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Prospective study of treatment outcomes with lag screw versus Herbert screw fixation in mandibular fractures

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Abstract. The principle of axial compression for better adaptation of fracture segments, with the advantage of increased stability and early function, is a promising means of avoiding the bulky rigid plates used previously. This study was done to compare the treatment outcomes between Herbert screw and lag screw fixation in mandibular fractures. Thirty patients with oblique displaced or undisplaced mandibular fractures requiring open reduction and internal fixation with rigid screw fixation, under general anaesthesia, were included. Herbert screws were used in 15 patients (group 1) and lag screws were used in the other 15 patients (group 2). Patients were followed up at 1 week, 6 weeks, 3 months, and 6 months for postoperative occlusion, inter-fragmentary mobility, pain, nerve sensation, and isodensity values on panoramic radiographs. Postoperative occlusion, inter-fragmentary mobility, pain, and nerve sensation were similar in the two groups. Group 1 patients attained isodensity values similar to the final follow-up value much faster than group 2 patients ($P < 0.05$). This study strongly suggests that the use of Herbert screws results in significantly faster healing as compared to lag screws, in terms of achieving higher isodensity values faster.

Key words: Herbert screw; lag screw; mandible fracture fixation.

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In 1976, Spiessl and colleagues established open reduction and internal fixation with the principles now advocated by the Arbeitsgemeinschaft für Osteosynthesefragen (Association for Osteosynthesis/Association for the Study of Internal Fixation (AO/ASIF)), mainly functionally stable fixation.[1] Schenk and Willenegger had previously shown that primary healing can be expected only if there is absolutely rigid fixation of the fragments.[2] Luhr introduced the concept of compression plating, the principle of axial compression for better adaptation of the fracture ends, combined with the distinct advantage of increased stability and early function.[3] However, the increased armamentarium made this less popular over a period of time. The concept of using only a lag screw was thus developed to fulfil this goal.

The lag screw technique for the maxillofacial region was first introduced in 1971 by Brons and Boering, who advocated the use of at least two screws to eliminate the rotational component in oblique fractures of the mandible.[4] Lag screw compression

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works by the head engaging the outer cortex first, with further rotations making the segments compress against each other.[5] It is limited by the fact that the head acts as a wedge and cannot be placed flush with the bone and hence its use is limited in areas of articulation. Another disadvantage is fracture of the proximal segment during screw tightening.

In 1984, Herbert and Fisher described the use of a screw with a differential pitch and a blank shaft in the centre for use in scaphoid bone fractures, which they called the Herbert screw.[6] The Herbert screw is a headless screw which works on the same principle as the lag screw. This screw has threads at both ends and a blank shaft in between. The threads at the leading end have a larger pitch and smaller diameter, while the threads at the trailing end have a smaller pitch and a larger diameter. This screw was introduced mainly to address the disadvantage of the lag screw head, which interfered in the articulation surfaces. Due to the differential pitch, the screw does not utilize the head to cause compression between the segments but draws both segments towards each other. As the leading end threads engage the inner cortex, the cortex is pulled out and compression is eventually caused as the trailing end threads engage the outer cortex.[7] A further advantage is the blank shaft in the centre with no threads along the fracture line.

Although the indexed contemporary literature currently includes only a single retrospective study in which a Herbert screw was placed in an edentulous atrophic mandible[8], there appear to have been no prospective studies on the treatment outcomes of Herbert screw fixation in maxillofacial trauma. Hence the present study was performed with the aim of comparing the treatment outcomes between Herbert screw and lag screw fixation of mandibular fractures.

Materials and methods

Thirty patients with oblique displaced or undisplaced mandibular fractures requiring open reduction and internal fixation (ORIF), who reported to the maxillofacial unit between September 2013 and September 2015, were included. Herbert screws were used in 15 patients (group 1) and lag screws were used in the other 15 patients (group 2). Subjects with oblique fractures or sagittally split fractures of the symphysis, parasymphysis, body, or angle of the mandible alone, with no bone loss, were included. Subjects with systemic diseases that could have interfered with healing (e.g., diabetes, chemotherapy or radiotherapy, and collagen disorders), comminuted fracture patterns, and patients not willing to participate were excluded from the study.

The institutional review board approved the identification and selection process of subjects meeting the inclusion criteria, as well as the treatment options used to accomplish this study. Written informed consent was obtained from all of the patients before the procedures. Prior to surgery, full case histories and clinical examinations were recorded on standardized forms. The preoperative radiographic assessment was done using digital panoramic radiographs (Kodak 8000 C Digital Panoramic and Cephalometric System). The radiographs for each patient were standardized by keeping the exposure time, voltage, and patient position constant at each follow-up. Other radiographic views or computed tomography were requested as deemed necessary. The preoperative radiographic assessment was done to identify the fracture lines, presence of a tooth in the line of fracture, degree of displacement, and inferior alveolar nerve location (Fig. 1). All patients were treated by ORIF with either titanium Herbert screws or titanium lag screws by a single surgeon. The patients were grouped by simple randomization using the envelope method of sampling, resulting in a double-blind study.

In the process of grouping the patients, matching was done by sex, medical history, and location and number of fractures to minimize confounding factors. The lag screw principle and the principles of rigid internal fixation were advocated for fixation.[9]

The Herbert screws used had a shaft diameter of 1.25 mm (3.2 mm cortical head and 2.5 mm cancellous head) and a length ranging from 8 mm to 24 mm. The outer cortex, followed by inner cortex, was drilled with a 2.3-mm drill bit. A bone tap of 2.5 mm was used to outline the threads in the inner fracture segment. Another bone tap of 3.0 mm was used only in the outer fracture segment. The lag screws used had a diameter of 2.0 mm or 2.5 mm and a length ranging from 8 mm to 24 mm. A countersink was prepared for the head of the lag screw. A drill bit of appropriate size, either 1.5 mm or 2.0 mm, was selected. The outer cortex, followed by inner cortex, was drilled with the appropriate drill bit. Both screws were procured from a local implant manufacturer.

The depth of the osteotomy was measured using a depth gauge, and a screw of corresponding length was selected and inserted until flush with the bone. A minimum of two screws were placed, and if the fractured segments were unstable, an additional screw was placed. All patients received intravenous antibiotics from the time of admission, followed by a course of oral antibiotics for 5–7 days after discharge.

Clinical and radiographic postoperative evaluations were performed (Figs 2 and 3). The clinical assessment included postoperative occlusion, inter-fragmentary mobility (assessed by bi-manual palpation across the fracture site), and pain (assessed by visual analogue scale). Nerve sensation was compared with the preoperative condition using mechanoreceptive (static light touch, brush directional stroke, and two-point discrimination) and nociceptive methods (pin pressure). Complications such as wound dehiscence, the presence of a wound infection, hardware exposure or loosening, reduced inter-incisal opening, and the need for hardware removal were also recorded. The postoperative radiographic assessment was done to determine the density of the healing fracture line by taking three standard points along the

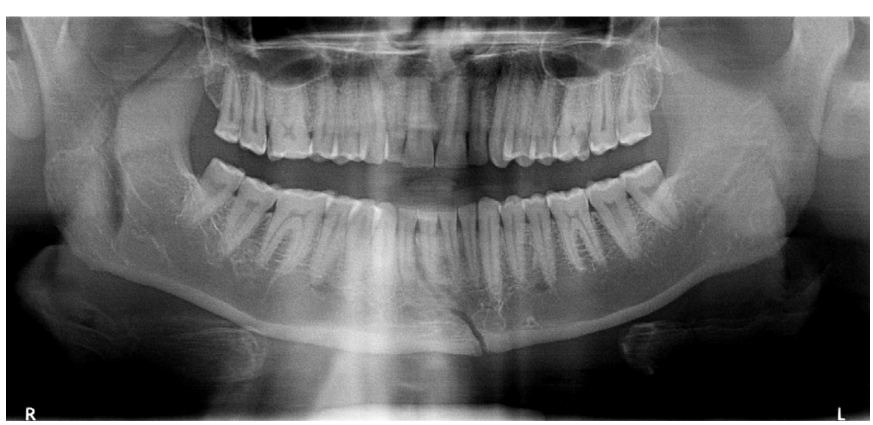

Fig. 1. Preoperative panoramic radiograph of a mandibular right parasymphysis fracture.

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