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Evaluation of surgical treatment in mandibular condyle fractures

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ABSTRACT

Aim: In the past, fractures of the mandibular condylar process were, as a rule, treated conservatively. At the Department of Maxillofacial and Oral Surgery of the University Medical Centre Ljubljana, Slovenia, our doctrine was changed in 2002 on the basis of preliminary results and reports in the literature, and these fractures were started to be treated surgically by open reduction and internal fixation with miniplates and screws, which led to good results and a shorter rehabilitation period. The goal of this study was to determine the safety and efficiency of surgical treatment, as well as to compare long-term results of surgical and conservative treatment, as objectively as possible.

Patients and methods: Two groups of patients, which had all sustained a unilateral, extra-articular mandibular condyle fracture, were compared. In the test group, there were 42 surgically treated patients, and in the control group, 20 conservatively treated patients. Clinical parameters and X-ray images were assessed in both groups and compared by the two tailed Student *t* test, and in case of attributive variables by the χ^2 test. Within the surgically treated group, postoperative and intraoperative complications were noted: temporary facial nerve palsy, development of a parotid salivary fistula, disturbance of auricle sensibility due to injury of the greater auricular nerve, miniplate fracture, as well as intraoperative bleeding, postoperative haematoma formation, infection, reoperation due to fragment malposition and other complications. Postoperative scars were also assessed.

Results: Statistically significant differences between the surgically and conservatively treated patients were found when comparing clinical parameters as well as X-ray images, the results being better in the surgically treated group. Complications of surgical treatment were also noted, the most important among them temporary paresis of facial nerve branches, which occurred in 10 patients (24%). Plate fractures occurred in five patients (12%), in four of them miniplates of sizes less than 2.0 mm were used. There were no cases of significant intraoperative bleeding, two cases (5%) required drainage of postoperative haematomas, and one patient (2%) experienced a mild postoperative infection, which was easily controlled with amoxicillin with clavulanic acid. The scar was hidden best if a facelift incision was used, and a hypertrophic scar developed in only one patient (2%).

Conclusion: Results of surgical treatment of condylar process fractures are superior to the results of conservative treatment, and the procedure is safe with the transparotid surgical approach and adequate surgical technique.

1. Introduction

There is still much debate about the best mode of treatment of fractures of the mandibular condylar process, although in the past decade the number of proponents of surgical treatment has been steadily increasing (Zide and Kent, 1983; Dahlström et al., 1989; Takenoshita et al., 1990; Konstantinović and Dimitrijević, 1992; Hayward and Scott, 1993; Eckelt and Rasse, 1995; Brandt and Haug, 2003; Vesnaver et al., 2005). In this Journal, the majority of papers in the last 5-year period (2006–2011) have discussed and favoured surgical treatment of condylar fractures (Eckelt et al., 2006; Biglioli and Colletti, 2008; Parascandolo et al., 2010; Meyer et al., 2008; Eckelt, 2006; Schneider et al., 2007) over conservative treatment (Zacharides et al., 2006).

At the Department of Maxillofacial and Oral Surgery of the University Medical Centre Ljubljana, Slovenia, as well as at other institutions worldwide, conservative treatment used to be the gold

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standard. In 2000, following reports and techniques described in the literature, we started treating our first patients surgically (Eckelt and Rasse, 1995; Ellis and Zide, 1995a, 1995b; Anastassov et al., 1997; Choi and Yoo, 1999). As the preliminary results were good, our doctrine was changed in 2002, and these fractures started to be treated surgically: the fracture was approached through a periauricular or retromandibular incision, reduced under direct vision, and internally fixated with miniplates and screws, which led to good results and a shorter rehabilitation period (Vesnaver et al., 2005).

After performing routine surgical treatment of mandibular condyle fractures for several years, a retrospective study was performed to compare long-term results of surgical and conservative treatment, as well as to determine the safety and efficiency of surgical treatment, as objectively as possible.

2. Patients and methods

Two groups of patients, who had all sustained a unilateral, displaced, extra-articular mandibular condyle fracture, were compared. The test group was treated surgically, and the control group, conservatively. None of the patients were younger than 14 years, they were all treated as inpatients, and in all of them, at least 2 years had passed since injury and treatment.

In the 5-year period from the beginning of 2002 until the end of 2006, 146 patients with condylar fractures were treated as inpatients at our Department in Ljubljana. The total number of condylar fractures was 179, with 33 patients (18.4%) having bilateral fractures. Of the 179 fractures, 118 (65.9%) were treated surgically, and 61 (34.1%) conservatively.

After eliminating bilateral, diacapitular (intra-articular), and conservatively treated patients, 69 consecutive patients remained that were surgically treated for unilateral, displaced, extra-articular mandibular condyle fractures in the 2002–2006 period. Of the 69 patients, 42 (61%) came in for examination after receiving the invitation, and they made up the test group. There were 15 female (36%) and 27 male (64%) patients, aged between 14 and 72 years, average 34.6 years. According to the SORG 2004 classification (Loukota et al., 2005), 11 (26%) cases were condylar neck fractures, with five being right-sided and six left-sided, and 31 (74%) were subcondylar fractures, with 15 being right-sided and 16 left-sided. In eight cases (19%), the fractures were of the dislocated (luxative) type.

In the control group, patients with the same type of fractures, treated in the 10-year period from 1997 until 2006, were included. In the hospital record books, a total of 40 consecutive patients meeting the aforementioned criteria were found, and 20 (50%) came in for examination after receiving the invitation, forming the control group. There were eight female (40%) and 12 male (60%) patients, aged between 14 and 80 years, average 34.4 years. There were 11 (55%) cases of condylar neck fractures, with six being right-sided and five left-sided, and nine (45%) were subcondylar fractures, with three being right-sided and six left-sided. In seven cases (35%), the fractures were of the dislocated type.

In surgically treated patients, the skin incision was periauricular or retromandibular, and a skin flap was elevated in the subcutaneous plane. The SMAS and parotid capsule were incised anteriorly from and parallel to the posterior rim of the ramus, branches of the facial nerve were identified, dissected and retracted out of the way. Masseter muscle fibres were then separated longitudinally and the fracture exposed. After reduction, the fracture was fixated with two straight miniplates or one trapezoid miniplate and screws. Postoperatively, patients were placed on a soft diet for 4–6 weeks (Vesnaver et al., 2005).

Initially, the indications for surgical treatment were the following: ramus shortening of more than 5 mm, angulation of the fractured condyle for more than 30°, or no contact between the fragments (Eckelt and Rasse, 1995). After gaining more experience, patients with smaller displacements started to be treated surgically as well (Eckelt et al., 2006).

Conservatively treated patients were given rigid intermaxillary fixation (IMF) for a 2–3-week period, followed by the use of guiding elastics, mouth opening exercises, and a temporary soft diet for 1–4 weeks. In children (not part of this study), orthodontic appliances were also used.

The following clinical parameters were compared between the two groups:

1. Maximal mouth opening – measurements of interincisal distances.
2. Lateral chin deflection upon maximal mouth opening – lateral deflection of inferior dental midline from resting position.
3. Both lateral excursions and mandibular protrusion – maximal voluntary lateral deflections of inferior dental midline from resting position bilaterally and difference between maximal protrusion and resting position of inferior incisors, respectively.
4. Bite forces bilaterally, i.e. on the injured and non-injured side – measured by an electromechanic bite force sensor (Design & manufacture: Janez Rozman, PhD). The bite force sensor was made of a small steel cage ($10 \times 10 \times 5$ mm) with four semiconductive leaflets glued onto its four vertical bars, two on the outer side and two on the inner side of the bars (Fig. 1).

The four leaflets were connected into a full Wheatstone bridge. When vertical load was applied to the cage, the vertical bars bent, with their inner sides contracting and their outer sides stretching, which caused the resistance of the semiconductive leaflets to change: it decreased in the leaflets on the inner side and increased in the ones on the outer side. The equilibrium of the Wheatstone bridge was thus disrupted and voltage appeared, which was linearly proportional to the amount of force used. The steel cage sensor was fixed with silicone into the hollow end of a metal arm and covered with plastic tubing, which enabled the patients to bite into it with no pain. The height of the sensor covered with plastic tubing was 8 mm (Fig. 2).

Three measurements of bite force were made on both sides and the maximal obtained values used in the calculations of bite force asymmetry. In each patient, the difference between the maximal bite forces on the non-fractured and fractured side was calculated (Fcont − Ffx). As the bite force can paradoxically be lower on the non-fractured side, absolute values were taken (ABS(Fcont − Ffx)). As patients' bite forces differ per se, the goal was to obtain the values of bite asymmetry, expressed in percentages. Therefore, the absolute values of bite force differences (ABS(Fcont − Ffx)) were divided by the average of bilateral bite forces (Fcont + Ffx)/2. The whole equation thus equals (ABS(Fcont − Ffx))/((Fcont + Ffx)/2).

5. Assessment of condylar motion symmetry by palpation – preauricular palpation of both TMJs upon mouth opening.
6. Occlusal disturbances – assessment of occlusion by the examiner and by the patient.
7. Pain in the TMJ - subjectively (rest, palpatory, opening, loading) and upon examination (direct palpation, pressure on chin).
8. Pathological phenomena (clicking and crepitation) in the temporomandibular joint – preauricular palpation of both TMJs upon mouth opening.
9. Facial symmetry – patients were photographed en face and the photos analysed. Additionally, the height and lateral protrusion of both mandibular angles was assessed by inspection and palpation.

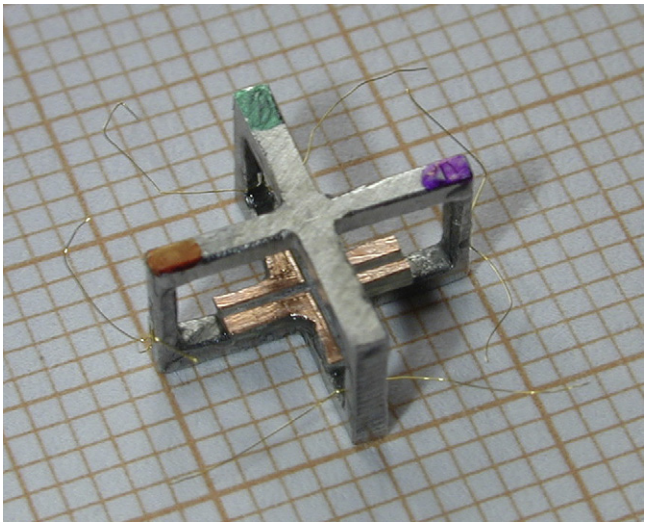


Fig. 1. Bite force sensor photographed on millimetre paper.

Fig. 2. Bite force sensor during measurement.

The use of intermaxillary fixation (IMF) and time frames of therapeutic procedures were also compared, as was also the duration of rehabilitation of chewing.

Orthopantomograms (OPG) and X-ray images were assessed, and the following parameters compared between the groups: shortening of the ramus, condylar angulation in the medial direction or antero-posteriorly, joint space width and the change of condylar translation on the side of injury upon mouth opening (Figs. 3–8). For assessment of condylar rotation and translation, X-rays of TMJs were taken with mouth closed and open and both parameters calculated from the different positions of the condylar head and ramus.

Within the surgically treated group, postoperative and intraoperative complications were noted: temporary facial nerve palsy, development of a parotid salivary fistula, disturbance of auricular sensibility due to injury of the greater auricular nerve, miniplate fracture, as well as intraoperative bleeding, postoperative haematoma formation, infection, reoperation due to fragment malposition and other complications. Postoperative scars were also assessed.

The results of measurements in the groups were compared by the two tailed Student *t* test, and in case of attributive variables by the χ^2 test.

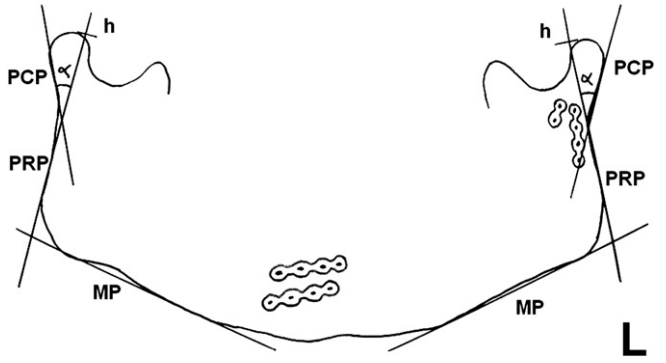


Fig. 3. OPG tracing after surgical treatment of a simple left-sided condylar fracture and symphyseal fracture. Bilateral measurement of ramus height and antero-posterior condylar angulation. h right = 83 mm, h left = 83 mm; α right = 23°, α left = 25°; MP: mandibular plane; PRP: posterior ramus plane; PCP: posterior condyle plane; α: angle between PCP in PRP i.e. between the condyle and ramus; h: total ramus height – measured from the intersection between PRP with MP to top of condylar head.

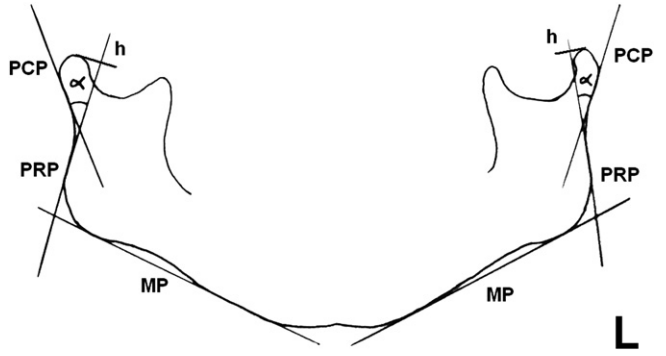


Fig. 4. OPG tracing after conservative treatment of a simple right-sided condylar fracture. Bilateral measurement of ramus height and antero-posterior condylar angulation. h right = 59 mm, h left = 65 mm; α right = 39°, α left = 28°; MP: mandibular plane; PRP: posterior ramus plane; PCP: posterior condyle plane; α: angle between PCP in PRP i.e. between the condyle and ramus; h: total ramus height – measured from the intersection between PRP with MP to top of condylar head.

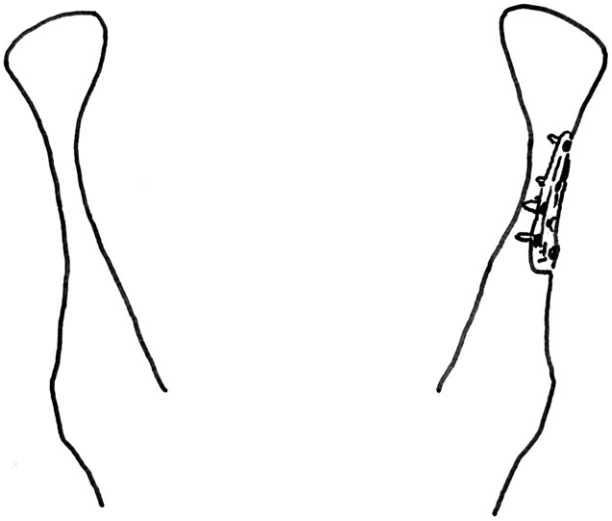


Fig. 5. Towne's view tracing of a surgically treated left-sided simple condyle fracture. The condyle had healed in its anatomic position.

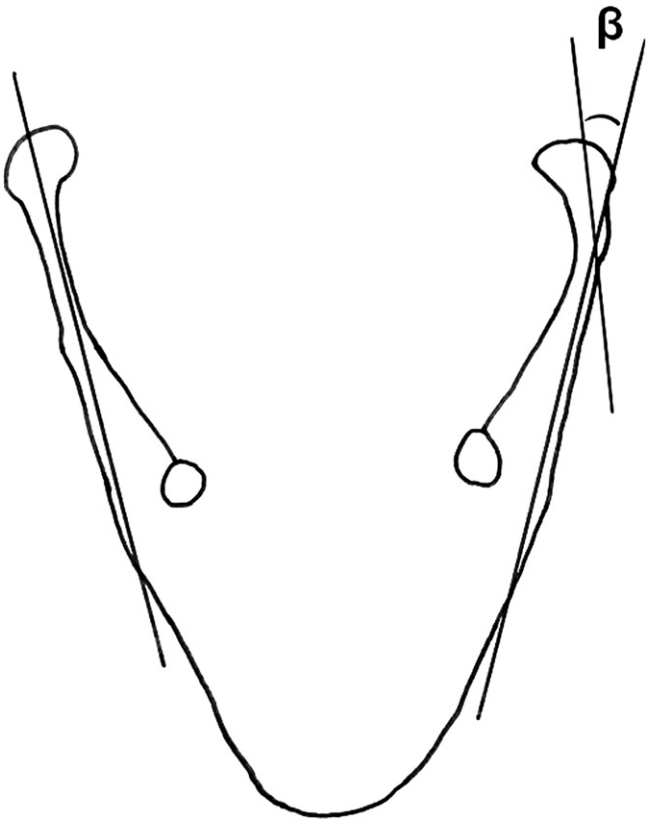


Fig. 6. Towne's view tracing of a conservatively treated left-sided simple condyle fracture. The condyle had healed with a residual medial angulation ($\beta = 20^{\circ}$), and it is obvious it healed to the ramus from the lateral aspect.

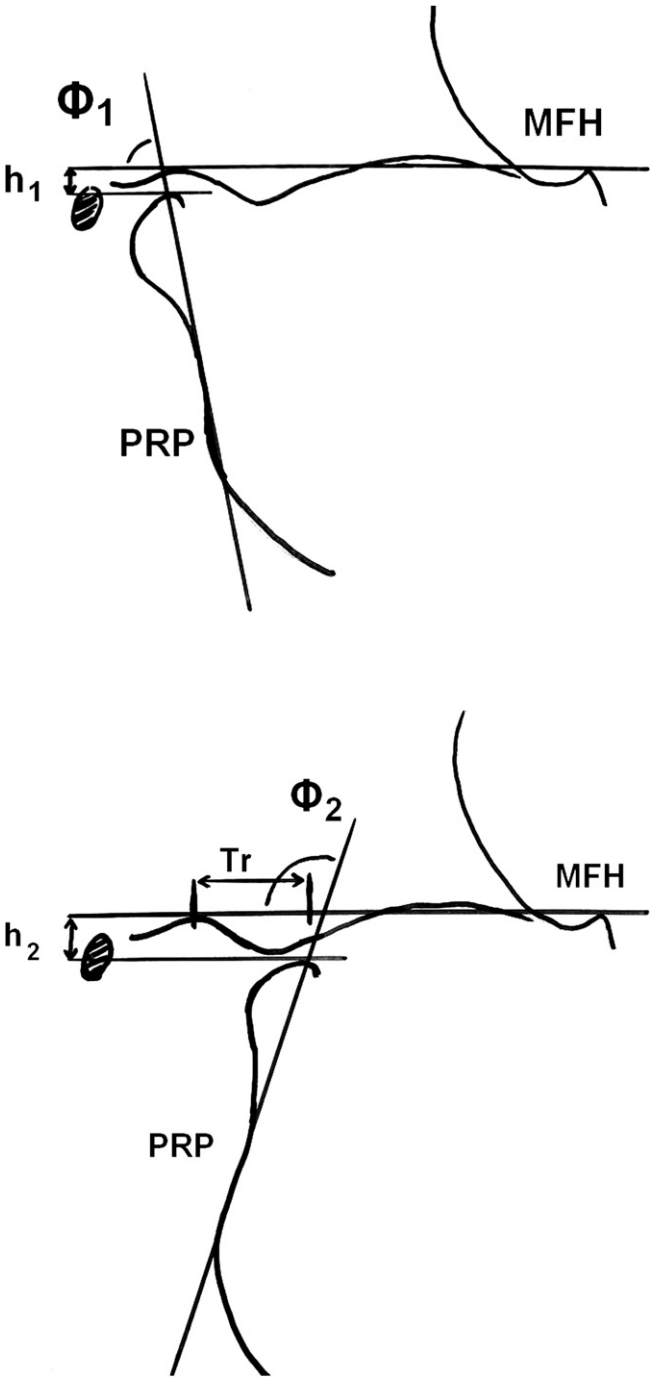
3. Results

Statistically significant differences between surgically and conservatively treated patients were found in most categories, the results being better in the surgically treated group.

There were fewer ipsilateral chin deflections upon mouth opening (surgical treatment 19%, conservative treatment 76%, $p < 0.001$) and of a lesser degree (surg 0.7 mm (SD 1.5 mm), cons 5.1 mm (SD 3.9 mm), $p < 0.001$). Asymmetry of lateral movements was smaller (surg 1.2 mm (SD 2.1 mm), cons 3.8 mm (SD 2.2 mm), $p < 0.001$) and condylar motion, assessed by palpation, was symmetric in a higher percentage of cases (surg 74%, cons 10%, $p < 0.001$) in surgically treated patients. There were less pathological phenomena in the joint upon mouth opening (surg 12%, cons 40%, $p < 0.05$). Differences in maximal mouth opening, however, did not reach the level of statistical significance: in the surgically treated group, average maximal mouth opening was 49.0 mm (SD 5.7 mm), with none of the patients opening less than 40 mm, and in the conservatively treated group, average maximal mouth opening was 47.3 mm (SD 6.2 mm), with two patients opening less than 40 mm.

There were less occlusal disturbances found by the examiner (surg 18%, cons 42%, $p < 0.01$) and reported by the patients (surg 26%, cons 47%, $p < 0.01$), and less facial asymmetries (surg 0%, cons 30%, $p < 0.001$) in the surgically treated group (Fig. 9).

A smaller percentage of patients was being placed into IMF (surg 20%, cons 80%, $p < 0.01$) and for a shorter time period (surg 4.1 days (SD 8.5 days), cons 19.3 days (SD 17.9 days), $p < 0.01$), and rehabilitation of chewing was faster in the surgically treated group (surg 6 weeks (SD 0 weeks), cons 9.5 weeks (SD 5.5 weeks), $p < 0.05$).



Figs. 7 and 8. TMJ X-ray tracing of condyle position with mouth closed (Fig. 7) and mouth open (Fig. 8). Comparing both X rays enables measurements of condylar movement. MFH: modified Frankfurt horizontal plane (top of glenoid fossa – infraorbital rim); PRP: posterior ramus plane; Φ1: angle between PRP and MFH with mouth closed; Φ2: angle between PRP and MFH with mouth open; h1: articular space height – distance between highest point of condylar head and top of glenoid fossa with mouth closed; h2: distance between highest point of condylar head and top of glenoid fossa with mouth open; Tr: translation – distance between condylar head position in mouth open and closed, measured on the MFP; Rotation: difference between Φ2 and Φ1; Downward movement of condylar head: difference between h2 and h1.

Bite force asymmetry between the injured and non-injured side was smaller in the surgically treated group, although the level of statistical significance was only reached in the subgroup of patients with dislocated (luxative) fractures (surg 9.2% (SD 10.4%), cons 48.2% (SD 34.8%), $p < 0.05$).

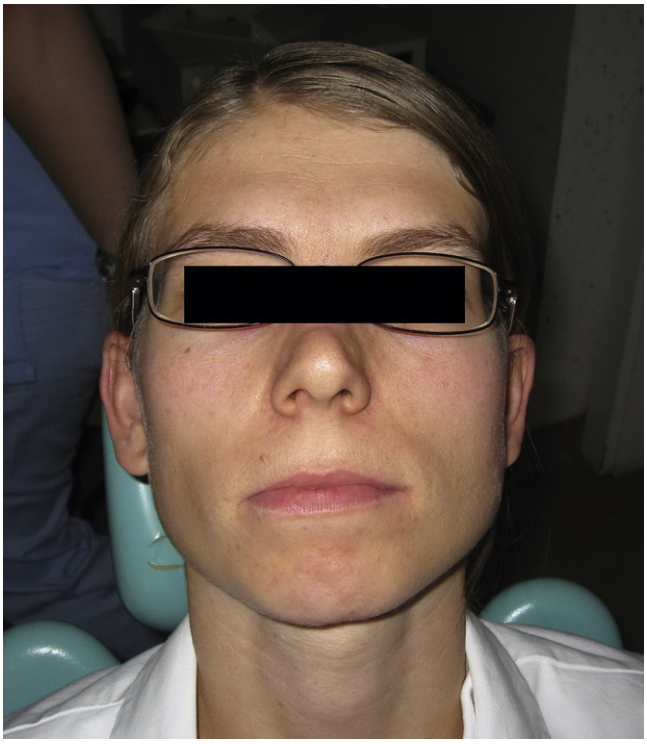


Fig. 9. Facial asymmetry after conservative treatment of a left-sided condylar fracture. Observe a more cranial and lateral position of the mandibular angle and a more cranial position of the left corner of the mouth.

Comparison of joint pain did not show statistically significant differences between the two groups.

X-ray analysis also demonstrated significantly better results in the surgically treated group. There were less cases of ramus shortening (surg 45%, cons 100%, $p < 0.001$), and the ones present were of a lesser degree (surg 1.4 mm (SD 2.0 mm), cons 6.5 mm (SD 2.7 mm), $p < 0.001$). There were less cases of medial angulation of the condyle (surg 26%, cons 100%, $p < 0.001$), and those present were of a lesser degree (surg 3.6° (SD 6.5°), cons 25.2° (SD 18.8°), $p < 0.001$). There were less cases of antero-posterior angulation (surg 74%, cons 100%, $p < 0.05$), and the ones present were of a lesser degree (surg 4.5° (SD 5.0°), cons 12.8° (SD 9.8°), $p < 0.01$). The articular space of the TMJ on the injured side was less widened after surgical treatment (surg 1.4 mm (SD 2.0 mm), cons 5.5 mm (SD 2.0 mm), $p < 0.05$). Translation of the injured condyle was diminished to a smaller extent (surg 1.4 mm (SD 2.0 mm), cons 6.6 mm (SD 5.2 mm), $p < 0.001$), and the rotation of both condyles less asymmetric in surgically treated patients (surg 2.7° (SD 2.8°), cons 5.1° mm (SD 4.4°), $p < 0.05$).

Complications of surgical treatment were also noted: 10 patients (24%) had temporary paresis of facial nerve branches, three (7%) had a transient salivary fistula, five (12%) had temporary, and one (2%) permanent paraesthesia of the greater auricular nerve. Two patients developed Frey's syndrome (5%). Three patients (7%) were reoperated on due to malposition of fragments, all within 4 days of the first operation. Plate fractures occurred in five patients (12%), in four of them miniplates of sizes less than 2.0 mm were used. There were no cases of significant intraoperative bleeding, two cases (5%) required drainage of postoperative haematomas, and one patient (2%) experienced a mild postoperative infection, which was easily controlled with amoxicillin with clavulanic acid. The scar was hidden best if a facelift incision was used, and a hypertrophic scar developed in only one patient (2%).

4. Discussion

As there is as yet still no general consensus about the preferred method of treatment for displaced condylar fractures, a wide range of clinical and radiological parameters was assessed and compared between the surgically and conservatively treated groups of patients (Hyde et al., 2002; Brandt and Haug, 2003; Smets et al., 2003; Eckelt et al., 2006; Zacharides et al., 2006).

The time frames from which surgically and conservatively treated patients were chosen were different (2002–2006 and 1997–2006, respectively). The reason is that after 2002, very few displaced fractures of the condyle were treated conservatively as inpatients, therefore a larger time frame was taken to increase the number of patients in the control group. Despite the larger time frame, the number of patients in the control group is smaller than in the test group. This clearly shows the negligent attitude towards condylar fractures in the past. It was believed they were self-limited, of minor importance and needed only conservative intervention (if at all).

Patients with bilateral fractures, non-displaced fractures and intra-articular fractures were not included in this study, as well as patients who were younger than 14 years at the time of injury. In bilateral fractures, it is much more difficult to assess joint function, as the contralateral side cannot be used for control, as is the case in unilateral fractures. Treatment of non-displaced fractures is not a subject of controversy, as these fractures heal well in the non-displaced position with a soft diet regimen only (Eckelt and Rasse, 1995; Devlin et al., 2002; Hyde et al., 2002; Schneider et al., 2007). At our institution, these patients are never given arch bars, as manipulation during arch bar placement could in fact displace the fracture (Ellis et al., 1999). However, the trend to operate on fractures even with minor displacements is present, as this benefits the patient (Eckelt et al., 2006). Intra-articular fractures are a completely different fracture type, they are approached and also fixed in a different manner than extra-articular fractures (Kermer et al., 1998; Hlawitschka et al., 2005; Vesnaver, 2008). Patients younger than 12 years still have a high remodelling capacity of the condyle, which makes objective assessment of the result of treatment virtually impossible (Takenoshita et al., 1990; Nørholt et al., 1993).

Most clinical measurements demonstrate a clear advantage of surgical treatment, as symmetry of condylar motion is restored much better than after conservative treatment. This obviously has to do with the lateral pterygoid muscle, whose function is restored after osteosynthesis of the condyle (Anastassov et al., 1997; Throckmorton et al., 2004; Ellis and Throckmorton, 2005). The difference in bilateral condylar motion was assessed by palpation and by measurements of chin deflection upon mouth opening, and the results correlate very well. The intra-articular cartilaginous apparatus also recovers better after surgical treatment, demonstrated not only by better movement, but also by less pathological phenomena on mouth opening. Maximal mouth opening, however, did not show significant differences between the groups. This is not surprising, as adaptations occur in both TM joints, with the uninjured joint taking on some work of the injured joint (Ellis and Throckmorton, 2005). As the lateral pterygoid function is diminished on the injured side due to malposition of the condyle, the contralateral lateral pterygoid pulls the condylar head anteriorly more vigorously, thus compensating for the injured side. This unbalance causes the chin to deflect to the injured side upon mouth opening (Silvennoinen et al., 1994).

Better results of surgical treatment were also obvious when assessing static clinical parameters, occlusion and facial symmetry. Changes in occlusion are very difficult to judge, as one practically never has records of pre-injury occlusion (Ellis et al., 2000; Smets et al., 2003). We postulated that prior to injury the same

percentage of patients in both groups had regular occlusion. Therefore, differences in post-traumatic occlusion between the groups were the result of different treatments, and it was proven that surgically treated patients had less occlusal disturbances. Facial symmetry was restored in all patients undergoing surgical treatment, whereas roughly one third of patients treated conservatively had pronounced symmetry disturbances. Interestingly enough, only one of the patients noticed she was asymmetric.

In surgically treated patients, IMF was used much less often and for a substantially shorter time period. The reason for applying postoperative IMF was an ipsilateral open bite, which practically always develops in these patients, and is caused by intra-articular effusion or haematoma. Even without the use of IMF, the open bite resolves spontaneously within 1–2 weeks.

Nowadays, IMF is never used in surgical treatment of fractured condyles at our department for two main reasons. During surgery, IMF cannot be used, as one has to manipulate the lower jaw to reduce the fracture. Postoperatively, IMF is completely unnecessary and potentially harmful, as it is beneficial for the patient not to be immobilised, but to start moving the TMJ as soon as possible (Satler and Oglivie-Harris, 1979; Kermer et al., 1998; Palmieri et al., 1999; Hyde et al., 2002). Forces that are great enough to fracture the condyle always cause a certain amount of intra-articular damage as well, and if such a joint is immobilised, permanent mobility restrictions can result. Instead, patients are encouraged to perform mouth opening exercises from the first postoperative day onwards: opening in the midline in front of the mirror with fingertips on both joints, as well as forced opening with the index and middle fingers of one hand on the lower teeth, and the thumb of the other hand on the upper teeth.

Rapid mouth opening exercises and no immobilisation were the reason for a shorter period of chewing rehabilitation in surgically treated patients. None of them experienced difficulties after the standard 6-week period of postoperative soft food diet. On the contrary, many conservatively treated patients had difficulties with chewing for several months.

X-ray analysis confirmed the superiority of surgical treatment obtained by clinical measurements. The position of the condyle and ramus height were better preserved, as was also condyle mobility (rotation and translation) upon mouth opening. Moreover, X-ray measurements were also in good correlation with clinical measurements. X-ray analysis would have been even more objective if CT or cone-beam CT (CBCT) images were made and analysed.

Of all the complications of condylar surgery, injury to the facial nerve branches with resulting palsy is the one most feared by surgeons. In our series, the percentage of temporary postoperative facial nerve palsies was quite high, but comparable to other studies (Ellis and Simon, 2000). It has to be stressed though, that all, even the slightest and very discrete palsies were recorded, and that all of them were temporary. Nerve injury occurred because of retraction of branches during surgery, as there was no case of accidental nerve branch transection. Therefore, injury must have occurred due to neuropraxia or axonotmesis, which also explains good recovery of nerve function (Burgess and Goode, 1994).

Currently a slightly different approach to the fractured condyle is used at our institution. The skin incision remains the same, but the SMAS and parotid capsule are no longer opened vertically, parallel to the posterior border of the ramus, but horizontally, roughly parallel to the facial nerve branches. The wide »window area« between the marginal and buccal branch is used for dissection through the parotid gland. When the masseter muscle is exposed, its fibres are opened longitudinally. With this approach, the nerve branches are encountered much less frequently and rarely have to be dissected, and the incidence of temporary postoperative palsies has fallen.

Parotid salivary fistulas appear if the SMAS and parotid capsule are not sutured in a watertight fashion. Therefore, it is imperative to open the SMAS and capsule sharply, using the scalpel, which results in a straight wound that can be closed watertightly with a running mattress suture (Ellis and Simon, 2000). If the SMAS and capsule are opened bluntly, a tattered wound results, rendering it impossible for watertight closure. The same is probably true for Frey's syndrome. Salivary fistulas all closed spontaneously within a few weeks, whereas Frey's syndrome can be treated effectively with intracutaneous injections of botulinum toxin on an outpatient basis (Prodnik and Vesnaver, 2009).

Injuries to the greater auricular nerve can occur if one slips deep to the superficial leaf of the cervical fascia below the earlobe. If one stays in the retinacula cutis plane while dissecting anteriorly, and only goes deep when well anterior to the earlobe, such injury is not possible (Vesnaver et al., 2005).

In the beginning of our series, several miniplate fractures occurred, always in patients where miniplates with screw diameters of less than 2.0 mm were used. When using 2.0 miniplates, a plate fracture occurred only in one patient who did not adhere to a modified soft diet period. It was our goal to always place either two straight 2.0 miniplates, one on the anterior and one on the posterior rim of the condyle, or one Modus® Trapezoid Condylar Plate (TCP®), the goal being the neutralisation of tensile, compressive and torsional forces present in the condyle region (Ellis, 2002; Meyer et al., 2002; Parascandolo et al., 2010).

The TCP is a very useful plate, designed specifically for this region, and comes in four sizes. Its increased three-dimensional stability is the result of the upper and lower cross bars. The TCP requires less periosteal stripping and provides stable fixation of the condyle. In our experience even the small, four hole TCP achieves adequate stability, which is in accordance with reports in the literature (Meyer et al., 2007, 2008). This is very beneficial, as the small size of the condylar fragment can often prevent the placement of two straight miniplates.

5. Conclusion

The results of surgical treatment of condylar process fractures are superior to the results of conservative treatment, and the procedure is safe with the transparotid surgical approach and adequate surgical technique.

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References

Anastassov GE, Rodriguez ED, Schwimmer AM, Adamo AK: Facial rhytidectomy approach for treatment of posterior mandibular fractures. J Craniomaxillofac Surg 25: 9–14, 1997

Biglioli F, Colletti G: Mini-retromandibular approach to condylar fractures. J Craniomaxillofac Surg 36: 378–383, 2008

Brandt MT, Haug RH: Open versus closed reduction of adult mandibular condyle fractures: a review of the literature regarding the evolution of current thoughts on management. J Oral Maxillofac Surg 61: 1324–1332, 2003

Burgess LPA, Goode RL: Diagnostic evaluation. In: Burgess LPA, Goode RL (eds), Reanimation of the paralyzed face. New York: Thieme, 3–10, 1994

Choi BH, Yoo JH: Open reduction of condylar neck fractures with exposure of the facial nerve. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 88: 292–296, 1999

Dahlström L, Kahnberg KE, Lindahl L: 15 year follow-up on condylar fractures. Int J Oral Maxillofac Surg 18: 18–22, 1989

Devlin MF, Hislop WS, Carto ATM: Open reduction and internal fixation of fractured mandibular condyles by a retromandibular approach: surgical morbidity and informed consent. Br J Oral Maxillofac Surg 40: 23–25, 2002

Eckelt U: Commentary regarding the publication "Fractures of the mandibular condyle: a review of 466 cases. Literature review, reflections on treatment and proposals" by N. ZACHARIADES et al. J Craniomaxillofac Surg 34: 433–434, 2006

Eckelt U, Schneider M, Erasmus F, Gerlach KL, Kuhlisch E, Loukota R, et al: Open versus closed treatment of fractures of the mandibular condylar process – a prospective randomized multi center study. J Craniomaxillofac Surg 34: 306–314, 2006

Eckelt U, Rasse M: Clinical, radiographic and axiographic control after traction screw osteosynthesis of fractures of the mandibular condyle region. Rev Stomatol Chir Maxillofac 96: 158–165, 1995

Ellis E, Palmieri C, Throckmorton GS: Further displacement of condylar process fractures after closed treatment. J Oral Maxillofac Surg 57: 1307–1316, 1999

Ellis E, Simon P, Throckmorton GS: Occlusal results after open or closed treatment of fractures of the mandibular condylar process. J Oral Maxillofac Surg 58: 260–268, 2000

Ellis E, Throckmorton GS: Treatment of mandibular condylar process fractures: biological considerations. J Oral Maxillofac Surg 63: 115–134, 2005

Ellis E: Discussion – a biomechanical evaluation of mandibular condyle fracture plating techniques. J Oral Maxillofac Surg 60: 80–81, 2002

Ellis EE, Simon P: Surgical complications with open treatment of mandibular condylar process fractures. J Oral Maxillofac Surg 58: 950–958, 2000

Ellis EE, Zide MF: Retromandibular approach. In: Ellis EE, Zide MF (eds), Surgical approaches to the facial skeleton. Baltimore: Williams & Wilkins, 139–153, 1995a

Ellis EE, Zide MF: Rhytidectomy approach. In: Ellis EE, Zide MF (eds), Surgical approaches to the facial skeleton. Baltimore: Williams & Wilkins, 154–160, 1995b

Hayward JR, Scott RF: Fractures of the mandibular condyle. J Oral Maxillofac Surg 51: 57–61, 1993

Hlawitschka M, Loukota R, Eckelt U: Functional and radiological results of open and closed treatment of intracapsular (diacapitular) condylar fractures of the mandible. Int J Oral Maxillofac Surg 34: 597–604, 2005

Hyde N, Mansiali M, Aghabeigi B, Sneddon K, Newman L: The role of open reduction and internal fixation in unilateral fractures of the mandibular condyle: a prospective study. Br J Oral Maxillofac Surg 40: 19–22, 2002

Kermer C, Undt G, Rasse M: Surgical reduction and fixation of intracapsular condylar fractures. Int J Oral Maxillofac Surg 27: 191–194, 1998

Konstantinović VS, Dimitrijević B: Surgical versus conservative treatment of unilateral condylar process fractures: clinical and radiographic evaluation of 80 patients. J Oral Maxillofac Surg 50: 349–352, 1992

Loukota RA, Eckelt U, De Bont L, Rasse M: Subclassification of fractures of the condylar process of the mandible. Br J Oral Maxillofac Surg 43: 72–73, 2005

Meyer C, Kahn JL, Boutemi P, Wilk A: Photoelastic analysis of bone deformation in the region of the mandibular condyle during mastication. J Craniomaxillofac Surg 30: 160–169, 2002

Meyer C, Martin E, Kahn JL, Zink S: Development and biomechanical testing of a new osteosynthesis plate (TCP®) designed to stabilize mandibular condyle fractures. J Craniomaxillofac Surg 35: 84–90, 2007

Meyer C, Zink S, Chatelain B, Wilk A: Clinical experience with osteosynthesis of subcondylar fractures of the mandible using TCP® plates. J Craniomaxillofac Surg 36: 260–268, 2008

Nørholt SE, Krishnan V, Sindet-Pedersen S, Jensen IB: Pediatric condylar fractures: a long-term follow-up study of 55 patients. J Oral Maxillofac Surg 51: 1302–1310, 1993

Palmieri C, Ellis E, Throckmorton GS: Mandibular motion after closed and open treatment of unilateral mandibular condylar process fractures. J Oral Maxillofac Surg 57: 764–775, 1999

Parascandolo SA, Spinizia A, Parascandolo ST, Piombino P, Califano L: Two load sharing plates fixation in mandibular condylar fractures: biomechanical basis. J Craniomaxillofac Surg 38: 385–390, 2010

Prodnik L, Vesnaver A: Case report: treatment of Frey's syndrome with Botulinum toxin type A. Slo Med Jour 78: 203–205, 2009

Satler RB, Oglivie-Harris DJ: Healing of intra-articular fractures with continuous passive motion. Am Acad Orthop Surg 28: 102–115, 1979

Schneider M, Lauer G, Eckelt U: Surgical treatment of fractures of the mandibular condyle: a comparison of long-term results following different approaches: functional, axiographical and radiological findings. J Craniomaxillofac Surg 35: 151–160, 2007

Silvennoinen U, Iizuka T, Oikarinen K, Lindqvist C: Analysis of possible factors leading to problems after nonsurgical treatment of condylar fractures. J Oral Maxillofac Surg 52: 793–799, 1994

Smets LMH, van Damme PA, Stoelinga PJW: Non surgical treatment of condylar fractures in adults: a retrospective analysis. J Craniomaxillofac Surg 31: 162–167, 2003

Takenoshita Y, Ishibashi H, Oka M: Comparison of functional recovery after non-surgical and surgical treatment of condylar fractures. J Oral Maxillofac Surg 48: 1191–1195, 1990

Throckmorton GS, Ellis E, Hayasaki H: Masticatory motion after surgical or nonsurgical treatment for unilateral fractures of the mandibular condylar process. J Oral Maxillofac Surg 62: 127–138, 2004

Vesnaver A, Gorjanc M, Eberlinc A, Dovšak DA, Kansky A: The periauricular transparotid approach for open reduction and internal fixation of condylar fractures. J Craniomaxillofac Surg 33: 169–179, 2005

Vesnaver A: Open reduction and internal fixation of intraarticular fractures of the mandibular condyle – our first experiences. J Oral Maxillofac Surg 66: 2123–2129, 2008

Zacharides N, Mezitis M, Mourouzis C, Papadakis D, Spanou A: Fractures of the mandibular condyle: a review of 466 cases. Literature review, reflections on treatment and proposals. J Craniomaxillofac Surg 34: 421–432, 2006

Zide MF, Kent JN: Indications for open reduction of mandibular condyle fractures. J Oral Maxillofac Surg 41: 89–94, 1983