The effect of maxillary–mandibular fixation on salivary immunoglobulin A and serum interleukin-6 in patients with mandibular fractures
Amr Mansoura, Abeer Kamalb, Basma Moussadc, Mohammed Dehis and Gloria Gameelc

Objectives The aim of this study was to determine the possible effect of maxillary–mandibular fixation as a definitive treatment for mandibular fracture on some aspects of immunocompetence.

Study design Sixteen patients with a fractured mandible were included in this study. They were selected from among those attending the outpatient clinic of the Oral and Maxillofacial Surgery Department, Faculty of Oral and Dental Medicine, Cairo University. Salivary immunoglobulin A and interleukin-6 were the immunologic parameters used throughout this study.

Results The level of salivary immunoglobulin A was increased significantly from the preoperative period to 1 week postoperatively; it then resumed a significant increase until the second week postoperatively and was decreased significantly at 4 weeks postoperatively.

Introduction and review of literature
The present study aimed at determining the effect of maxillary–mandibular fixation (MMF) on the immunocompetence of patients with a fractured mandible. Most of the researches on oral and maxillofacial trauma have been directed extensively toward the improvement of surgical approaches, appliances, and techniques; however, the study of trauma and jaw immobilization with regard to a patient’s immunocompetence has not received the same attention. Many factors influence a patient’s immune defense mechanism such as age, degree of trauma, nutrition, systemic disease, psychological stress factors, as well as planned surgical trauma [1–7].

Interleukin-6 (IL-6) and salivary immunoglobulin A (sIgA) are the immunologic parameters used throughout this study. sIgA plays a key role in maintaining oral immunocompetence. It prevents adherence of microorganism to the oral mucosa. It has a proinflammatory function as it enhances the function of nonspecific host defense elements and facilitates phagocytosis. IL-6 is an important cytokine that plays a key role in amplifying inflammation. It responds very early to trauma and is easily detected in serum because of lack of systemic inhibitors. It is usually involved in the early stages of the immediate postoperative reaction. It is also an essential cytokine for induction of immunoglobulin [8–10].

Fractures of the mandible are the most common type of injury in the field of maxillofacial trauma. Treatment of mandibular fracture by MMF is considered as a simple and widespread modality of treatment. Patients undergoing MMF were exposed to additional trauma during treatment. Arch bar fixation causes periodontal trauma and inflammation during the period of immobilization. In addition, owing to the length of the treatment, the patients are exposed to many influential factors such as stress resulting from the fixation and staying away from the pattern of normal life, malnutrition, and loss of weight. All these factors may have a certain impact on the immune competence of patients during the treatment period [11–14]. Results of the study may contribute to the management of patients with mandibular fractures.

Patients and methods
Sixteen patients with a fractured mandible due to trauma were included in this study; they were selected from among patients attending the outpatient clinic of the Department of Oral and Maxillofacial Surgery, Faculty of Oral and Dental Medicine, Cairo University. The age of the patients ranged between 18 and 39 years; they had no contraindications for MMF and had sufficient bilateral dentition to allow for MMF and assessment of an occlusal relationship. Finally, the fracture line should be bound by dentition on both distal and proximal segments (Table 1).

Diagnosis of a mandibular fracture was established on the basis of careful history taking and thorough clinical and radiographic examinations (Fig. 1). A specially prepared
examination sheet was used for recording all the gathered data, starting from the date of administration, personal data of the patient, medical history, case history, and chief complaint of the patient.

The selected sample included 16 patients, 14 men and two women. The cause of injury was interpersonal violence in eight (50%) patients and motor vehicular accidents (MVA), falls, and industrial accidents in eight patients. The fracture was located in the body of the mandible in eight patients (50%) and was parasymphyseal in eight patients (50%).

A standard panoramic radiograph was obtained preoperatively to reveal the fracture line, anatomic location of the fracture, type of fracture, and presence of any pathological lesions. Patient consent was obtained before starting treatment by maxillary–mandibular fixation. The concept of fixation, duration of treatment, feeding technique, speech problems that could be encountered, and the expected prognosis were discussed with the patient before commencing treatment.

A prefabricated Erich Arch Bar was used as an anchorage appliance. It was fixed under local anesthesia (mepecaine-L; Alexandria Pharmaceutical Co., Alexandria, Egypt). The fractures were reduced using elastic band traction. During maximum interdigitation and preinjury occlusion, the elastic bands were replaced by maxillary–mandibular ligation wires (Fig. 2).

Four samples from serum and nonstimulated mixed saliva were collected at different intervals: preoperatively and 1, 2, and 4 weeks postoperatively. Venous blood was obtained from the antecubital site of the patient’s arm; it was immediately poured in a clean test tube. The serum sample was prepared by centrifuging and stored at –20°C until analysis. A nonstimulated mixed saliva sample was collected by instructing the patient to swallow and then asking him/her to retain saliva in his/her mouth until he/she would normally wish to swallow then collecting it using a disposable syringe. The collected saliva was centrifuged and stored at –20°C until analysis.

The assay for the immunologic parameters in the present research was performed at the Department of Clinical Pathology and Immunology, National Research Center, Egypt. sIgA and serum IL-6 were tested using the enzyme-linked immunosorbent assay technique. The collected data were tabulated and statistically analyzed using a paired sample t-test and the analysis of variance test (ANOVA).

Results
Levels of salivary immunoglobulin A at the different time intervals
On measuring the preoperative level as a reference point for comparison with postoperative intervals of 1, 2, and 4 weeks, it was detected that there is a significant increase at 1, 2, and 4 weeks postoperatively. On taking the 1-week postoperative level as a reference point for comparison with 2- and 4-week postoperative levels, it

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Age</th>
<th>Sex</th>
<th>Etiology</th>
<th>Anatomic location</th>
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<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>Female</td>
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<td>Posterior fracture</td>
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<tr>
<td>2</td>
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<td>Male</td>
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<td>Posterior fracture</td>
</tr>
<tr>
<td>3</td>
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<td>Posterior fracture</td>
</tr>
<tr>
<td>4</td>
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<td>Posterior fracture</td>
</tr>
<tr>
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<tr>
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<td>20</td>
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<td>MVA</td>
<td>Posterior fracture</td>
</tr>
<tr>
<td>11</td>
<td>22</td>
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<td>MVA</td>
<td>Posterior fracture</td>
</tr>
<tr>
<td>12</td>
<td>23</td>
<td>Male</td>
<td>Falling</td>
<td>Anterior fracture</td>
</tr>
<tr>
<td>13</td>
<td>24</td>
<td>Male</td>
<td>Interpersonal violence</td>
<td>Posterior fracture</td>
</tr>
<tr>
<td>14</td>
<td>33</td>
<td>Female</td>
<td>Falling</td>
<td>Anterior fracture</td>
</tr>
<tr>
<td>15</td>
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<td>Male</td>
<td>MVA</td>
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<tr>
<td>16</td>
<td>39</td>
<td>Male</td>
<td>Interpersonal violence</td>
<td>Anterior fracture</td>
</tr>
</tbody>
</table>

Anterior fracture: parasympheseal fracture.
Posterior fracture: body fracture.
MVA, motor vehicle accident.
was detected that there is a significant increase at 2 weeks and a significant decrease at 4 weeks postoperatively. On comparing the level of sIgA 2 weeks postoperatively with that 4 weeks postoperatively, it was detected that there is a statistically significant decrease in the level of sIgA at 4 weeks postoperatively (Table 2 and Fig. 3).

Levels of serum interleukin-6 at different time intervals

On measuring the preoperative level of serum IL-6 as a point of comparison with those 1, 2, and 4 weeks postoperatively, it was detected that there is a significant increase at 1, 2, and 4 weeks postoperatively. On taking the level of serum IL-6 at 1 week postoperatively as the reference point, it was detected that there was a statistically significant increase in the level of IL-6 at 2 weeks postoperatively. On talking the level of serum IL-6 in blood at 1 week postoperatively as a reference point, it was detected that there was a statistically nonsignificant decrease in the level of IL-6 at 4 weeks postoperatively. On comparing the level of serum IL-6 at 2 weeks postoperatively with that at 4 weeks postoperatively, it was detected that there is a statistically significant decrease in the level of IL-6 at 4 weeks postoperatively (Table 3 and Fig. 4).

Discussion

The majority of the previous studies and researches on the treatment of mandibular fractures was directed at the improvement of surgical approaches, techniques, and devices. However, the study of MMF with regard to the immunocompetence of a patient has not received the same attention.

Table 2 Statistical evaluation of changes that occurred in the levels of salivary immunoglobulin A at different time intervals

<table>
<thead>
<tr>
<th>sIgA</th>
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<th>SD</th>
<th>t-paired</th>
<th>P-value</th>
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<td>Preoperatively</td>
<td>59.5625</td>
<td>17.67849</td>
<td>-6.135</td>
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<td>78.9375</td>
<td>26.36024</td>
<td>9.605</td>
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<tr>
<td>Preoperative</td>
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<td>17.67849</td>
<td>-6.135</td>
<td>0.000</td>
</tr>
<tr>
<td>2 weeks postoperatively</td>
<td>85.1563</td>
<td>24.13070</td>
<td>-8.339</td>
<td>0.000</td>
</tr>
<tr>
<td>Preoperatively</td>
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<td>17.67849</td>
<td>-6.135</td>
<td>0.000</td>
</tr>
<tr>
<td>4 weeks postoperatively</td>
<td>73.2875</td>
<td>23.13747</td>
<td>-7.758</td>
<td>0.000</td>
</tr>
<tr>
<td>1 week postoperatively</td>
<td>78.9375</td>
<td>26.36024</td>
<td>-8.339</td>
<td>0.000</td>
</tr>
<tr>
<td>2 weeks postoperatively</td>
<td>85.1563</td>
<td>24.13070</td>
<td>-5.444</td>
<td>0.000</td>
</tr>
<tr>
<td>Preoperatively</td>
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<td>17.67849</td>
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<td>4 weeks postoperatively</td>
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<td>73.2875</td>
<td>23.13747</td>
<td>-7.758</td>
<td>0.000</td>
</tr>
</tbody>
</table>

sIgA, salivary immunoglobulin A.

| Fig. 3 |

Mean sIgA levels preoperatively and 1, 2, and 4 weeks postoperatively.

Table 3 Statistical evaluation of changes that occurred in the level of serum IL-6 at different time intervals

<table>
<thead>
<tr>
<th>IL-6</th>
<th>Mean</th>
<th>SD</th>
<th>t-paired</th>
<th>P-value</th>
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<tr>
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<td>3.79508</td>
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<tr>
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<td>4.80125</td>
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<td>3.79508</td>
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<td>2 weeks postoperatively</td>
<td>13.6688</td>
<td>4.94176</td>
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<td>4 weeks postoperatively</td>
<td>11.3373</td>
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<td>1 week postoperatively</td>
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<td>4.80125</td>
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<td>4.80125</td>
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</table>

IL-6, interleukin-6.

| Fig. 4 |

Mean IL-6 levels preoperatively and 1, 2, and 4 weeks postoperatively.

Immunoglobulin A (IgA) is one of the immunologic parameters that is predominant in salivary secretions. It plays a key role in maintaining oral immunity through the continuous bathing adherent effect of saliva on oral mucosa. It has a proinflammatory role as it enhances the function of nonspecific host defense elements and facilitates phagocytosis; for these reasons sIgA was used as a monitor to determine the effect of oral trauma on the integrity of local immunity [15,16].

IL-6 was another immunologic parameter used in the study. It is a sensitive mediator that responds very early and rapidly to trauma, whatever be its magnitude. It is easily detected in serum because of the lack of systemic inhibitors that usually exist for other ILs, as reported by Gauldine et al. [17]. Many different types of tissue cells participate in the release of IL-6; it almost exists in circulation. Hence, it is involved in the early stages of the immediate postoperative reaction. IL-6 is used as a monitor for complicated sequelae after trauma by measuring the plasma concentration, which acts as an early marker of post-traumatic damage. It is also an essential cytokine for induction of immunoglobulins. The present study was designed to determine the possible effect of MMF on both systemic and local immunologic responses and to detect these responses through two selected parameters [18,19].

Patients between 18 and 39 years of age were selected to be the sample in this study as patients in this age group are more susceptible to mandibular trauma such as vehicular accidents, assaults, falls, and sports or industrial
injuries compared with older patients and have less bone resilience compared with younger patients. This concept of selection is supported by several studies [20–22]. The present study was directed toward a sample of patients who are medically free from disease, have no risk associated with MMF, and have a simple, reducible, and recent mandibular fracture. MMF was a suitable technique for the definitive treatment of such patients without the need for additional surgical trauma caused by open reduction direct fixation. Weight loss is one of the major side effects associated with MMF following jaw fracture; it prevents the movement of the mandible, thus the intake of only liquid or well blanderized food is possible; this usually leads to weight loss of 10–15% of the initial body weight. Mastication and ingestion are seriously compromised. When the dietary intake of a previously healthy individual is decreased for about 10–12 days, protein energy malnutrition may occur, resulting in loss of weight [23–25].

On comparing the preoperative results of the two calibers of the study (sIgA and IL-6) with their reference values, a marked increase as compared with the preoperative level was observed. This finding supports the hypothesis that traumatic injuries induce inflammatory changes with marked elevation in the level of mediators. In addition, MMF and periodontal trauma will result in an increased level of sIgA and serum IL-6 [15,16].

At 4 weeks postoperatively, it was observed that there was a marked decrease in the levels of sIgA and serum IL-6 as compared with those at 2 weeks postoperatively. This may support the hypothesis that a prolonged period of MMF may cause weight loss and protein energy malnutrition in patients, which could induce immunodeficiency changes that explain the decrease in levels of the two calibers [23,24].

Acknowledgements
The authors thank Dr Ibrahim Hegazy, Professor of Public Health and Community Medicine, Faculty of Medicine, Cairo University, for carrying out the statistical analysis for this work.

Conflicts of interest
There are no conflicts of interest.

References
25. Mc Gee DW, Mc Cumry DN. Protein malnutrition reduces the IgA immune response to oral antigen by altering B cell and suppressor T cell functions. Immunology 1988; 64:697.