Effect of early or delayed treatment upon healing of mandibular fractures: a systematic literature review

Niels Ulrich Hermund¹, Søren Hillerup², Thomas Kofod², Ole Schwartz², Jens Ove Andreasen²

¹Department of Oral and Maxillofacial Surgery, Hillerød Hospital; ²Department of Oral and Maxillofacial Surgery, University Hospital (Rigshospitalet), Copenhagen, Denmark

Correspondence to: Jens Ove Andreasen, Department of Oral and Maxillofacial Surgery, University Hospital (Rigshospitalet), Copenhagen, Denmark Tel.: (45) 35 45 24 31 Fax: (45) 35 45 23 64 e-mail: jens.ove.andreasen@rh.hosp.dk Accepted 1 March, 2006 Abstract – The possible relation between treatment delay and healing complications in mandibular fracture treatment (excluding condylar fractures) was reviewed systematically. Twenty-two studies were identified. No randomized studies focused on the effect of immediate or delayed treatment. The main focus of most studies was surgical repositioning and internal skeletal fixation. The healing complications analyzed in this study were infection in the fracture line and malocclusion. Statistical analysis of the influence of treatment delay upon healing complications was possible in six studies. Four studies showed no significant difference between immediate and delayed treatment. One study showed a preference for healing for cases treated within 3 days, whereas another study indicated that treatment time between 3 and 5 days were optimal with the lowest rate of complications. Finally, a few studies identified confounding factors such as alcohol, drug abuse and/or non-compliance, factors which have been shown strongly to influence the likelihood of complications. A significant problem in this analysis was that rather few patients were actually treated on an acute basis (i.e. within 12 or 24 hours after injury), a fact which together with the lack of control of confounding factors made this analysis problematic. In conclusion, there is presently no strong evidence for either acute or delayed treatment of mandibular fractures in order to minimize healing complications; new studies including a substantial number of cases treated on an acute basis are very much needed.

Guidelines for fracture treatment of the mandible and the maxilla are mostly not evidence based (1, 2). A variety of treatment modalities exist which create confusion about which methodology to choose. A number of treatment procedures in jaw fracture management imply surgical anatomical repositioning and internal fixation. Consequently, it becomes critical how the involved tissues respond to this surgical trauma at various times after injury. Analysis of the effect of treatment delay upon healing after traumatic dental injuries showed surprisingly that most trauma types were not influenced by delayed treatment (e.g. crown fractures, root fractures and intrusive luxations) (3).

In clinical studies of healing of mandibular fractures, the effect of treatment delay upon healing in mandibular fractures has been discussed in several publications, and 11 studies found no relation effect of treatment delay upon fracture healing (4–14). In nine studies it was concluded that such a relation could exist with increasing numbers of complications (infection, malocclusion, malunion or/and non-union) happening in case of delayed treatment (15–23). Finally, some authors have claimed that a maximum delay of treatment of 12 h (24, 25) or 24 h (26) are acceptable for optimal jaw fracture healing.

It appears from these statements in the literature that there exists a diversity of opinions concerning the influence of treatment delay upon fracture healing. The purpose of the present study was therefore to review in details such clinical studies where treatment delay has been included in the statistical analysis in order to reveal time period(s) after trauma where healing capacity is at a maximum.

Materials and methods

The databases WINSPEAR, MEDLINE and COCH-RANE were checked for relevant studies using the key words 'treatment delay', 'jaw fracture', 'mandibular fracture' and 'maxillary fracture'. Furthermore, hand search was performed in various trauma journals.

All identified studies were analyzed according to the rules of COCHRANE and classified according to the level of evidence from 1–5 (27). In the statistical analysis either a chi-square test was used or a Fisher's test in case of 2×2 tables, and 5% was chosen as the level of evidence.

Results

No randomized studies were identified. All together, 22 studies were retrieved from the literature, which included information about healing and treatment delay. Only six

studies included sufficient documentation to allow for statistical analysis. Unfortunately, none of these studies went to a second level of analysis, namely stratified analysis in which a control could be made of confounding factors such as severity of fracture, number of fractures, alcohol or drug abuse, non-compliance or treatment delay because of an already existing infection being neglected by the patient. The results of an analysis of these individual studies are found in Tables 1–2.

In a study by Wagner et al. (4) on 100 mandibular fractures, the infection rate was analyzed for treatment delay ranging from 0-18 days (Table 1, Fig. 1). No significant difference in the complication rates (infection) was found within the time frame investigated.

Maloney et al. (16) published a study on 116 fractures treated either before or after 3 days and complication rates at 0% and 10% were found respectively, which was a significant difference (Table 1). This study was the basis for treatment suggestions published in 2001 by the same authors where a very complex treatment protocol was designed based on the time interval from injury to treatment (i.e. more or less than 3 days). However, no valid data was given for this approach and the study has been seriously criticized for the lack of reliable data supporting the treatment protocol (29).



Fig. 1. Treatment delay related to occurrence of postoperative complications in 100 cases. Number of complications are indicated in the bars and number of fractures treated below the bars. After Wagner et al. (2) days: n = 10 n = 16 n = 16 n = 14 n = 9 n = 16 n = 29.

A very detailed retrospective study of 286 consecutive patients with mandibular fractures, published by Moulton-Barret and co-workers in 1998, showed the lowest complication rates (including infection, malocclusion) in patients who received treatment 4–10 days following

Table 1. Treatment delay related to frequency of complicated jaw fracture healing

Author	Delay days	No. of patients/fractures	Type of fracture	Treatment (Open/closed)	Frequency of complications (%)	<i>P</i> -value	Control of confounding factors
Wagner et al. (4)	0–1 2 3–5 6 ≥7	10 12 36 13 29	Mandibular	Open	1 (10) 4 (33) 3 (8) 3 (23) 2 (7)	0.12	No data
Maloney et al. (16)	0–3 >3	57/86 24/30	Mandibular Mandibular	Closed Closed	0 (0) 3 (10)	0.02	No data
Moulton-Barrett et al. (21)	0–3 4–10 >10	134 141 11	Mandibular Mandibular Mandibular	Open + closed Open + closed Open + closed	26 (19) 14 (10) 2 (18)	0.08	No data

Table 2. Treatment delay related to frequency of jaw healing complications

	No of		Treatment		Average treat- ment-delay			Control of
Author	patients	Type of fracture	(Open/closed)	Complication	п	x ± SD	<i>P</i> -value	factors
Terris et al. (12)	36	Mandibular	Open	÷Complications + Complications (infection + malunion)	25 6.6 ± 2.5 11 6.5 ± 5.2		NS	No data
Chole and Yee (8)	79	Mandibular	Open + closed	+ Complications	58 16	1.9 ± 2.0 1.7 ± 1.5	NS	No data
Kaufman et al. (7)	53	Facial fractures with neurologic injury	Open + closed	Infection ÷Complications + Complications	10 43	7.0 7.8	NS	No data
	53		Open + closed	Malunion ÷Complications + Complications	10 43	7.1 7.8	NS	
NS, not significant.								

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trauma, whereas treatment carried out earlier or later had a higher complication rate (21) (Table 1).

Terris et al. (12) published a study where it was analyzed whether patients with or without treatment complications had a difference in treatment delay. As it appears from Table 2, no difference was found.

Chole and Yee (8) studied the outcome of treatment of 79 mandibular fractures and the statistical analysis showed that cases without complications had a treatment delay of 1.9 days, whereas cases with complications had a treatment delay of 1.7 days. It was concluded that treatment delay was not a significant cause of treatment complications.

In a study reported by Kaufman et al. (7) of 53 patients with facial fractures and at the same time a neurological trauma, patients with or without complications (infection and malocclusion) had the same treatment delay (7–8 days).

Discussion

In order to understand the healing events as they relate to immediate or delayed treatment, some pros and cons should be mentioned in favor of *early* treatment.

Pros:

- **1** Invasion of bacteria to the wound site will be restricted (in case of open fractures);
- **2** No or minimal swelling (makes surgical access to the fracture area easier);
- 3 Comfort for the patient due to early treatment;
- **4** Shorter hospitalization.

Cons:

- **1** Often the surgery is performed as an acute surgical procedure by less experienced surgeons, a fact which could represent a risk;
- **2** Tissues are not 'prepared' for surgery because of restricted circulation (see later) and the lack of the full inflammatory response to the trauma (i.e. mobilization of neutrophils, macrophages, fibroblasts and vasculature and the immunological response);
- **3** High cost due to surgery performed as a non-elective procedure after hours.

It is important to consider that the outcome of fracture treatment is entirely dependent upon the cellular activity in the trauma region and the presence or absence of bacteria at the fracture (healing) site. The cells participating in primary healing process take days to be recruited (fibroblast, macrophages, endothelial cells, osteoblasts, osteoclasts) and a time frame of approximately 3–4 days exists before this cellular response is at a maximum (30, 31).

Furthermore, especially during the first 24 h the coagulum is very sensitive to invasion of bacteria because of the limited amount of leucocytes in the coagulum (30). Concerning the role of microorganisms it is known that bacteria invasion in ischemic tissue is very fast and in this regard invasion may take place within a few hours (30).

To examine the effect of treatment delay, an ideal situation would be the analysis of randomized clinical trials where groups of patients have been allocated to various lengths of treatment delay. No such studies exist. It is therefore necessary to rely on published material where treatment has been carried out - for various reasons - with different delays. In this regard, it is very important to recognize that this may imply a strong bias in out come of these treatment results. For instance, many drug abusers who are known to have a tripled amount of complications in fracture healing often show up late after the initial trauma (9), the cause being that they have ignored the presence of the fracture and only report for treatment when unbearable symptoms arise (i.e. usually infection) and pain. Finally, lack of patient compliance has also been shown to be significantly related to complicated fracture healing (9).

The present study deals with a very delicate problem namely whether healing complications after mandibular fractures can be related to a treatment delay or not. Such an analysis is of importance for all fracture treatments and especially in a trauma center where treatment strategies should be made for multi-injured patients and where many specialists have a legitimate interest in treating the patients as soon as possible. Many of these patients suffer from other skeletal fractures, and it might therefore be of interest to analyze the influence of a delay in relation to the outcome in orthopedic surgery. In regard to closed reduction of ankle fractures Hørnes and Strømsøe (32) showed that a delay of 5 days or more in the treatment of closed ankle fractures resulted in 80 % wound infections compared with 3% for treatment within 5 days. However, in a similar study by Fogel and Murray (33) such a difference could not be found. Mehlman et al. (34) examined the effect of early or delayed treatment of supracondylar humeral fractures and could not find such relation to fracture complication. In open fractures of the lower leg, immediate treatment (i.e. within the first day) was followed by a significantly lower infection rate compared to later treatment (35). In conclusion in orthopedics, there is apparently not an universal agreement upon the effect of treatment delay upon healing of fractures of the extremities.

The present analysis of the effect of treatment delay upon healing of mandibular fractures is severely compromised by the lack of control of confounding factors. Such a control should as a minimum include a stratified analysis.

In the present analysis it is therefore necessary to realize that several confounding factors (i.e. factors which interfere with the measure of treatment delay) are most likely present as a treatment delay is often related to a series of factors that may negatively influence the treatment outcome. Thus, it might be suspected that complex fractures, which by their very nature are followed by higher complication rates (37), are for various reasons often offered delayed treatment. Of concern is also that alcohol or drug abuse may influence the healing results. It is known that abusers often show up late for treatment and they are known to have a very high complication rate (36). In none of the retrieved studies treatment delay was related to drugs abuse. Non-compliance patients have also been found to be related to healing complications (17) and this factor was also not controlled in the different studies reported.

The figures from Wagner et al. (4) may indicate a bimodal appearance of complications centered around 2 days and 6 days with a window of opportunity for a limited complication rate on day 3 and 4. However, this distribution was not found significant maybe due to the limited number of cases in the study.

The two other studies [Maloney et al. (14), Moulton-Barrett et al. (19)] showed significant or almost significant different complication ratios in patients treated up to or later than 3 days; however, with opposite preference for complications.

A significant problem exists in the present analysis, that so few patients were apparently treated on an acute basis i.e. within 12 or 24 hours after injury. This represents a weak point in the analysis (Table 1). A consensus of the importance of treatment delay upon healing of mandibular fractures, based on the analyzed studies is difficult to make as these studies showed different results. The suggestions by Maloney (16, 28) of different treatment approaches according to time after injury (i.e. being less or more that 74 h) are apparently not supported by other studies (29).

In that regard it should be considered the significant finding of an augmented risk of infection is based on only three cases occuring in the group with late treatment (Table 1). Two other studies [Wagner et al. (4) and Moulton-Barret et al. (21)] seem to indicate a bimodal occurrence of complications. The slightly lowered complication rate found after 3–5 days in Wagner's study may indicate that tissues get 'prepared' for surgery after a few days by initiation of the wound healing response (30). This bimodal appearance is partly supported by the data from Moulton-Barret et al. (21). However this apparent bimodal appearance of complications is at best a trend and no significant relation could be demonstrated (Table 1).

In the discussion of treatment delay, it should be mentioned that the very acute treatment approaches (i.e. within the first 12 h) may imply that less experienced surgeons will often be operating the patients. In that regard it is of interest that open reposition of jaw fractures has been shown to be a technique sensitive procedure (36). This factor indicates that jaw fracture treatment should possibly be performed as a semi-elective procedure.

In conclusion, based on the present studies it seems not possible to reach a definite conclusion about the influence of treatment delay upon the risk of healing complications. It therefore seems reasonable to choose early treatment for the comfort of the patient.

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