm) indicating freedom from symptoms and the right endpoint (100 mm) indicating the worst imaginable symptoms. After treatment (stages 2 and 3), the patient also rated the experienced overall treatment result on a scale (0=free of symptoms, 1=marked improvement,

2=slight improvement, 3=unchanged, 4=slight aggravation, 5=marked aggravation).

Maximum unassisted jaw opening, jaw opening at clicking, and laterotrusion of the jaw were measured at the central incisors as the largest of three measurements, taking the overbite and the deviation of the midline into account. Pressure pain threshold of the TMJ was measured with an electronic algometer (soft rubber tip  $0.5 \text{ cm}^2$ , application rate 20 kPa/s; Somedic, Sollentuna, Sweden) applied to the lateral pole of the condyle. Three measurements were made at each site with 1-min intervals between trials. An acetate template with markings and a label fixed on the skin over the TMJs ensured precise relocation of the algometer between stages and trials. The pain threshold was calculated as the mean of the last two trials. Tenderness by palpation was scored on a scale from  $0^{\circ}$  (no tenderness) to 3° (strong tenderness) based on verbal report and reflex responses [16]. Maximum unilateral bite force was recorded (miniature bite-force recorder; Kleven, Oslo, Norway) unilaterally at first molars during clenching [1]. Four biteforce measurements were made on each side, and the molar bite force was assessed as the mean of the last three trials from both sides.

## MR imaging

Bilateral TMJ imaging (Siemens Magnetom Vision, 1.5 Tesla; Siemens, Erlangen, Germany) was performed with a TMJ surface coil at stages 1 and 2 in the Department of Neuroradiology, Copenhagen University Hospital (author AAW). Images were taken with the teeth in maximal contact (intercuspal position) and during maximum opening supported with a bite block. The examination included sagittal and coronal imaging of the TMJ with closed mouth and sagittal images with open mouth. Sagittal sections were orientated perpendicular to the long axis of the condyle, and coronal sections were taken in parallel to the long axis. Proton density and T2-weighted images were acquired using a double-echo turbo spin-echo sequence (TE=17/119 ms, TR=1800, turbo factor=7, FOV=160×160 mm<sup>2</sup>, matrix=  $255 \times 512$ , and slice thickness=3 mm). Each sequence yielded 8-10 sections.

The examinations were interpreted blindly with respect to treatment modality (author AP) according to Dworkin and LeResche [8]. On the images of the TMJ with closed mouth, the disc position was classified as superior, i.e., normal (the posterior band of the disc was superior to the condyle, or the central thin zone of the disc was located between the anterior prominence of the condyle and the posterior aspect of the articular eminence), or as anteriorly displaced (the posterior band of the disc was located clearly anterior to the 12:00 position or at least at the 11:30 position). In addition, the disc displacement was classified on the sagittal images with open mouth as disc displacement without reduction (DDNR, the posterior band remained clearly anterior to the 12:00 position) or with reduction (DDR, the disc reduces to a superior position on opening).

#### Radiographic imaging

The examination at stages 1 and 2 was performed at the School of Dentistry. It consisted of conventional oblique, lateral transcranial radiographs (Siemens Orbix; Siemens, Erlangen, Germany) taken with the mouth closed and the teeth in the intercuspal position and during maximum jaw opening. Changes in the maximum translation of the condylar head were assessed blindly with respect to treatment modality (author IS) by comparison of the radiographs from stages 1 and 2.

### Statistical analysis

The data were analyzed with conventional statistical methods (Statistica, version 5.0; StatSoft, Tulsa, OK, USA) and reported as mean and SD. Differences between measurements in patients with conventional conservative treatment and patients with surgery were analyzed with the Mann–Whitney U test. Differences within treatment groups were analyzed with Friedman ANOVA (modified condylotomy; stages 1, 2 and 3) and Wilcoxon matched pairs test (conservative treatment; stages 1 and 2). Statistical significance was accepted at P < 0.05.

## Results

In all patients treated for painful reciprocal clicking, the condition at admittance was characterized clinically as RDC/TMD DDR (IIa) and arthralgia (IIIa). However, based on the information obtained from the magnetic resonance imaging (MRI) and the radiographs, the diagnosis of one patient in the surgical group (male, 44 years old) was DDNR with slight osseous remodeling. In one patient in the nonsurgical group (female, 44 years old), the disc position was classified as normal (Table 1). In the contralateral TMJs classified as DDR, the clinical classification coincided with the information from the MRI. However, in three more contralateral joints without clinical diagnoses, the discs were anteriorly displaced assessed from the MRI.

The painful reciprocal clicking disappeared after treatment in all patients in the surgical group but in none of the patients in the nonsurgical group (Table 1). Accordingly, the subjective assessments of the severity of the TMJ disorder and the clicking and the intensity of the pain during jaw function decreased significantly in the surgical group (Table 2). The posttreatment ratings of treatment

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**Table 2** TMJ pain and disorder in eight patients with painful and severe reciprocal clicking before treatment (stage 1), and 1/2 year (stage 2) and 1 year (stage 3) after surgical treatment or 1/2 year (stage 2) after conventional, conservative treatment

Mean (SD)	Treatments						
	Modified condylotomy (n=4)			Conservative treatment $(n=4)$			
	Stage 1: before treatment	Stage 2: after treatment	Stage 3: after treatment	Stage 1: before treatment	Stage 2: after treatment		
Global subjective assessment of treatment result (0–5)	_	0.3 (0.5) <sup>a</sup>	0.5 (0.6) <sup>a</sup>	_	2.8 (0.5)		
Global subjective assessment of TMJ disorder (0–3)	2.8 (0.5) <sup>b</sup>	$0.8 (0.5)^{a}$	0.5 (0.6) <sup>a</sup>	2.8 (0.5)	2.0 (0.0)		
Subjective assessment of TMJ clicking (VAS 0–100)	83.0 (17.4) <sup>b</sup>	0.8 (1.5) <sup>a</sup>	$0.0 (0.0)^{a}$	82.3 (10.0)	73.3 (14.9)		
TMJ pain during jaw function (VAS 0–100)	63.0 (14.3) <sup>b</sup>	17.5 (21.8)	5.5 (11.0)	70.3 (7.4)	37.3 (31.9)		
TMJ pain with the jaw at rest (VAS 0–100)	6.8 (7.8)	1.0 (2.0)	0.0 (0.0)	21.8 (24.0)	12.8 (15.9)		
Ipsilateral TMJ algometry (kPa)	107.3 (64.4)	121.3 (61.0)	199.3 (92.7)	95.5 (47.2)	114.3 (51.9)		
Tenderness by ipsilateral TMJ palpation (0–3)	1.5 (1.0)	0.8 (1.5)	0.0 (0.0)	2.3 (0.5)	1.0 (1.2)		

Dashes represent no data before treatment.

<sup>a</sup> Significantly different from values after conventional conservative treatment (P<0.05; Mann–Whitney U test). No significant differences of values before treatment (stage 1) between the surgical and nonsurgical groups (Mann–Whitney U test)

<sup>b</sup> Significant differences among stages of modified condylotomy (P < 0.05; Friedman ANOVA); no significant differences between stages of conservative treatment (Wilcoxon matched pairs test)

results, severity of disorder, and clicking were also significantly lower after condylotomy than the ratings in the nonsurgical group even if the corresponding assessments before treatment (stage 1) did not differ (Table 2). No significant changes were recorded in the group with conservative treatment, as the recordings from patient to patient varied a great deal (Table 2). In both groups, there was little TMJ pain with the jaw at rest and it did not change significantly with treatment (Table 2). Also, the clinical recordings with algometry and palpation did not decrease significantly or differed significantly between treatment modalities (Table 2). The surgical and nonsurgical groups did not change or differ significantly with respect to jaw function in terms of bite force (Table 3).

In the patients who had the modified condylotomy, not only the clicking but also the intermittent locking of the jaw disappeared. However, according to the MRI, the disc position was only normalized or completely "recaptured" in two of the four patients (Table 1). No normalization was present in MRI of the contralateral joints. After treatment, small changes were recorded in the surgical group in jaw opening movement and laterotrusion. The values were significantly lower compared to the nonsurgical group (Table 3) but still within normal range of motion. With conservative treatment, the clicking persisted and the disc position was unchanged. However, the jaw opening distance corresponding to the opening and to the closing click tended to increase on an average with about 6 mm from stage 1 to stage 2 (Table 3).

No permanent side effects like sensory or occlusal changes were noted 1/2 and 1 year postoperatively. One patient in the surgical group (male, 24 years old) and one patient in the nonsurgical group (female, 42 years old) accepted the offer to have the alternative treatment modality afterwards as promised before the randomization. The male wanted treatment for minor residual TMJ pain and the female for persisting intermittent locking of the jaw.

## Discussion

The purpose of this prospective pilot study was to compare surgical and nonsurgical treatment of painful reciprocal TMJ clicking. We realize that, due to the limited number of participants in each group, conclusions should be drawn with caution. However, it was notable that clicking was eliminated in the surgical group, whereas it persisted in the nonsurgical group. Also, the pain during function was significantly reduced after modified condylotomy, whereas the reduction was insignificant in the nonsurgical group.

The self-report of the patients having surgical intervention also showed that their TMJ condition improved significantly better than the patients who had conservative treatment, i.e., the same positive effect from modified

Mean (SD)	Treatments						
	Modified condylotomy ( <i>n</i> =4)			Conservative treatment $(n=4)$			
	Stage 1: before treatment	Stage 2: after treatment	Stage 3: after treatment	Stage 1: before treatment	Stage 2: after treatment		
Maximum active jaw opening capacity (mm)	51.5 (2.5) <sup>a</sup>	43.5 (4.7) <sup>b</sup>	45.8 (5.0)	51.0 (1.4)	51.8 (2.2)		
Jaw opening distance at opening click (mm)	15.0 (8.9)	Ν	Ν	16.8 (7.5)	23.0 (5.4)		
Jaw opening distance at closing click (mm)	6.5 (3.9)	Ν	Ν	6.8 (1.9)	12.5 (4.5)		
Ipsilateral jaw laterotrusion (mm)	7.8 (2.2)	7.8 (1.7) <sup>b</sup>	9.5 (1.0) <sup>b</sup>	10.5 (2.4)	11.5 (1.0)		
Contralateral jaw laterotrusion (mm)	8.5 (2.4)	8.5 (2.1)	9.3 (2.2)	11.3 (1.5)	11.3 (1.7)		
Maximum unilateral bite force (N)	342.3 (85.0)	322.5 (112.0)	323 (172.3)	317.5 (49.1)	284.5 (115.9)		

**Table 3** Jaw function in eight patients with painful and severe reciprocal clicking before treatment (stage 1), and 1/2 year (stage 2) and 1 year (stage 3) after surgical treatment or 1/2 year (stage 2) after conventional conservative treatment

N no clicking after treatment

<sup>a</sup> Significant differences among stages of modified condylotomy (P<0.05; Friedman ANOVA); no significant differences between stages of conservative treatment (Wilcoxon Matched pairs test)

<sup>b</sup> Significantly different from values after conventional conservative treatment (P<0.05; Mann–Whitney U test). No significant differences of values before treatment (stage 1) between the surgical and nonsurgical groups (Mann–Whitney U test)

condylotomy as reported by Upton and Sullivan [27]. Generally, TMJ structures show large variation, and different loading may alter morphology and produce disc hesitation and stretching of the attachments, as well as TMJ sounds [5, 20]. Disc-interference disorders also involve inflammation, changes in the articular surfaces, alteration in joint pressures and synovial fluid, and production of a variety of biochemical substances causing TMJ pain. Probably the surgical intervention, as a consequence of possible positional changes of the condylar segment, also changed the loading of the disc and the attachments and reduced the interference between condyle and disc during movement [2] and, thus, the potential for clicking and joint inflammation.

The clinical recordings of the symptoms and function of the TMJ and the disc position imaged in the MR scanning did not necessarily coincide. Although reciprocal TMJ clicking and associated pain were the inclusion criteria, the disc position on the pretreatment MR scanning (stage 1) varied between the patients from normal position to reducing (DDR) and nonreducing (DDNR) displaced discs. Rammelsberg et al. [22] only found DDR in 81% of the patients with reciprocal clicking, and DDR has also been found in MR scanning in 25% of asymptomatic subjects [17]. This apparent paradox may be due to internal derangement being a much more complicated process than simply a displaced disc [7]. However, the main issue of the study was to analyze the effect of treatment on a severe and painful TMJ condition, not disc positions on the MRI.

The conservative treatment had no influence on the presence of TMJ clicking and on the disc position in the posttreatment MR scanning (stage 2), even if the jaw opening distance at the opening click tended to increase in association with the jaw exercises. In the patient group with surgical intervention, all TMJ clicking was eliminated postoperatively (stage 2). However, despite the same elimination of the TMJ clicking and the improved TMJ condition, the position of the discs in the surgical group varied between normal and displaced without reduction (DDNR) in the postoperative MR scanning (stage 2), i.e., the same disparities between clinical observations and MR scanning as observed before treatment. Based on the MR scanning, the displacement of the discs was reduced in 50% corresponding with the 50-80% reduction reported after condylotomy of symptomatic TMJs [3, 30]. In conclusion, our preliminary study suggests that modified condylotomy is a promising option to reduce symptoms and clinical signs in reciprocal TMJ clicking, and with severe painful clicking far better than conventional conservative treatment.

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