Fractures of the mandibular condyle: A review of 466 cases. Literature review, reflections on treatment and proposals

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SUMMARY. Introduction: The incidence of condylar fractures is high. Condylar fractures can be extracapsular (condylar neck or subcondylar) or intracapsular, undisplaced, deviated, displaced or dislocated. Treatment depends on the age of the patient, the co-existence of other mandibular or maxillary fractures, whether the condylar fracture is unilateral or bilateral, the level and displacement of the fracture, the state of dentition and the dental occlusion, and the surgeon’s experience. Purpose: This report presents the experience acquired in the treatment of 466 condylar fractures over 7 years, reviews the pertinent literature and proposes guidelines for treatment. Material and methods: The archives of KAT, General District Hospital between 1995 and 2002 were scrutinized and the condylar fractures were recorded. The aetiology, age, sex, level of fracture, degree of displacement, associated facial fractures, malocclusion, and type of treatment were noted. Results: Four hundred and sixty-six condylar fractures were admitted, the male:female ratio was 3.5:1. Road traffic accidents were the main cause and most fractures were unilateral, displaced, subcondylar, occurred on the left side and were treated conservatively. Conclusions: Early mobilization is the key in treating condylar fractures. Whilst rigid internal fixation provides stabilization and allows early mobilization, conservative treatment is the treatment of choice for the majority of fractures. Children and intracapsular fractures are treated conservatively with or without maxillo-mandibular fixation. Open reduction is recommended in selected cases to restore the occlusion, in severely displaced and dislocated fractures, in cases of loss of ramus height, and in edentulous patients. It may be considered in those with ‘medical problems’ where intermaxillary fixation is not recommended. © 2006 European Association for Cranio-Maxillofacial Surgery

Keywords: condylar fractures with/without displacement; dislocation

INTRODUCTION

The proportion of condylar fractures among all mandibular fractures is between 17.5% and 52% (Zachariades et al., 1983; Bochlogiros, 1985; Zachariades & Papavassiliou, 1990; Stylogianni et al., 1991; Silvennoinen et al., 1992; Newman, 1998; Marker et al., 2000a; de Riu et al., 2001; Miloro, 2003; Villarreal et al., 2004). Indeed, according to Killey (1974), the most common unilateral fracture is of the condyle, and the most common bilateral fracture is of the condylar heads. According to Villarreal et al. (2004) they are the most controversial fractures regarding diagnosis and management. Most are not caused by direct trauma, but follow indirect forces transmitted to the condyle from a blow elsewhere. Consequently condylar fractures are those most commonly missed (Silvennoinen et al., 1992; Lee et al., 1993 Pereira et al., 1995). Their displacement is determined by the direction, degree, magnitude and precise point of application of the force, as well as the state of dentition and the occlusial position. With adequate molar support and the teeth in occlusion, little or no displacement is likely to be sustained, while with the mouth widely open the full force will be transmitted to the condyles (Rowe and Killey, 1968). Direct impact leads to a unilateral fracture (MacLennan, 1969) as the weak condylar neck breaks easily and there is no intracranial displacement; thus the condyle protects the brain in mandibular fractures (Oikarinen, 1994).

There are two types of fracture, intracapsular and extracapsular (MacLennan, 1969), but for practical purposes, the anatomical level of the fracture is divided into three sites: the condylar head (intracapsular), the condylar neck (extracapsular) and the subcondylar region (Lindahl, 1977; Laskin, 1991; Zhang and Obeid, 1991; Silvennoinen et al., 1992; Newman, 1998; editorial, 1999). The fracture is classified as: undisplaced, deviated, displaced (with medial or lateral overlap, or complete separation), and dislocated (outside the glenoid fossa) (MacLennan, 1969; Lindahl, 1977; Zhang and Obeid, 1991; Silvennoinen et al., 1992; Newman, 1998; Hyde et al., 2002). Lindahl (1977) also classifies condylar head fractures into horizontal, vertical, and compression types. According to Lindahl, (1977) condylar head dislocation is more frequent in children.

Four elements determine articular function following condylar fracture, the fracture site and
displacement, discal integrity, and occlusal guidance (Gola et al., 1992). Following trauma there may be a varying degree of limited mandibular movement due to muscle spasm, oedema and haemarthrosis (MacLennan, 1969). These factors also predispose to mandibular deviation to the injured side on opening (MacLennan, 1969). Deviation may follow trauma even in the absence of fracture (MacLennan, 1969).

The great dependence on private transport (Marker et al., 2000a) and consequent traffic accidents adds to overall numbers (Larsen and Nielsen, 1976), but personal violence remains the most frequent cause of condylar fractures (Silvennoinen et al., 1992), although severe fractures occur more frequently after falls and road traffic accidents. According to Larsen and Nielsen (1976), work related mandibular fractures usually occur in men whilst condylar fractures are strongly associated with falls, which are most common in women (Zachariades et al., 1990a). The most common causes of trauma in children are falls from a bicycle, on steps, and during mandible may result (Rowe, 1969; Zachariades et al., 1990b). Temporomandibular joint disorders such as ankylosis and dysfunction, malocclusion, chronic dislocation and pain on the injured as well as the non-injured side may also occur (Lee et al., 1993; Hovinga et al., 1999). High intracapsular fractures and fracture dislocations may both lead to damage of the articular cartilage, the underlying germinal cell layer and the lower layer of the retrodiscal tissue which is involved in bone regeneration, especially in infants (MacLennan, 1965, 1969; Gola et al., 1992). Although injuries to the condylar cartilage as well as gross condylar head dislocation in children can reduce the capacity for complete remodelling and often result in mandibular deviation (Lindahl and Hollender, 1977a), it may be assumed that a (genetic) guidance system exists to rebuild the condylar process in children sustaining fractures (Lindahl and Hollender, 1977a, b). Remodelling of the distal stump may occur with formation of an anatomically normal condyle (Lindahl, 1977; Lindahl and Hollender, 1977b). The presence of the articular disc and capsule seems to play an important role in this process (Lindahl and Hollender, 1977a).

When a fractured condyle occurs in a child under 3 years of age, the fracture is usually of the compression type (Zide and Kent, 1983) and this may explain why the condylar cartilage is more frequently engaged in children than in adults (Lindahl, 1977; Lindahl and Hollender, 1977b). In children over 3, most fractures are linear (Zide and Kent, 1983). In a child between 3 and 11, the dislocated fractured condylar segment tends to be resorbed after successful therapy (Zide and Kent, 1983). Clinical evidence supports the belief that over the age of 4 years there is less danger of growth impairment from damage to the condylar centre (MacLennan, 1969). There is also experimental evidence that the glenoid fossa grows downward and becomes shallow to adapt to the new position of the condyle (Lindahl and Hollender, 1977a, b; Zhang and Obeid, 1991). Mastication and speaking disturbs healing, but such motion facilitates functional remodelling (Walker, 1994). Teenagers show condylar remodelling, which is neither complete nor predictable (Lindahl, 1977). Irrespective of age, remodelling always occurs in the condyle as a result of displacement or dislocation of the condylar fragment but they reflect the age-related reduced cellular activity of the condyle (Dahlström et al., 1989). Remodelling may be interpreted as a process directed to meet the demands of function and growth and occurs in such a way that during mandibular movements rotation takes place without translation (Dahlström et al., 1989). When skeletal growth has ceased, the condylar cartilage is mature, there is no increased cellular activity or remodelling. An adjusting, functional remodelling does occur, however (Lindahl and Hollender, 1977a, b; Brown and Obeid, 1984). The condylar displacement determines three required adaptations that are necessary to maintain normal occlusion: neuromuscular, skeletal, and dento-alveolar adaptation (Ellis, 1998). In children and younger individuals, a new temporomandibular articulation is established by remodelling, and by extrusion of the anterior and/or intrusion of posterior teeth (Ellis, 1998). A new flat glenoid fossa may develop (Hidding et al., 1992). The masticatory adaptations that occur after conservative treatment produce a uniquely favourable outcome most often (Ellis, 1998). Condylar regeneration and remodelling with adaptive changes lead to functional reconstitution of the joint even with severe displacement (Strobl et al., 1999). There is no association between incomplete remodelling and the occurrence of pain dysfunction syndrome (Thorén et al., 2001). In adults, fractures only remodel functionally (Lindahl, 1977). The ability of the adult to remodel and adapt is more impaired and less predictable following dislocation of the condyle (Takenoshita et al., 1990) and is also age dependent (MacLennan, 1969). The need for open reduction is thus greater in the postpubertal patient (Zide and Kent, 1983; Takenoshita et al., 1989). Despite more severe fractures in the youngest age-group, Dahlström et al. (1989) found that twice as many subjects in the oldest group experienced dysfunction. Treatment of condylar fractures depends on physical and imaging evidence of the fracture, on the extent of injury (whether it is unilateral or bilateral), the level of the fracture, the degree of displacement and dislocation, the size and position of the fractured condylar segment, the dental
malocclusion and mandibular dysfunction, the completeness of the dentition, the presence of concomitant facial fractures, the clinical experience of the surgeon, the age, general state, and the willingness of the patient to be operated (MacLennan, 1969; Ikemura, 1985; Konstantinovic and Dimitrijevic, 1992; Hayward and Scott, 1993; Türp et al., 1996; AAOMS, 2001; de Rui et al., 2001; Villarreal et al., 2004). The radiological interpretation is occasionally difficult owing to the superimposition of many adjacent structures (Rowe and Killey, 1968). Fractures extending into the capsule and sagittal fractures may be missed (consensus, 1999).

A wide spectrum of management is seen from analgesia alone, physiotherapy, intermaxillary fixation right through to exploration of all displaced condylar neck fractures with fixation (Moos, 1998). Immobilization re-establishes or maintains normal occlusion and relieves posttraumatic pain (Ikemura, 1985). Nevertheless in selected cases without occlusal deviation or other symptoms (such as pain), no immobilization is required and active physiotherapy with close follow-up will suffice. It is believed that the conservative approach should be regarded as the first choice of treatment for condylar fractures (Cook and Mac Farlane, 1969; Türp et al., 1996; Smets et al., 2003; Villarreal et al., 2004) because as long as there is contact between the proximal and distal bone fragments union will take place with an acceptable functional result (MacLennan, 1969; Villarreal et al., 2004). As oedema and muscle spasm are important causes for malocclusion, time for these to resolve may be helpful (A consensus, 1999; editorial, 1999) although in a number of cases the lack of knowledge of the pretraumatic occlusal relationship can also be a handicap (Ellis et al., 2000). Closed reduction provides good results (Zide and Kent, 1983), conservative methods of treatment are technically simpler and can offer reduced overall morbidity with satisfactory functional results with infrequent ankylosis and avascular necrosis. There would be little justification for surgically exposing the area provided the vertical height and occlusion are maintained (MacLennan, 1969; Baker et al., 1998; Haug and Assael, 2001). Cook and MacFarlane (1969) claim that following conservative treatment there is no correlation between the degree of radiographic displacement and the subsequent clinical findings (A consensus, 1999). A favourable conservative outcome depends on: a growing patient up to puberty, a fragment which is confined within the temporo-mandibular joint space with a slight dislocation, and an intact dentition which can maintain a proper joint space (Yasuoka and Oka, 1991). The duration of immobilization ranges from 2 to 4 weeks (Yasuoka and Oka, 1991; Silvennoinen et al., 1994; Banks, 1998; Iizuka et al., 1998). However, Silvennoinen et al., (1994) recommended early mobilization of the jaw and functional rehabilitation as an essential part of the treatment (Gola et al, 1992). In contrast, according to Killey (1974), if the mandible is immobilized for a period longer than about 10 days, there is a risk of ankylosis of the condylar head.

Surgical treatment to reapproximate the fractured segments has been advocated to avoid the complications of open bite, retrognathia, pain, reduced lateral and protrusive mobility and deviation on opening (Jeter et al., 1988; Lachner et al., 1991). Surgical treatment of condylar fractures includes relatively difficult procedures (Hall, 1994). Open reduction aims at anatomical repositioning and rigid fixation of the fragments, occlusal stability, rapid return to function, maintenance of vertical ramus dimension, no airway compromise and less long-term temporomandibular joint dysfunction (Zhang and Obeid, 1991; Baker et al., 1998; Newman, 1998; Hovinga et al., 1999; Ellis et al., 2000; Choi et al., 2003).

Bilateral condylar fractures cause most malocclusions (Ellis, 1998). Such patients, treated by placing arch bars and using a short course of intermaxillary fixation followed by guiding elastics may still develop asymmetry, malocclusion and an open bite (Ellis and Throckmorton, 2000). All this may not be noticed until the elastics have been removed for 12-24 hours (Ellis, 1998). It is believed that once condylar non-union has occurred, conservative treatment is ineffective (Rowe and Killey, 1968; Pereira et al., 1995) and the joint is prone to arthritic sequelae (Zide, 2001). However, to achieve satisfactory reposition, it may even be necessary to detach and reseat the condylar head (Mikkonen et al., 1989; Baker et al., 1998; Villarreal et al., 2004). There are reports of avascular necrosis of the proximal segment following removal and open reduction of the fragment as a free graft (A consensus, 1999; editorial, 1999). This, however, has been disputed by others (Banks, 1998). According to Takenoshita et al. (1990) return to function following open reduction does not seem to be better than after closed reduction but it is more rapid. Others, however, observed better results with the open approach (Konstantinovic and Dimitrijevic, 1992; Hidding et al., 1992; Worsaae and Thorn, 1994; Oezmen et al., 1998).

The debate about open versus closed treatment has advanced with new surgical techniques and hardware that has become available (Kent et al., 1990; Bos, 1999; Villarreal et al., 2004). With the advent of osteosynthesis allowing fixation, stabilization and fracture healing in the anatomically correct position (Jeter et al., 1988; Eckelt and Rasse, 1995; Eckelt and Hlawitschka, 1999; Santler et al., 1999) as well as early mobilization (Hall, 1994) to restore function of the temporomandibular joint, we have witnessed the beginning of a new era in the treatment of condylar fractures (Kent et al., 1990; Joos and Kleineheinz, 1998) as more aggressive surgical approaches have become increasingly common (Iizuka et al., 1998; Ellis et al., 1999, 2000). Open reduction and internal fixation of condylar process fractures is a delicate operation in an area with many anatomical hazards (Ellis et al., 2000). It may prove technically difficult (Silvennoinen et al., 1992; Norholt et al., 1993) to manipulate and reduce the segments (Zide and Kent, 1983) especially
when the condyle is medially displaced (Mikkonen et al., 1989). Complications include facial nerve damage, scar, haemorrhage and vascular compromise to the proximal segment (Lachner et al., 1991; Pereira et al., 1995; editorial, 1999; Zachariades et al., 2001). The mandibular condyle may be approached through a preauricular, retrolauricular, submandibular, retroromandibular, coronal, intraoral incision and combinations thereof (Messer, 1972; Peters et al., 1976; Petzel, 1982; Kitayama, 1989; Habel et al., 1990; Kent et al., 1990; Santler et al., 1999; Undt et al., 1999; Choi et al., 2001; Devlin et al., 2002; Villarreal et al., 2004). Open reduction for intracapsular and split condylar head fractures is considered experimental, by some as the internal fixation can be difficult (Sorel, 1998; editorial, 1999).

MATERIAL AND METHODS

From the Oral and Maxillofacial archives of KAT General District Hospital, the patients that were admitted with condylar fractures from January 1, 1995 until December 31, 2002 were evaluated. This is an 8 year period selected from an extensive experience of over 30 years in a major Trauma Hospital, where hundreds of such cases have been treated. This particular period was selected because we had already developed adequate experience with bone plates so as to use them efficiently when we felt that they were indicated. Several parameters were considered such as the number of fractures, the age and sex of the patient, the aetiology of the fracture, the affected side, (unilateral or bilateral), the relationship between the proximal and distal segments, the relationship between the proximal segment and the temporal fossa, the level of the fracture (condylar head, condylar neck, subcondylar), the association with other fractures of the mandible and/or the middle third of the face, and treatment. In the majority of cases intermaxillary fixation was applied under local anaesthesia in the Outpatient Department and not in the operating room. This report, however, is restricted to the patients that were admitted in the Inpatient Department and not those treated on an outpatient basis. Osteosynthesis was applied under general anaesthesia when required. Indications for the type of treatment chosen were based on the age of the patient, the level of fracture, adequacy of function and general condition of the patient. Data were based on routine radiographs (and some CT scans) and was classified according to Lindahl (Rowe & Williams, 1985). Clinical data were not considered reliable as most of the patients did not attend follow-up.

RESULTS

There were 368 patients with a total of 466 fractures (288 men and 80 women). In 98 cases, bilateral fractures were recorded. In men, 211 fractures were unilateral and 77 were bilateral (total 365); in women, 59 fractures were unilateral and 21 were bilateral (total 101). Two hundred and nineteen fractures were recorded on the right and 247 on the left side. Of the unilateral fractures, 121 were recorded on the right and 149 on the left side.

Considering the relationship between the proximal and the distal segments, 40 undisplaced fractures were recorded on the right and 49 on the left side (total 89). Further analysis indicated that 24 unilateral fractures on the right side and 37 on the left were undisplaced, while among the bilateral condylar fractures 16 undisplaced fractures were recorded on the right side and 12 on the left. There were 59 deviated fractures, 26 on the right and 33 on the left side. Among these, 15 unilateral fractures of the right side and 25 on the left side plus 11 of the bilateral deviated fractures were right sided and 8 on the left side.

Three hundred and eighteen fractures were displaced (145 on the right and 173 on the left): 77 unilateral displaced fractures were recorded on the right, and 98 on the left side plus 68 displaced fractures among the bilateral cases were right sided and 75 on the left. Further analysis of the displaced fractures indicated that medial overlap was recorded 57 times on the right and in 81 cases on the left side. More specifically, in unilateral cases 34 fractures on the right and 48 on the left showed medial overlap, while among bilateral cases 23 right sided and 33 left sided showed medial overlap. Lateral overlap was recorded on the right in 22 and on the left in 19 cases. More specifically: 10 unilateral cases on the right and 13 on the left, while among bilateral cases lateral overlap was recorded in 12 cases on the right and in 6

<table>
<thead>
<tr>
<th>Fragment relationships</th>
<th>R</th>
<th>L</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unilateral</td>
<td>Bilateral</td>
<td>Total</td>
</tr>
<tr>
<td>Undisplaced</td>
<td>24</td>
<td>16</td>
<td>40</td>
</tr>
<tr>
<td>Deviated</td>
<td>15</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Displaced</td>
<td>77</td>
<td>68</td>
<td>145</td>
</tr>
<tr>
<td>Medial overlap</td>
<td>34</td>
<td>23</td>
<td>57</td>
</tr>
<tr>
<td>Lateral overlap</td>
<td>10</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>Ant/post override</td>
<td>28</td>
<td>30</td>
<td>58</td>
</tr>
<tr>
<td>No contact</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
</tbody>
</table>
cases on the left. Anteroposterior over-ride was recorded on the right in 58 and on the left in 59 cases. More specifically, anteroposterior over-ride among unilateral fractures was recorded in 28 cases on each side, while in bilateral cases it was recorded in 30 cases on the right and 31 on the left side. There was no contact in 8 cases on the right side and 14 on the left side. More specifically, no contact was recorded in 5 unilateral cases on the right side and 9 on the left, while among bilateral cases no contact was recorded in 3 cases on the right and 5 on the left (Table 1).

Taking into consideration the relationship between the proximal segment and the temporal fossa, 90 of the displaced fragments were dislocated. Thirty-four fracture dislocations were recorded on the right and 56 on the left side. Out of those, 12 unilateral fractures were recorded on the right and 26 on the left, while among bilateral fractures 22 were recorded on the right and 30 on the left side.

Out of the 39 intracapsular fractures 18 were on the right and 21 on the left side. One hundred and thirty seven condylar neck fractures were recorded (71 on the right and 66 on the left) and 290 subcondylar fractures (130 on the right and 160 on the left). There was no data available on one fracture. Of the total of 270 unilateral fractures 21 were intracapsular (11 on the right and 66 on the left) and 290 subcondylar fractures (130 on the right and 160 on the left). There was no data available on one fracture. Of the total of 270 unilateral fractures 21 were intracapsular (11 on the right and 66 on the left) and 290 subcondylar fractures (130 on the right and 160 on the left). There was no data available on one fracture. Of the total of 270 unilateral fractures 21 were intracapsular (11 on the right and 66 on the left) and 290 subcondylar fractures (130 on the right and 160 on the left). There was no data available on one fracture. Of the total of 270 unilateral fractures 21 were intracapsular (11 on the right and 66 on the left) and 290 subcondylar fractures (130 on the right and 160 on the left). There was no data available on one fracture. Of the total of 270 unilateral fractures 21 were intracapsular (11 on the right and 66 on the left) and 290 subcondylar fractures (130 on the right and 160 on the left).

The patients’ age is shown in Table 2. The youngest patient was 9 years old and the oldest eighty four. Only 3 patients were under the age of ten with 5 condylar fractures (2 were bilateral), 3 were intracapsular, 1 involved the condylar neck and 1 was subcondylar.

Table 3 shows the main causes of fractures. Road traffic accidents were the main cause both in men and women. Two hundred and six patients (not fractures) were involved in road traffic accidents. One hundred and sixty-seven were men and 39 were women. Violence was the second cause of such fractures involving 50 patients, 44 men and 6 women. There were 14 cases related to accidents that occurred in relation to work (industrial); out of these, 12 were men and 2 women. The number of cases related to sports was 13 (9 men and 4 women). In 55 cases, other causes were mentioned. There was no record on 30 cases. The following fractures were recorded in cases of road traffic accidents: 23 intracapsular, 86 condylar neck and 157 subcondylar fractures. In relation to violence, 1 intracapsular, 7 neck and 42 subcondylar fractures (Table 4). There were 129 fractures on the right and 137 on the left sustained after road traffic accidents including 52 bilateral.

Table 2 – The patients’ age

<table>
<thead>
<tr>
<th>Patients age (yrs)</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–10</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>11–20</td>
<td>55</td>
<td>16</td>
</tr>
<tr>
<td>21–30</td>
<td>115</td>
<td>23</td>
</tr>
<tr>
<td>31–40</td>
<td>40</td>
<td>12</td>
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<tr>
<td>41–50</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>51–60</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>61–70</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>71–80</td>
<td>7</td>
<td>5</td>
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<tr>
<td>81–90</td>
<td>40</td>
<td>11</td>
</tr>
<tr>
<td>No data</td>
<td>288</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 3 – The aetiology of the condylar fractures

<table>
<thead>
<tr>
<th>Fracture aetiology</th>
<th>Male</th>
<th>Female</th>
<th>Total (pts.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTA*</td>
<td>167</td>
<td>39</td>
<td>206</td>
</tr>
<tr>
<td>Violence</td>
<td>44</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>Industrial</td>
<td>12</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Sports</td>
<td>9</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>No data</td>
<td></td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>

*RTA—road traffic accidents.

Table 4 – The level of fractures sustained in road traffic accidents and violence

<table>
<thead>
<tr>
<th>Fracture level</th>
<th>RTA</th>
<th>Violence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracapsular</td>
<td>23</td>
<td>1</td>
</tr>
<tr>
<td>Condylar neck</td>
<td>86</td>
<td>7</td>
</tr>
<tr>
<td>Subcondylar</td>
<td>157</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>266*</td>
<td>50*</td>
</tr>
</tbody>
</table>

*When counting bilateral fractures as 2 fractures

Table 5 – The types and percentages of additional fractures accompanying the condylar fractures

<table>
<thead>
<tr>
<th>Additional fractures</th>
<th>R</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandibular symphysis and parasympyseal</td>
<td>52%</td>
<td></td>
</tr>
<tr>
<td>Mandibular body</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>Mandibular angle</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Coronoid and ramus</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Middle third of face</td>
<td>17%</td>
<td></td>
</tr>
</tbody>
</table>

R, right; L, left.
In 265 patients with 342 condylar fractures, 326 more fractures were recorded in addition to condylar fractures with some patients presenting with more than one additional fracture. In 103 cases 124 condylar fractures were recorded with no other fracture of the facial skeleton. One hundred and sixty-nine fractures of the mandibular symphysis and the parasympyseal area were recorded in association with condylar fractures. In 61 cases, the condylar fracture was associated with a fracture of the body of the mandible. There were also 35 angular fractures as well as 3 fractures of the ramus, and three of the coronoid process. Finally the condylar fractures were associated with 55 cases of fractures of the middle third of the face (Table 5).

Three hundred and five patients (242 men and 63 women) presented with maloocclusion while 63 patients did not. As has already been stated there were 124 condylar fractures that were not associated with other fractures (46 on the right side, 36 on the left side and 21 bilateral). Out of these, 40 fractures (17 on the right, 9 on the left, and 7 bilateral) presented without malocclusion. From the 342 condylar fractures associated with other fractures, 40 cases (5 on the right, 15 on the left, and 10 bilateral condylar fractures) presented without and 302 cases (69 on the right, 99 on the left, and 67 bilateral fractures) presented with malocclusion. Further analysis indicated that in 84 condylar fractures that were not associated with other fractures malocclusion was recorded in 7 unilateral intracapsular fractures (4 on the right and 3 on the left side), 13 unilateral condylar neck fractures (8 on the right and 5 on the left side), 36 unilateral subcondylar fractures (17 on the right and 19 on the left side) and 14 bilateral fractures.

TREATMENT

In 32 cases no treatment was deemed necessary. In addition there were 9 cases with concomitant fractures treated with osteosynthesis where no surgical intervention was considered necessary for the condylar fracture. That brings the total number of untreated condylar fractures to 41. Physical therapy was the only form of treatment in additional 9 fractures bringing the total of condylar fractures where no surgical treatment was applied to 50.

Intermaxillary fixation as the sole mode of treatment was applied in 167 cases. To the above number one should add 149 cases where intermaxillary fixation was part of the treatment for associated fracture(s) in other parts of the mandible (or the maxilla) that were treated with osteosynthesis. That brings the total of cases treated with intermaxillary fixation to 316.

Miniplate osteosynthesis of a condylar fracture was applied in 22 cases. From these 19 cases were associated with other fractures. In only 1 case bilateral condylar osteosynthesis was applied (this was associated with other fractures as well). All fractures treated with open reduction were subcondylar fractures. In all but two there was malocclusion. In the one case with no occlusal deviation there was dislocation and in the other there was lateral displacement of the condyle, which also had occurred in another two fractures treated with open reduction; the latter, however, also demonstrated malocclusion. Altogether 16 of the fractures that were treated with miniplates demonstrated displacement: in 9 cases it was medial, in three it was lateral, anteroposterior override was recorded in 3 and there was no contact in 1 case. Six cases with no displacement were also treated with open reduction; they were all associated with malocclusion; two cases without malocclusion were treated with miniplates; in one of these the condyle was dislocated and in the other there was lateral displacement and no contact between the fragments. Intermaxillary fixation was applied in 19 of the 22 cases treated with osteosynthesis.

Physical therapy was part of every treatment. Mouth opening and deviation was checked on a weekly basis. More complicated cases were followed more often. Those in intermaxillary fixation were also checked weekly. At that time the intermaxillary fixation was removed and the patient was advised to open and close the mouth for about an hour or an hour and a half before maxillomandibular fixation was applied again.

DISCUSSION

According to Silvennoinen et al. (1992) isolated unilateral condylar fractures are often more severe than those associated with other fractures, probably because in the latter type the force is also absorbed by the horizontal part of the mandible. In these series it was not possible to confirm or dispute the above statement as it is not quite clear what makes one condylar fracture more severe than another (i.e. is it the level, the displacement, the kind of displacement, etc). There was no significant difference between men and women. Silvennoinen et al. (1992) reported that among unilateral fractures there is a high proportion of undisplaced fractures. This is in agreement with our findings as 68.5% were unilateral undisplaced fractures, whilst 31.5% of undisplaced fractures were bilateral. However, only 12% of our fractures were deviated in contrast to Silvennoinen et al. (1992) who found that deviation was the most common general category. Sixty-nine per cent of the fractures were displaced and 56% of the displaced fractures demonstrated some form of overlap, which was on the right in 44% and in 56% of the cases on the left side; 77% displacement was medial, while in 23% of the cases it was lateral. This is probably due to traction of the lateral pterygoid muscle pulling at the fragment and due to the lateral (temporomandibular) ligament which hinders lateral displacement.
Anteroposterior override was recorded in 37% of the displaced fractures and was equally distributed between unilateral and bilateral cases on each side of the mandible. In 7% of the displaced fractures there was no contact between the fragments. When excluding dislocated fractures, unilateral fractures prevail among all categories (undisplaced, deviated, displaced), and (with the exception of fractures with lateral displacement) most undisplaced, deviated, displaced and dislocated fractures occur on the left side. Twenty-eight per cent of the displaced fractures (19% of the total) were dislocated. Eight per cent of the fractures were intracapsular, 29% were condylar neck fractures and 62% were subcondylar. The latter agrees with Silvennoinen (1977) has also found that Lindahl (1977) has also found that condylar fractures are encountered when considerable force is involved. We were unable to confirm the intracapsular part of the statement and can only speculate that bilateral fractures are indeed the result of excessive force. Out of the 19% of condylar neck fractures, 41% were unilateral and 59% were bilateral (2:3). Although the number of patients under 5 years of age was very limited, there is a clear indication that in younger ages a great number of fractures is intracapsular.

The 466 fractures represent the total of condylar fractures that were admitted, seen or treated as inpatients in this department. Condylar fractures with minimal or no occlusal deviation or in the absence of significant symptoms (comprising approximately 1% of the total) were occasionally seen on an outpatient basis. This category was not included in the present report due to lack of adequate and comparable information. Whereas in 28% of the cases no other fracture was recorded, in 72% there were other fractures. More specifically, in 12% of the unilateral and 13% of the bilateral condylar fractures additional fractures were recorded. More bilateral condylar fractures were recorded when additional mandibular fractures were found and more condylar fractures per patient were associated with more mandibular fractures, presumably as a stronger force had been exerted. Lindahl (1977) has also found that concomitant fractures of the mandibular body are more frequent in bilateral than in unilateral condylar fractures. It appears therefore that condylar fractures result from an indirect force applied to the mandible, associated with at least one other mandibular fracture, mostly symphyseal or parasymphyseal. This suggests that condylar fractures may be the result of the exertion of force which is not fully absorbed in the majority of cases in the area of its primary application, i.e. the mental region. The body was involved in 19% of the cases (with a similar distribution between both sides) and 11% of the additional fractures involved the angle. The middle third of the face was involved in 17% of the additional cases (Table 5). Malocclusion was three times more frequent when additional mandibular fractures were recorded; but when only condylar fractures were present, malocclusion was recorded in 12% of intracapsular fractures, 31% of condylar neck fractures and 57% of subcondylar fractures.

Treatment outcomes require: pain-free mouth opening greater than 40 mm (Mezitis et al., 1989), overall good mobility, restoration of occlusion, stable temporomandibular joints, absence of preauricular depression, osseous union, good facial and jaw symmetry, speech, deglutition and swallowing (Walker, 1994; A consensus, 1999; Widmark, 2000; AAOMS, 2001; Villarreal et al., 2004). With these parameters, it matters little how condylar fractures are managed (Hidding et al., 1992; Walker, 1994). Satisfactory results do not always require exact anatomical repositioning (Joos and Kleinheinz, 1998). Even when impaired growth of the mandibular ramus on the fractured side is apparent, good aesthetic and functional results are possible (Feifel et al., 1992). According to Haug and Assael (2001) there are only few differences in outcome between patients treated with maxillomandibular fixation or rigid internal fixation (Zide and Kent, 1983; Zhang and Obeid, 1991; Konstantinovic and Dimitrijevic, 1992; Moos, 1998; editorial, 1999; Palmieri et al., 1999; Ellis et al., 2000). If the results are equal, the simpler treatment should be preferred (Hayward and Scott, 1993). Fourteen per cent of the patients with no malocclusion or other symptoms were treated with physiotherapy alone; they were advised to exercise opening and closing their mouth in a mirror to avoid or correct deviation. No other active treatment was used.

Malocclusion, chronic pain, limited mobility and asymmetry are occasionally associated with closed reduction (Haug and Foss, 2000; Umstadt, 2000; Brandt and Haug, 2003) regardless of the type of fracture. They felt that there is no relationship between the severity of displacement and the outcome of closed reduction (A consensus, 1999; editorial, 1999). Others feel that closed treatment for more displaced condylar fractures is more prone to produce suboptimal results (in particular, deviation on mouth opening, loss of ramus height, and malocclusion). They also feel that the frequency of these complications is proportional to the severity of fragment displacement (Tokenoshiba et al., 1989; Zhang and Obeid, 1991; Baker et al., 1998; Ellis, 1998; Eckelt and Hwiwitscha, 1999; Ellis et al., 2000). Also, radiographs show significantly better condylar position after surgery than conservative treatment (Kent et al., 1990; Ellis and Dean, 1993). Condylar repositioning cannot usually be achieved non-surgically (Iizuka et al., 1991). However, functional results can still be satisfactory as no correlation exists between the clinical and radiographic results (Iizuka et al., 1991; A consensus 1999).

In cases with bilateral mandibular fractures and midfacial fractures, the establishment of a mandibular platform is essential for reconstruction of the midface (Banks, 1998; A consensus, 1999; Haug and Foss, 2000). Conservative methods such as building up the posterior occlusion (Killey, 1974) are considered insufficient by Banks (1998) and others (A consensus, 1999). Our experience in selected cases
is not in agreement with these authors. Open reduction should allow rapid healing and rapid return to normal function (Takenoshita et al., 1990; Choi et al., 1999) with or without a short period of intermaxillary fixation (Elli and Dean, 1993; Hall, 1994; Haug and Assael, 2001; Assael 2003). However, open reduction and internal fixation do not necessarily guarantee that this result is permanent (Ellis et al., 2000; Zide, 2001). The more rigid the fixation of the condyle, the higher the risk of postoperative disadvantageous remodelling and dysfunction. This is a result of alteration of the condylar position and increased loading (Alpert, 1989; Ravelli et al., 1989; Iizuka et al., 1991; Hayward and Scott, 1993; Silvennoinen et al., 1994; Iizuka et al., 1998). As accurate repositioning of the fracture segments will not necessarily guarantee a correct physiological position of the condyle in the fossa (Iizuka et al., 1998), open reduction and repositioning without direct fixation supplemented with postoperative intermaxillary fixation has also been proposed (Iizuka et al., 1991; Iizuka et al., 1998; A consensus, 1999; Brandt and Haug, 2003).

Fixation with very rigid miniplates gives more stability than transosseous wiring (Iizuka et al., 1991; Zachariaides et al., 1994). Although single miniplates can be adequate if the fragments are aligned properly (Undt et al., 1999), functional forces actually exceed the rigidity of one miniplate, and therefore the use of two has been proposed, or alternatively a single 2.4 mm plate or a single 2.0 mm mini-dynamic compression plate that offers more resistance to rotation and 3-point bending (Hammer et al., 1977; Koberg and Momma, 1978; Choi et al., 2001; Haug and Assael, 2001; Wagner et al., 2002; Brandt and Haug 2003; Rallis et al., 2003). Bicortical screws have also been advocated (Hammer et al., 1977; Wagner et al., 2002). However, in the condylar neck the amount of bone is not always adequate to permit placement of 2–3 screws per fragment (Zachariaides et al., 1994; Haug and Assael, 2001). A single L or Y shaped plate as well as 3-D plates have also been used in this department with good results. Biodegradable plates and screws may present a new solution which has not yet been adequately tested. Lag screw osteosynthesis has also been attempted with mixed results as well as Kirschner pins (Mizuno and Shikimori, 1990; Kalvela et al., 1995; Schneider et al., 2005). In cases with bilaterally displaced or dislocated condyles, rigid internal fixation of at least one side with more severe displacement is the treatment of choice according to Baker et al. (1998) and Newman (1998). Reduction of one side is often sufficient to allow functional training subsequently (Iizuka et al., 1991) although it may result in increased displacement on the other side (A consensus, 1999). Intracapsular fractures are an absolute contraindication for open reduction (Haug and Assael, 2001). We used miniplate osteosynthesis of condylar fractures in 5.7% of the patients or 4.7% of the condylar fractures. Of these cases, 86% were associated with other fractures. In only 1 case, bilateral condylar osteosynthesis was performed; this was associated with other fractures as well. Our indications for open reduction were persistent malocclusion following conservative treatment (i.e. intermaxillary fixation) with or without dislocation and lateral displacement of the condyle. Although at least 2 weeks of intermaxillary fixation after open reduction have been recommended for a condylar fracture to allow for good wound healing (Takenoshita et al., 1990), we feel that guiding elastics are sufficient in most cases for a shorter period of time. In selected cases they are not even required at all provided the patient is kept under close observation.

It has been stated (editorial, 1999) that the intraoral approach has rather limited use for minimally displaced fractures, but it can now be combined with newer methods such as percutaneous insertion of screws (Jeter et al., 1988; Lachner et al., 1991) or contra-angle drills with or without endoscopy. All our cases that were treated surgically were approached intraorally.

Fractures in children before or in the early teens – regardless of the respective type of condylar fracture diagnosed – are said to be predictably successfully treated by closed reduction (Norholt et al., 1993; Hovinga et al., 1999; editorial, 1999; Strobl et al., 1999; Ellis et al., 2000; Thoren et al., 2001) with or without 1–3 weeks of maxillo-mandibular fixation followed by guiding elastics to bring the mandible into normal occlusion, and physiotherapy (Norholt et al., 1993; Hovinga et al., 1999). Soft diet and immediate mobilization seems to be an alternative treatment (Thoren et al., 2001) if the occlusion is not altered. With closed reduction, serious growth disturbances are rare (Hovinga et al., 1999). Even in cases of deviation, displacement or total dislocation, the condylar fragment remodelling with the ultimate reproduction of a comparatively normal articular process and normal or almost normal masticatory function (Rowe, 1968; Thoren et al., 2001). In order to assess treatment, one must wait until growth is completed (Feifel et al., 1992). In this age group, crushing injuries affecting the condylar cartilage, however, may result in considerable deformity in later years, particularly when such injuries occur before the age of 6 years (Rowe, 1968). It appears that the condyle is highly vascular during the first years of life and a crushing injury could result in considerable extravasation of blood, avascular necrosis, pathologic ossification and ankylosis (Rowe, 1968). Considering the healing capabilities and the technical difficulties in fixing the segments (Hall, 1994) and the anticipated remodelling in young ages (Takenoshita et al., 1989), surgery before puberty should be reserved for exceptional cases such as missile injuries (Banks, 1998), in selected cases with extensive dislocation and lack of contact between the fragments, and in cases with multiple fractures of the midface, in which the mandible has to serve as a guide to reposition the midfacial bones (Hovinga et al., 1999). There is a definite correlation between injury to the cartilaginous portion of the condylar head and
facial growth disturbances (Feigel et al., 1992; Lee et al., 1993). All children were treated conservatively in this hospital but jaw immobilization in younger ages is also associated with various technical problems such as the patient’s behaviour and response, and the nature of their dentition (Haug and Foss, 2000).

Complications depend on the different types of fractures, displacement or dislocation, bilaterality, other additional fractures of the mandible or associated maxillary fractures and those in children (Dahlström et al., 1989; Moos, 1998). Complications of trauma to the temporomandibular joint are far-reaching in their effects and not always immediately apparent (Rubens et al., 1990; Palmieri et al., 1999). Ankylosis, however, is infrequent (Zhang and Obed, 1991; Hall, 1994; Banks, 1998; Palmieri et al., 1999) and it has been estimated to occur in only 0.2–0.4% of condylar fractures (Ellis, 1998). It does not develop as a rule with a moving jaw and active physiotherapy (Takenoshita et al., 1990) and is thought to be associated more often with intracapsular fractures (Alpert, 1989). However, hypomobility is reported to occur in around 8–10% (Ellis, 1998). The longer the periods of intermaxillary fixation, the more hypomobility is likely (Amaratunga, 1987) although from the patient’s standpoint the amount of opening may be perfectly satisfactory (Mezitis et al., 1989; Ellis, 1998). Therefore, one should apply early mobilization at the expense of a stable occlusion (Banks, 1998). Late arthritic changes (Kent et al., 1990) may occur 10–50 years later in cases treated by closed reduction but there is lack of long-term follow-up (Zide and Kent, 1983).

Displacement or dislocation of the condylar head and bilateral condylar fractures particularly in the edentulous individual and/or in combination with other mandibular or maxillary fractures can result in great loss of posterior vertical dimension. This in turn can lead to malocclusion, deviation of the mandible to the affected side, anterior open bite or contralateral open bite and pain due to overload (Alpert, 1989; Mikkonen et al., 1989; Raveh et al., 1989; Kent et al., 1990; Rubens et al., 1990; Takenoshita et al., 1990; Izuka et al., 1991; Silvennoinen et al., 1992, 1994; Zachariades et al., 1993; Ziccardi et al., 1997; Banks, 1998; Ellis, 1998; Undt et al., 1999; Marker et al., 2000b; de Riu et al., 2001).

Patients were followed for an average of 1 month only and no major complications were encountered. Mouth opening was considered adequate considering the time elapsed with no patient complaining of significant deviation and no complaints for pain was noted. All patients were recalled but the trauma patient population tends to be less reliable than the general population (Haug and Assael, 2001). Indeed, in one study only 20% responded to recall (Haug and Assael, 2001). We sent 273 letters and only 30 patients (11%) responded. This can also be attributed to the fact that they live all over the country, many are impoverished, some have no permanent address, and the geographical peculiarities (islands) may often render the journey difficult. Thus no firm conclusion can be drawn from such a small number, particularly with the limited number of children. However, no patient considered it necessary to return for further treatment.

CONCLUSIONS AND PROPOSITIONS

(A)
- In condylar fractures, men outnumber women by approximately 3.5 times.
- Unilateral condylar fractures comprise approximately two-thirds of the total both in men and in women.
- Condylar fractures occur a little more often on the left side.
- Nineteen per cent of the condylar fractures are undisplaced, 12% deviated and 69% displaced. Fifty-six per cent of the displaced fractures demonstrate some form of overlap (77% medial and 23% lateral), 37% demonstrate anteroposterior override and in 6% of the cases there is no contact. Nineteen per cent of the condylar fractures are dislocated.
- Functional outcome was satisfactory, especially in those who showed up for follow-up.

(B) As there is no protocol governing the treatment of condylar fractures, the following principles related to closed and open reduction are proposed. Treatment depends on the individual case and the surgeon:
- Open versus closed treatment is judged individually.
- As long as there is contact between the proximal and distal bone fragments, union will take place with an acceptable functional result. Even if significant displacement of the fracture is present, the treatment should be non-surgical as long as the condyle is in the fossa.
- Unilateral condylar fractures in general, fractures with normal occlusion, and the majority of non-displaced or slightly displaced condylar fractures are best treated non-surgically by closed reduction, intermaxillary fixation and subsequent functional training, or a regime of analgesics and soft diet with close monitoring.
- Displaced condylar fractures with altered occlusion may also be treated satisfactorily in 50% with intermaxillary fixation. In cases with displaced fractures maxillo-mandibular fixation should always be used, even if the occlusion is unchanged on admission. An open reduction, however, may be required.
- Absolute indications for non-surgical treatment are intracapsular condylar fractures, high condylar fractures close to or involving the articular surface, and fractures in growing children.
- Conservative treatment may be required when the patient’s past medical history does not allow the administration of general anaesthesia.
Surgery should be performed in the adult whenever the vascular supply of the displaced part of the condyle is compromised as in cases of severely displaced condyles (i.e. displacement greater than 45° in either the coronal or the sagittal plane and lateral extracapsular displacement), where the fractured parts are widely separated so that non-union or fibrous union is probable, dislocated subcondylar or condylar neck fractures that have separated from normal attachments, out of the glenoid fossa and lie outside the normal area of condylar translation, as well as in cases of mechanical interference with mandibular function.

Medial or lateral override resulting in significant loss of vertical ramus height, that cannot be compensated in any other way (particularly the bilateral group) is an indication for open reduction.

Open reduction is recommended for condylar fractures (especially one side of bilateral fractures) associated with fracture(s) elsewhere in the mandible and as part of a panfacial injury and/or comminuted maxillary fractures. If open reduction and rigid internal fixation is to be used for other mandibular or maxillary fractures, it may also be used for subcondylar fractures to avoid intermaxillary fixation.

Open reduction is recommended when it is impossible to achieve pretraumatic or adequate occlusion by closed reduction, in cases where conservative therapy has failed, and an anterior open bite results.

Open reduction is the treatment of choice for condylar fractures with displacement of the condyle into the middle cranial fossa, for compound fractures and where there is a foreign body in the joint.

Open reduction and rigid internal fixation should be contemplated for the edentulous or the mandible with lack of posterior support, and those with skeletal abnormalities (such as open bite and prognathism) that compromise occlusal stability.

Open reduction may be the patient’s (or surgeon’s) preference considering that the most important advantage of using rigid internal fixation is to avoid or shorten the period of maxillo-mandibular fixation. It may be related to the available technology (i.e. miniplates), resources of the hospital and the patient’s insurance company’s ability to pay.

Seizure disorders, asthma, chronic obstructive pulmonary disease, drug addiction, psychiatric problems, mental retardation and associated injuries may dictate the need for open reduction.

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Dahlström L, Kahnberg K-E, Lindahl L: 15 years follow-up on mandibular and maxillary fractures, and rigid internal fixation is to be used for other mandibular or maxillary fractures, it may also be used for subcondylar fractures to avoid intermaxillary fixation.

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