Introduction and Hypothesis

Mandibular body fractures are the second-most common fracture of the mandible in cats.\(^2\) Titanium miniplates provide an advantageous option for fracture reduction with excellent outcomes and faster return to function over current standard of care.\(^3,4\)

There has been no published studies on the biomechanical properties of intact cat mandibles nor have there been studies comparing non-locking or locking miniplates on mandibular fractures in cats.

Hypothesis: The locking miniplate constructs (LC) will have superior biomechanical properties compared to the non-locking miniplate constructs (NLC) for stabilization of caudal mandibular fractures in cats.

Results

\(\text{Fig. 1: Pre-test photographs of plate-mandible constructs. Of the 20 mandibles tested: 7 were LC (A), 7 were NLC (B), and 6 were left intact.}\)

\(\text{Fig. 2: Post-failure photographs and radiograph depicting the failure modes observed in the study. Most plate-mandible constructs (13/34) failed by an incomplete bone fracture (A, arrow) which propagated caudally from the osteotomy surface adjacent to the screws in the caudal bone segment in a longitudinal direction toward the angular process. Plate bending (B, arrow), occurred in two LC and one NLC. Screw pullout (C, arrows) and incomplete fracture occurred in a single LC without the fracture propagating to the osteotomy. Most intact mandibles (5/6) failed with an incomplete transverse fracture (D, arrow) that started at the alveolar margin distal to the mandibular first molar tooth and propagated towards the condylar process adjacent to the PMMA fixture.}\)

\(\text{Fig. 3: Radiographs of the rostral segment of the mandible with the implants removed to assess screw involvement with tooth roots and the mandibular canal. Most mandibles showed no radiographic evidence of screw-root involvement (A). Radiographic evidence of screw-root involvement (B, arrow) occurred at a similar incidence in both LC and NLC treatment groups. All plate-mandible constructs experienced some degree of screw-mandibular canal involvement in their radiographs.}\)

\(\text{Fig. 4: Bending moment-angular displacement curves of representative mandibles that indicate first yield (diamonds), second yield (circles), peak (triangles), and failure (squares) points. LC peak bending moment and load was 1.5 times greater than NLC and LC were twice as stiff as peak loading than NLC.}\)

Methods

Cadaveric feline mandibles (\(n=20\)) were obtained and randomly divided into three groups using a blocked study design. Two groups were plated with either a LC or NLC miniplate configuration and an osteotomy was made immediately distal to the first mandibular molar tooth mimicking a caudal mandibular fracture. One group was left intact for comparison. A single load-to-failure test was applied to each mandible and the results were compared using a pairwise ANOVA from ranked data.

Radiographs were obtained before and after plating and after mechanical testing to evaluate iatrogenic damage to the roots and mandibular canal. A Student’s \(t\)-test was performed to analyze differences between the groups.

Discussion

This is the first study to provide evidence-based analysis of the biomechanical properties of the intact feline mandible and internal fixation for caudal mandibular fracture in cats. Plate-mandible constructs were significantly weaker at yield, peak and failure loads compared to intact mandibles, except for LC configuration which had stiffness at peak load similar to intact mandibles. LC configuration had superior strength and stiffness at peak loading compared to NLC configuration.

We found that radiographic evidence suggesting that dental or mandibular canal damage is a possible complication of internal fixation in the mandible of cats. Radiographic evidence of screw-root involvement was not significantly different between LC and NLC groups, with most plate-mandible constructs not receiving any dental trauma.

Therefore, pre-surgical planning based on computed tomography and dental radiography is prudent practice to reduce the risk of iatrogenic damage.

In conclusion, locking plate and locking screws configuration is the recommended internal fixation method for stabilization of caudal mandibular fractures in cats due to its superior biomechanical properties compared to the non-locking configuration. Appropriate pre-surgical imaging is critical for fracture characterization and choosing an appropriately sized miniplate.

References


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