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ORIGINAL ARTICLE

# Surgical management of unilateral body fractures of the edentulous atrophic mandible

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## Abstract

**Introduction** Management of body fractures in patients with edentulous atrophic mandibles represents a challenging task due to patient's age, medical comorbidities, poor bone quality, and vascularity, as well as reduced contact area between the fracture ends. The aim of the study was to assess the demographic and clinical variables, the surgical technique, and outcomes of unilateral body fractures of the edentulous atrophic mandible managed at several European departments of oral and maxillofacial surgery.

**Methods** This study is based on a systematic computer-assisted database that allowed the recording of data of all patients with fractures of the atrophic edentulous mandible from the involved maxillofacial surgical units across Europe between 2008 and 2017. The following data were recorded for each patient: gender, age, comorbidities, etiology, synchronous body injuries, degree of atrophy of the mandible according to Luhr classification, type of surgical approach and fixation, length of hospitalization, and presence and type of complications.

**Results** A total of 43 patients were included in the study: 17 patients' mandibles were classified as class I according to Luhr, 15 as class II, and 11 as class III. All patients underwent open reduction and internal fixation by extraoral approach in 25 patients, intraoral in 15 patients, and mixed in 3 patients. A single 2.0 miniplate was used in 16 patients, followed by a single 2.4 reconstruction plate in 13 patients, by two 2.0 miniplates, and three 2.0 miniplates. Outcome was considered to be satisfying in 30 patients, with no complications. Complications were observed in 13 cases.

**Conclusions** Treatment of unilateral body fractures of the edentulous mandible must still be based on the type of fracture, degree of atrophy, experience of the surgeon, and patients' preference. An adequate stability can be obtained by different plating techniques that have to be appropriately tailored to every single specific patient.

**Keywords** Atrophic mandible · Fracture · Edentulous · Body · Management

## Introduction

Management of body fractures in patients with edentulous atrophic mandibles represents a challenging task due to patient's age, medical comorbidities, poor bone quality, and vascularity, as well as reduced contact area between the fracture ends [1–22].

Currently, open reduction and internal fixation is considered the golden standard of treatment and the most predictable method of managing fractures of the atrophic mandible [1–5].

Nevertheless, there is still no consensus about the optimal surgical approach and the best plating system option. Furthermore, in the literature, few articles present uniform populations regarding body fractures of edentulous atrophic mandibles, probably due to the rarity of this condition.

Consequently, several types of load-sharing and load-bearing plate fixation have been proposed, including miniplates with or without compression applied to the lateral border, inferior border, and/or superior border of the fractured mandible; titanium mesh applied to the lateral or inferior

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border or both; bone clamps, reconstruction plates applied laterally or inferiorly, with or without simultaneous bone grafting; wire osteosynthesis; external fixation with biphase pins; and indirect fixation by circum-mandibular wiring of a prosthesis [1–8].

Moreover, a Cochrane review concluded that there is currently inadequate evidence for the the effectiveness of a single approach in the management of fractured atrophic edentulous mandibles and the treatment is often based on clinicians previous experience [1–8].

Therefore, several European centers that had already shown research experience in maxillofacial trauma [12–22] decided to collaborate on a multicenter research project about the management of unilateral body fractures of the edentulous atrophic mandible, in order to obtain a wide study population and to reduce bias.

The aim of the study was to assess the demographic and clinical variables, the surgical technique, the outcomes, and patterns of unilateral body fractures of the edentulous atrophic mandible managed at several European departments of oral and maxillofacial surgery.

## Methods

This study was conducted at several European departments of oral and maxillofacial surgery: Division of Maxillofacial Surgery, University of Eastern Piedmont (Novara, Italy); Department of Maxillofacial Surgery, University Hospital Dubrava (Zagreb, Croatia); Clinic of Maxillofacial Surgery, School of Dentistry, University of Belgrade (Belgrade, Serbia); Department of Oral surgery, Faculty of Dental medicine, Medical University (Plovdiv, Bulgaria); Department for Oral and Maxillofacial Surgery, Bogomolets National Medical University (Kiev, Ukraine); Service de Stomatologie et Chirurgie Maxillo-faciale, CHU de Nantes (Nantes, France); Department of Oral and Maxillofacial Surgery, Aalborg University Hospital (Aalborg, Denmark); Department of Maxillofacial Surgery, North Estonia Medical Centre Foundation (Tallinn, Estonia); Department of *Maxillofacial* and Oral Surgery of the University Medical Centre (Ljubljana, Slovenia); and Maxillofacial Department, Hospital Universitario Central de Asturias (Oviedo, Spain).

This study is based on a systematic computer-assisted database that allowed the recording of data of all patients with fractures of the atrophic edentulous mandible from the involved maxillofacial surgical units across Europe between January 1, 2008, and December 31, 2017.

Only patients that were diagnosed with unilateral body fractures of the atrophic edentulous mandible were included.

The following data were recorded for each patient: gender, age, comorbidities, etiology, synchronous body injuries (orthopedic, encephalic, thoracic, abdominal), degree of atrophy of the mandible according to Luhr classification, type of surgical approach (extraoral, intraoral, mixed), plating systems used for fixation (one 2.0 plate, two 2.0 plates, three 2.0 plates, one 2.4 reconstruction plate), timing of surgery (within 24 h, within 72 h, beyond 72 h), length of hospitalization, and presence and type of complications at 3 months (inferior alveolar nerve deficit, exposed plate, osteomyelitis/infection).

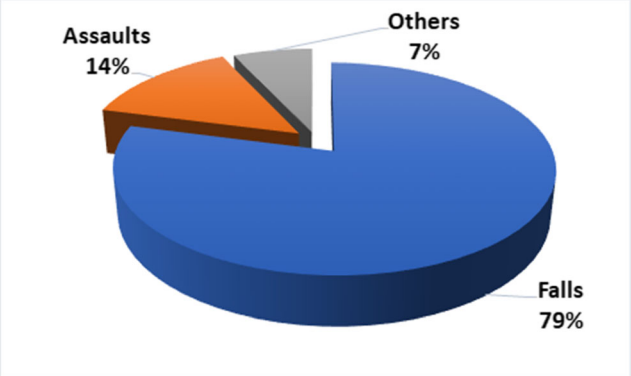


**Fig. 1** Etiology distribution within the study population

The following categories of the cause of injury were considered: fall, motor vehicle accident, assault, sport injury, work injury, and other causes.

The degree of atrophy of the mandibles was categorized according to Luhr et al. [5]: bone height from 16 to 20 mm was classified as class I, from 11 to 15 mm as class II, and equal or less than 10 mm as class III atrophy.

Patient characteristics were analyzed using descriptive statistics. Statistical analysis was used to search for associations among multiple variables. Statistical significance was determined using the $\chi^2$ test or, if the sample sizes were too small, the Fisher exact test. Statistical significance was set at 0.05. We followed the Helsinki Declaration guidelines, according to local laws. The study was exempt from requiring institutional review board approval as a retrospective study, according to a local institution.

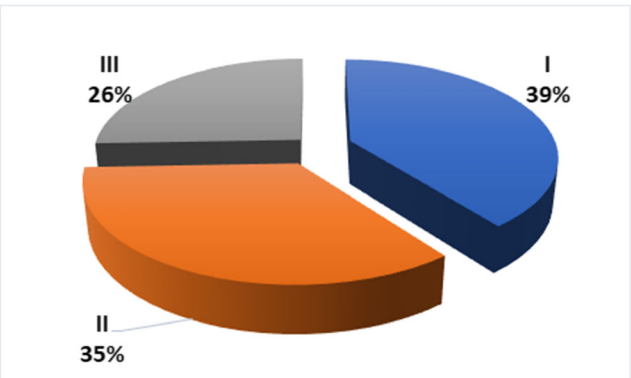


**Fig. 2** Luhr classification of edentulous mandibles of the study population

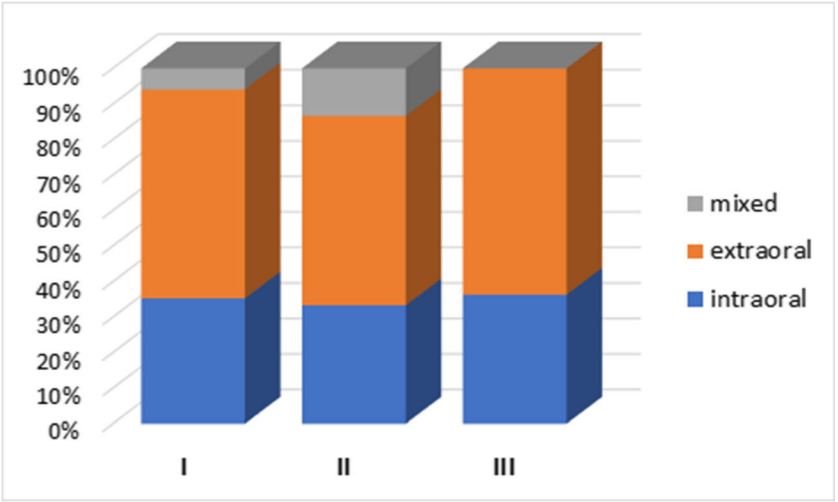


**Fig. 3** Proportion of surgical approaches according to Luhr classes of atrophy

## Results

A total of 43 patients (15 male and 28 female patients) fulfilled the inclusion criteria and were included in the study.

The mean age of the study population was 74.7 years (median, 77 years; standard deviation, 10.7 years; range, 52 to 94 years).

On the whole, 26 patients (60%) reported one or more comorbidities, the most frequent being hypertension [13], followed by dementia [6], heart rhythm disease [6], and diabetes [5].

As for etiology, the most frequent cause of injury was fall with 34 patients (79%), followed by assaults (6 patients, 14%), and other causes (3 patients, 6%) (Fig. 1).

On the whole, 17 patients' mandibles were classified as class I according to Luhr, 15 as class II, and 11 as class III (Fig. 2).

Concomitant injuries were observed in 5 patients out of 43. Most frequently observed concomitant injuries were orthopedic injuries (4 patients).

All patients underwent open reduction and internal fixation that was performed within 24 h in 20 cases, within 72 h in 7 cases, and beyond 72 h in 16 patients.

The selected surgical approaches were extraoral in 25 patients, intraoral in 15 patients, and mixed in 3 patients. Figure 3 depicts the proportion of surgical approaches according to Luhr's classification of atrophy.

As for plating systems, a single 2.0 miniplate was used in 16 patients, followed by a single 2.4 reconstruction plate in 13 patients, by two 2.0 miniplates in 12 patients, and three 2.0 miniplates in 2 patients. Figure 4 depicts the distribution of the used plating systems according to Luhr's classification of atrophy. No bone graft was used.

Outcome was considered to be satisfying in 30 patients, with no complications. Complications were observed in 13 cases. The most frequently encountered complication was inferior alveolar nerve (IAN) deficit (10 patients), whereas infection of plates and exposition of plates were observed in 2 and 1 patients, respectively.

Mean length of hospitalization was 6.8 days (range, 1–25; SD, 4.9).

No significantly statistical association was found between the considered variables.

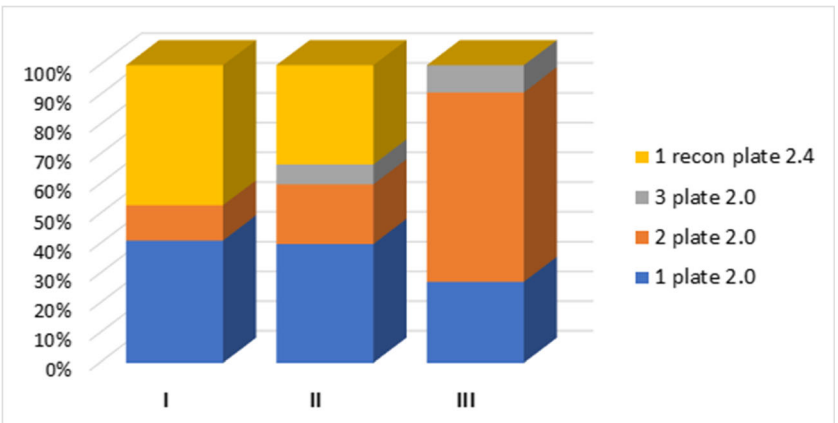


**Fig. 4** Distribution of the used plating systems according to Luhr classes of atrophy

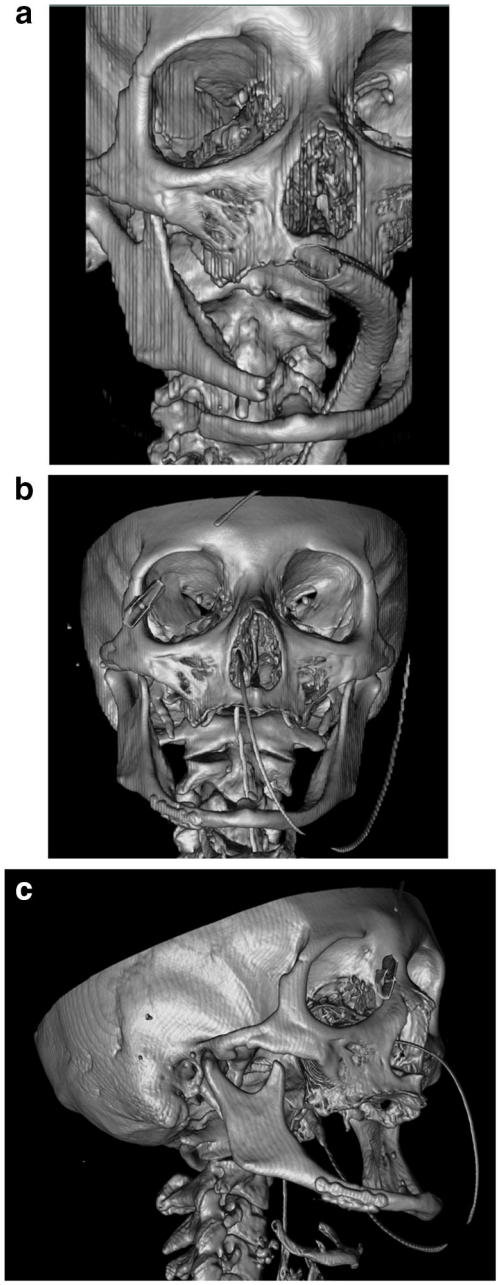


**Fig. 5** Female patient from Aalborg center, 86 years, reporting a dislocated mandibular body fracture following a fall (**a**). Past medical history included dementia. The mandible was rated as Luhr class III. The patient underwent open reduction and internal fixation within 24 h, by an extraoral approach and the placement of two 2.0 miniplates (**b**, **c**). No complication was observed postoperatively

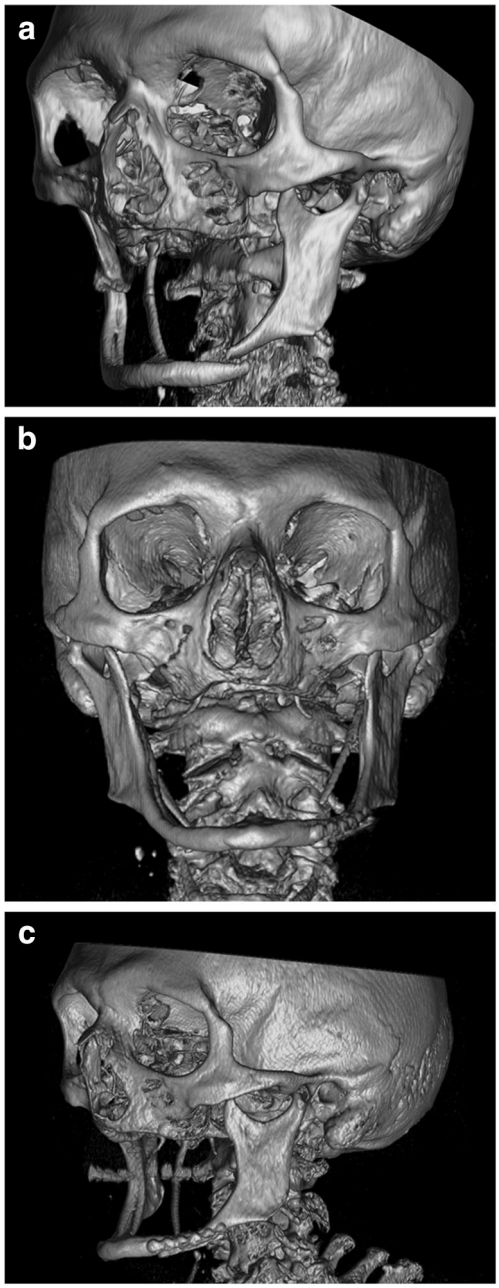


**Fig. 6** Male patient from Aalborg center, 92 years, reporting a dislocated mandibular body fracture following a fall (**a**). Past medical history included dementia. The mandible was rated as Luhr class III. The patient underwent open reduction and internal fixation within 24 h, by an extraoral approach and the placement of two 2.0 miniplates (**b**, **c**). IAN deficit was observed postoperatively

## Discussion

The rarity and the complexity of fractures of the atrophic mandible still make them one of the most challenging fields of maxillofacial trauma.

First of all, the old age, the high percentages of comorbidities, and the social frailty in patients with fractures of the edentulous atrophic mandible are important features to be considered for the general management of these frail patients. In fact, in our study population, mean age was 74.7 years and 60% of patients presented one or more comorbidities. The frequency of falls as etiological factor confirms an actual trend of maxillofacial trauma in the elderly.

It was interesting to notice a quite uniform distribution of Luhr's classification of the considered mandibles (Fig. 2).

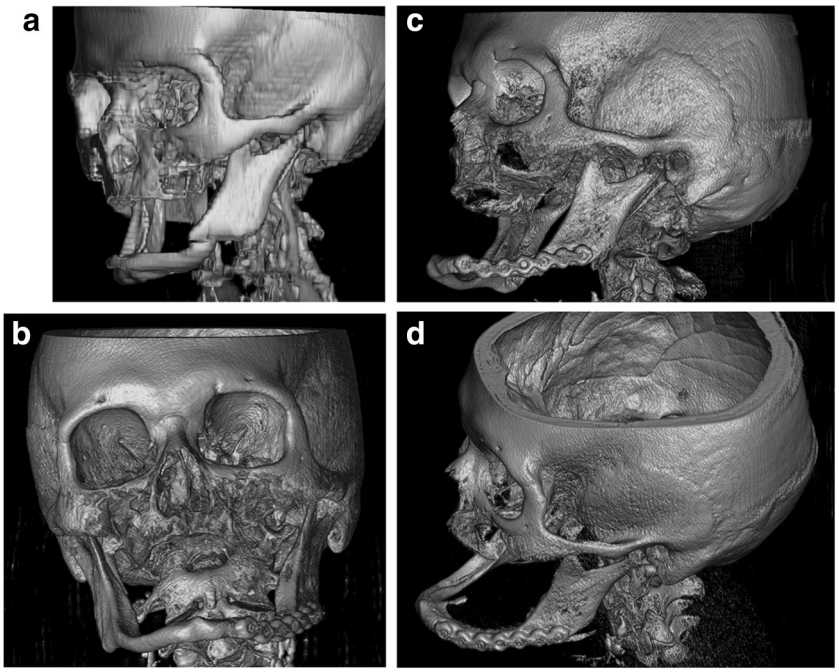


**Fig. 7** Female patient from Aalborg center, 78 years, reporting a dislocated mandibular body fracture following a fall (**a**). Past medical history included dementia and hypertension. The mandible was rated as Luhr class II. The patient underwent open reduction and internal fixation within 24 h, by an extraoral approach and the placement of a single reconstruction 2.4 plate (**b**, **c**, **d**). Inferior alveolar nerve deficit was observed postoperatively

Timing of surgery was not significant, as the delayed treatment in 16 patients may have been often determined by a complex management of comorbidities in these challenging patients.

The most important findings of our study regard surgical approaches and plating systems.

An extraoral approach was performed in 25 patients, an intraoral one in 15 patients, and a mixed access in 3 patients. Figure 3 depicts the proportion of surgical approaches according to Luhr's classification of atrophy; apparently, the degree of atrophy did not represent a determining factor for the choice of the surgical approach. In all the Luhr class III, most patients underwent an extraoral approach, while about 30–40% of patients underwent an intraoral access.

Instead, as for plating systems, there was a substantial uniform distribution between a single 2.0 miniplate (16 patients), a single 2.4 reconstruction plate (13 patients), and two 2.0 miniplates (12 patients). Nevertheless, the situation becomes more interesting if we consider the fixation techniques in relation to Luhr's classification (Fig. 4). In the study population, a single 2.4 reconstruction plate was more frequently used in Luhr classes I and II. In patients assigned to Luhr class III, the most commonly used plating system was two 2.0 miniplates. Finally, about 25–35% of patients in each Luhr class were treated by a single 2.0 miniplate. (Fig. 5, 6, and 7).

The present study solely includes unilateral body fractures, since bilateral body fractures in Luhr class III represent a more complex issue with much higher load and muscle traction on the anterior part of the mandible, which need stronger fixation plates. In fact, the treatment strategy would be significantly different in case of bilateral body fractures due to larger muscle traction on the anterior segment, which needs stronger fixation plates. The good results in the present article with 1–3 miniplate fixation of the atrophic edentulous mandible may be a consequence of only including unilateral fractures.

Of course, our results confirm the Cochrane conclusion: clinicians should base their decisions on clinical experience and in conjunction with patients' preferences where appropriate [1–8]. In this type of trauma, it is fundamental to balance the patient age, the anesthesiology risks, the degree of atrophy of the mandible, the need and preferences of the patients, the presence of a denture, and the experience of a surgeon with specific plating systems. Nevertheless, chronologic age should not be a contraindication to a carefully administered general anesthetic [1–8].

For example, as for surgical approach, extraoral approach has been traditionally proposed, in order to avoid complete periosteal stripping of the mandible and to reduce the risks for plate infection or exposition. Moreover, in Luhr class III, the inferior alveolar nerve is located on top of the alveolar crest and interferes with an intraoral approach and it is difficult to adapt a reconstruction plate by an intraoral approach. Therefore, extraoral approach may be useful for selected atrophic edentulous mandibular fractures.

However, intraoral approach may reveal to be less invasive, may avoid extraoral scars, may decrease the risk of injury to the facial nerve, and may offer in high-risk patients the possibility of treatment of these fractures under local anesthesia [1–4].

As for plating systems, the therapeutic problem is represented by nonunion, malunion, and fibrous union of atrophic edentulous mandible fractures [1–6]. The dimension of

fixation plates for the treatment of fractures of atrophic mandibles remains a controversy in the literature. Some authors suggested the use of the smallest available plates, others the use of the most rigid plates, others the use of a less rigid fixation in Luhr class I and a more rigid fixation in Luhr classes II and III [1–9].

The used plating systems in the involved European centers seems to follow the statement that clinical decision should be made on a case by case basis, in agreement with the Cochrane report. It seems that the more atrophic is the mandible, the less rigid the fixation (but with more plates). It is interesting to notice that no malunion or fibrous union were reported. Probably, a role could also be assigned to the maintaining of the periosteal blood supply, in comparison with a more rigid fixation. Of course, this study solely includes unilateral body fractures, because bilateral Luhr class III fractures need stronger plates. According to the AO principles of treatment (fracture reduction and immediate function), atrophic mandible fractures should be seen as a typical load-bearing situation, and consequently, after its reduction, these fractures should be stabilized with a reconstruction plate, currently a 2.4 locking plate.

The amount of bone height available in the severely atrophic (Luhr class III) edentulous mandible does not always permit the placement of a reconstruction plate to maintain biomechanical integrity. Thus, alternative options such as one or two 2.0-mm miniplates may reveal to be useful to obtain a greater soft tissue coverage with a lesser likelihood of plate exposure, as well as an enhanced biomechanical integrity. Due to the small bone height at the fracture level, when the atrophic edentulous mandible fractures are treated using reconstruction plates, the screws are generally placed in the symphyseal and in the angular regions.

Of course, some limitations are associated with the retrospective nature of this study, such as the short-term follow-up that may have influenced some conclusions, such as the complication rate or the ability of these patients to get prosthetic rehabilitation.

## Conclusions

In conclusion, treatment of unilateral body fractures of the edentulous mandible must still be based on the type of fracture, degree of atrophy, experience of the surgeon, and patients' preference. An adequate stability can be obtained by different plating techniques that have to be appropriately tailored to every single specific patient.

### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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