

# Lingual Splint for Sagittal Fractures of Mandible; An Effective Adjunct to Contemporary Osteosynthesis: A Case Series with Review of Literature

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## Abstract

Sagittal fractures of the mandible frequently pose challenges in open reduction and internal fixation due to their unfavorable fracture pattern. The powerful lingual musculatures of the mandible exert tremendous displacing forces on the fracture fragments, resulting in gross lingual displacement. The control of the displaced lingual cortical plate and its restitution to the normal anatomical position before fixation is technically demanding. The article presents a simple and practically effective method of reducing such fractures with the use of a prefabricated lingual splint. The article also reviews the numerous types of lingual splints with their clinical indications.

## Keywords

- ▶ mandible
- ▶ fracture fixation
- ▶ splints
- ▶ sagittal fracture

Sagittal/oblique fractures of the mandible are a common but challenging entity. The fracture line in such cases separates the buccal and lingual cortices over a variable extent depending on the anteroposterior extent of the fracture line, the presence of teeth in the arch, and the resultant pull exerted by muscles such as geniohyoid, genioglossus, and mylohyoid (▶ Fig. 1A).<sup>1</sup>

Unlike linear fracture patterns, oblique fractures render complexity in management in three aspects: (1) The fracture line on the buccal and lingual cortical plates is in different planes, the buccal usually being anterior which make use of miniplates less effective in achieving interfragmentary reduction, (2) difficulty in approximating the displaced lingual cortical plate to the buccal cortical plate to achieve precise anatomic reduction, and (3) inability to verify fracture reduction on the lingual side, intraoperatively.

Accurate anatomic reduction of sagittal fractures or correction of lingual splay is a critical step before positioning of miniplates or lag screws, to achieve precise fixation. Reduction of mandibular splay is made either by manual

compression at the angle region by “hand-holding technique”<sup>2</sup> or by using instruments such as reduction clamps,<sup>3</sup> temporary screw,<sup>4</sup> positioning wires,<sup>5</sup> Becker bone holding forceps,<sup>6</sup> or temporary intraoperative external fixation of mandibular fractures.<sup>7</sup> However, these methods are associated with practical limitations. Manual compression and hand-holding techniques require a skilled assistant and are not reliable for predictable results, while application of the abovementioned instruments is cumbersome, time-consuming, and associated with potential soft tissue injury.

Alternatively, techniques such as (1) modification of fixation implants like over bending the miniplate<sup>2</sup> or (2) use of different designs of implants like reconstruction spanning plate,<sup>8</sup> three-dimensional (3D) plates,<sup>9,10</sup> and 2-mm 3D rectangular grid compression plates<sup>11</sup> help in simultaneous lingual reduction as well as fracture fixation. However, these are relatively expensive and require precision in surgical technique.

This article presents a simple and effective method of using a prefabricated lingual splint to reduce the displaced lingual cortical plate in sagittal fractures of the mandible.

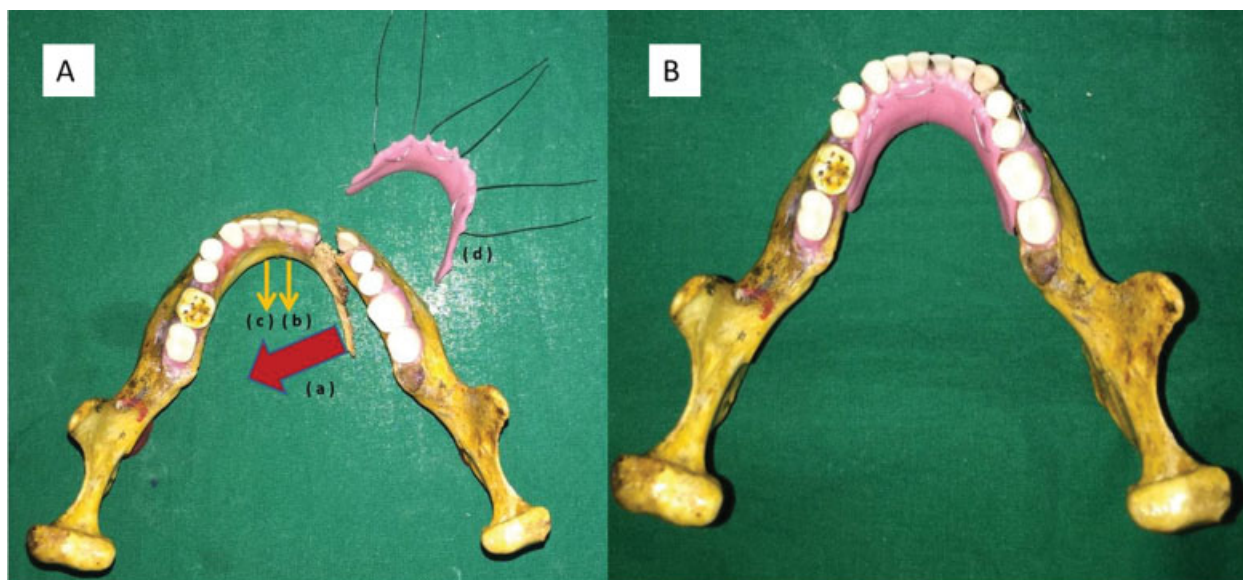
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**Fig. 1** (A) Sagittal fracture of the mandible: Displacing forces (a) mylohyoid, (b) geniohyoid, (c) genioglossus, and (d) lingual splint. (B) Reduction of fracture fragments with a lingual splint.

## Review of Literature

Lingual splints of various designs have been used traditionally for the management of various types of fractures. Before the advent of plates and screws and when the concept of open reduction internal fixation (ORIF) was not in practice, splints were the sole modality of reducing as well as fixing fractures. Desault and Chopart fabricated the first intraoral splint for mandibular fracture in 1780.<sup>12</sup> It was an occlusal splint made of iron which was connected to a plate on the chin. Since then, splints have been used in different forms for several clinical conditions involving trauma. Bean's splint was the first kind of intraoral splint fabrication following the simulation and reduction of fracture lines in the plaster models and model surgery using articulator.<sup>13</sup>

Zaki et al described a compound splint which was composed of intraoral as well as extraoral components for the management of comminuted mandibular fracture. The intraoral part included a maxillary palatal splint as well as a mandibular labiolingual splint which aided in fracture reduction and an extraoral mandibular splint which stabilized the aligned fracture fragments.<sup>14</sup> Intraoral lingual splints have also been used to control the mandibular segments after access osteotomies for resection of the tumor in the posterior tongue and floor of the mouth.<sup>15</sup>

Niimi et al gave a comprehensive description of numerous types of splints for varying fracture patterns involving maxilla and mandible.<sup>16</sup> Lingual splints have been found to be very effective in reducing complicated fracture pattern with lingual displacement. They consisted of a lingual plate which was secured to the mandible using interdental wiring.

Lingual splints have been modified in many ways to suit different clinical indications. The commonly used designs are the lock type splint,<sup>15</sup> split acrylic splint,<sup>17</sup> stainless steel acrylic basket splint,<sup>18</sup> compound splint,<sup>14</sup> and the labiolingual splint.<sup>16</sup>

Lock type<sup>15</sup> splints were used for planned osteotomy of the mandible. It consisted of a labial and lingual part which was connected by using stainless steel wire behind the last molar teeth. The labial portion was sectioned near the mental foramen on the side contralateral to the side of access osteotomy. On either side of the split, tie buttons were fixed which were used to lock the labial parts after the completion of the procedure.

The labiolingual splints<sup>16</sup> were structurally different from lingual splints in that they consisted of labial as well as a buccal component which encircled the teeth providing good cross-arch stability. Therefore, they were very useful in fractures of the mandible with partially edentulous state or mobile teeth. They also played a very important role in mandible with primary and mixed dentition where maximum coverage of the teeth is ideal for retention of the splint. The extra coverage provided by the splint compensates for the unfavorable morphology and reduced clinical crown of deciduous teeth.

A stainless steel acrylated basket splint has been used in a 3-year-old child for fixation of parasymphysis fracture, which was secured by circummandibular wiring. This type of splint neither allowed raising of the bite nor hindered the eruption of teeth.<sup>18</sup> Hegab et al described a split acrylic splint for the treatment of mandibular fractures in children,<sup>17</sup> which had a labiolingual component without occlusal coverage that favored unimpeded eruption of teeth. For pediatric patients, yet another modification to facilitate continuous eruption of teeth was an orthodontic splint which included labial and lingual arch wires soldered to orthodontic bands fixed to deciduous second molars.<sup>19</sup>

Intraoral lingual splints have been fabricated with (1) acrylic, (2) metals such as iron or lead which may be cast or soldered, and (3) metal-reinforced acrylic.<sup>12</sup> In comparison with an acrylic splint, a metal splint demonstrates greater strength with minimal thickness and colonizes less microbial growth, while the advantages of acrylic splint are

the lighter weight and its ability to flow in between embrasures for a snug fit. A comparative study of histological changes in the tissues adjacent to splints demonstrated gingivitis in 48 hours, which progressed to periodontitis with alveolar bone resorption in 6 weeks. The study emphasized the importance of good oral hygiene while using lingual splints.<sup>20</sup> However, this is not clinically relevant when splints are only used intraoperatively to facilitate reduction and removal after internal fixation.

## Case Reports

The following is a description of three cases which demonstrate the use of lingual splints in sagittal fractures of the mandible with a severe lingual displacement of fracture fragments; two cases of parasymphysis fracture, reduced with a lingual splint and fixed by miniplates, and one parasymphysis fracture managed by using a lingual splint and lag screw fixation. In all three cases, the splint was removed postfixation. The essentials for fabricating a pre-surgical lingual splint are computed tomography (CT) scans with good axial sections that demonstrate the oblique fracture line and preoperative study casts.

## Lingual Splint: Design and Function

An acrylic lingual splint was fabricated presurgically using study casts. The alginate impressions were taken following administration of local anesthesia of the fractured side to facilitate painless impression procedures. Models were made using dental stone and fracture line was simulated in these models. Using the study models, mock surgery was performed to reestablish ideal arch relationship and occlusion. The splints were then prepared covering the lingual surface of the aligned arches extending from the first molar of one quadrant to the other quadrant, using self-cure acrylic. Perforations were drilled through the interdental aspect of the splint for passage of stainless steel wires. Stainless steel wires are passed through the holes from lingual to buccal aspect interdental. The average time taken for the splint preparation was approxi-

mately 1 hour from the start of taking impressions till the final splint fabrication. Tightening of the wires buccally ensures a precise approximation of the lingual cortical plate to the buccal segment as demonstrated in a mandibular model (→ Fig. 1B).

### Case 1

A 27-year-old male patient reported to our institution with complaints of pain and swelling over the right lower part of the face, following a road traffic accident. Clinical examination revealed tenderness and step deformity in the right parasymphysis region. Intraorally, the occlusion was observed to be deranged. Segment mobility was present between 42 and 43. Provisionally, the patient was diagnosed to have a fracture of right parasymphysis.

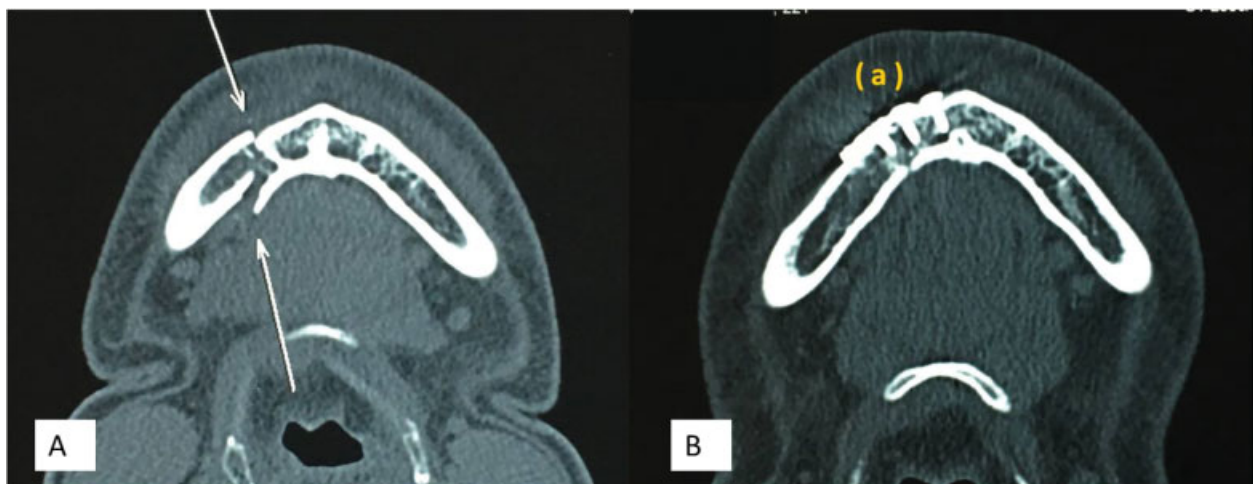
→ Fig. 2A reveals a sagittal fracture in the right parasymphysis region. Under general anesthesia, fracture site was exposed through a vestibular incision extending from 41 to 45. An acrylic lingual splint fabricated as described earlier was positioned, and wires were passed through the interdental spaces. The twisting of wires on the buccal side approximated the buccal and lingual cortices across the fracture site. Occlusion was checked with intermaxillary fixation, and two miniplates were used along Champys lines of osteosynthesis to achieve fixation. Postoperative CT demonstrated good anatomic reduction of the sagittal fracture on the buccal as well as lingual aspect (→ Fig. 2B).

### Case 2

A patient aged 37 years presented with right parasymphysis fracture of the mandible with a fracture pattern extending obliquely from 42 on the buccal side to 46 on the lingual side. The fracture was managed by using lingual splints for reduction before use of lag screws for fixation (→ Fig. 3A, B).

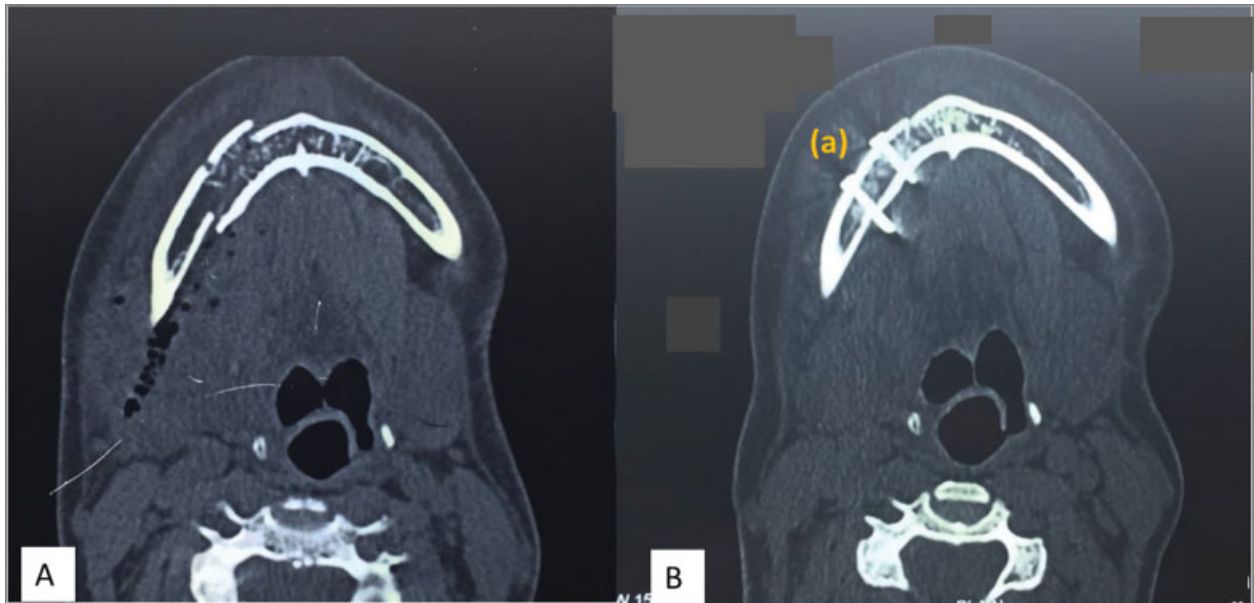
### Case 3

Examination of a 28-year-old patient with a history of mandibular trauma revealed sublingual hematoma, avulsed 43, deranged occlusion, interfragmentary mobility between 42 and 44, and gross displacement of fracture fragments. → Fig. 4A, B demonstrates the good precision



**Fig. 2** (A) Preoperative CT axial view, (B) postoperative CT axial view—(a) miniplate in position. CT, computed tomography.





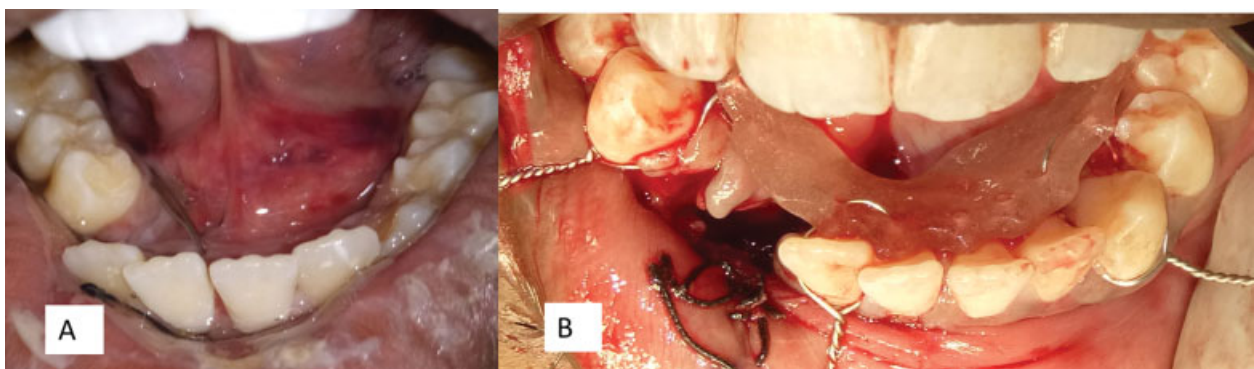
**Fig. 3** (A) Preoperative CT axial view, (B) postoperative CT axial view—(a) lag screw in position. CT, computed tomography.

achieved intraoperatively in the fracture reduction using splints, which was later fixed with two miniplates. The pre- and postoperative occlusal radiographs (→**Fig. 5A, B**) show the correction of lingual splay observed in sagittal fractures.

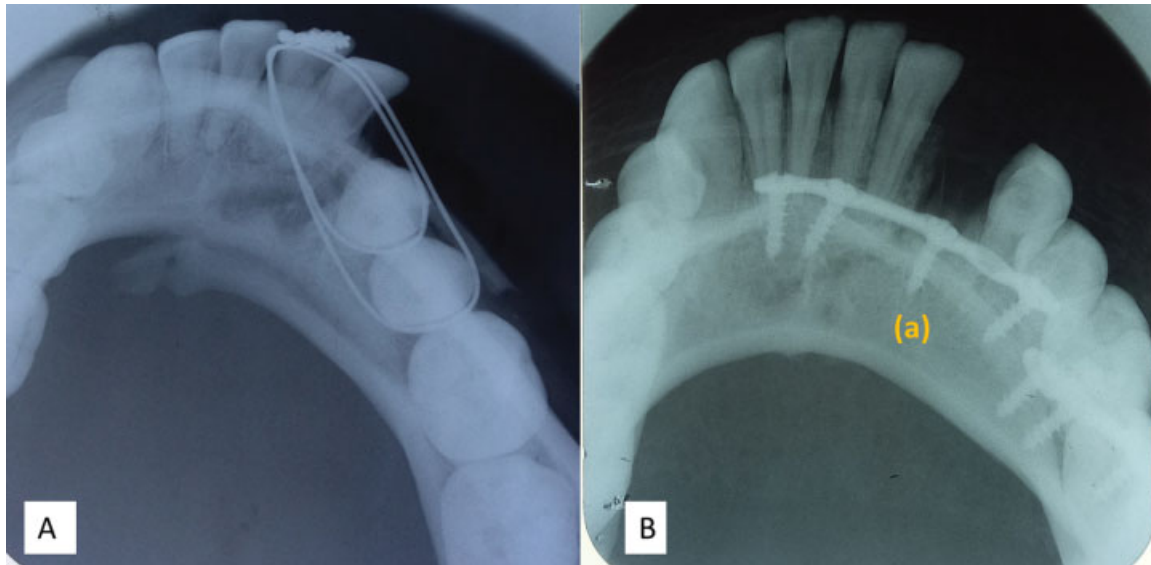
## Discussion

The use of splints has been on the decline with the advent of ORIF of mandibular fractures. However, the concept of their use in mandibular fractures is worth reviving today, due to many advantages offered by lingual splints. Biomechanical studies have established that during functional loading of the mandible in the transverse plane, the strain is concentrated more on the lingual cortical plate which results in the splaying of the lingual cortex. The use of lingual splints in such cases simplifies the reduction and fixation of sagittal mandibular fractures, especially those which are displaced lingually.<sup>21</sup>

At present, miniplates are the commonly used implants to achieve osteosynthesis in mandibular fractures. However, the major limitations of using miniplates in sagittal fractures are (1) the inability to achieve buccolingual approximation of the fracture fragments as they are predominantly monocortical and do not produce interfragmentary compression in the buccolingual direction, (2) inability to check the anatomic reduction on the lingual aspect intraoperatively, and (3) inability to prevent lingual splay and torsional forces during fixation. In such situations, lingual splints may be an important method of achieving the interfragmentary reduction, especially in the buccolingual direction. The wires of the lingual splint when tightened, achieve fracture reduction comparable to the use of lag screw technique, as demonstrated by the clinical cases. Though lag screws are considered ideal for sagittal fractures, they are technique sensitive and require special armamentarium. Lingual splints are thus a viable alternative to lag screws. It is also noteworthy that use of lag screw mandates the precise reduction of fracture



**Fig. 4** Lingual splint positioned intraoperatively. (A) Lingually displaced fracture fragments with collapsed arch and avulsed 43, (B) splint in position with restoration of arch width.



**Fig. 5** (A) Preoperative occlusal view, (B) postoperative occlusal view—(a) miniplates in position.

fragments before fixation, which may be done effectively with a lingual splint. The use of lingual splints is associated with some limitations such as additional time and expense toward preoperative laboratory work for splint fabrication.<sup>22</sup> Further taking impressions may be painful and inconvenient to patients due to associated trismus and mobility of fracture fragments. As a protocol, our patients were managed with administration of local anesthesia. However, this limitation may also be eliminated with the use of the recently available computer-aided design/computer-aided manufacturing<sup>23</sup> technology for splint fabrication.

Lingual splints offer many advantages; they improve the precision in achieving anatomic reduction of the fracture. In addition to permitting verification of the accuracy of dental occlusion intraoperatively, splints reduced the intraoperative time for fracture reduction. However, our study did not record the time objectively and a randomized controlled trial comparing the time taken for reduction of sagittal fractures with and without splints might provide accurate data regarding the same. The greatest advantage of the lingual splint is that the model surgery performed before splint fabrication permits the surgeon to visualize how the fractured components of the mandible need to be rotated, to establish the reduction of the fractures. The splint also holds the fractured segments stable, preventing rotation, during the application of rigid plate in screw fixation.<sup>24</sup>

Further, lingual splints may serve as a “standalone” management tool in medically compromised<sup>25</sup> and pediatric<sup>26</sup> patients, where management of fractures by the closed method is indicated. In such patients, it is significantly superior to conventional cap splints or intermaxillary fixation, permitting the patient to perform normal jaw movements and to chew his food by facilitating occlusal contact.

## Conclusion

The role of lingual splints in sagittal fractures of the mandible is noteworthy. They serve as a simple but effective

adjunct to fracture reduction, before semirigid (miniplates) or rigid (lag screws) fixation, especially to prevent lingual splay of fracture fragments. However, its use should be weighed against the time and cost of preparation.

### Funding

None.

### Conflict of Interest

None.

### Ethical Clearance

Not required.

### Patient Consent

None required.

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