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# Lag screw vs miniplate fixation in treatment of condylar neck fractures: A systematic review

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## SUMMARY

*Background.* Fractures of the mandibular condyle region, particularly high condylar neck and condylar process fractures can lead to tremendous functional and aesthetic impairments and are challenging to treat. A conservative approach is the treatment of choice in non-displaced cases. However, fractures with significant displacement pose considerable difficulty as they require surgical intervention. Various techniques, including lag screws and miniplates, are currently available. This review aimed to assess the usage patterns and outcomes of lag screw and miniplate fixation techniques in cases of mandibular condyle region fractures.

*Material and methods.* This review was conducted following the PRISMA guidelines. A comprehensive search of Science Direct, Springer Link and PubMed databases was performed, supplemented by a manual internet search. Keywords "lag screw", „miniplate", "condylar fracture", "high condylar neck fracture", "fixation" were utilized. This review included human subject studies and in vitro studies published in the previous ten years.

*Results.* A total of eight studies were included in the qualitative analysis. Four studies assessed miniplate fixation while the other four examined fixation with lag screws. Five out of six in vivo studies assessed mouth opening, healing of the surgical site, occlusion during follow-up, and patient satisfaction. All studies showed satisfactory results in functional restoration. In-vitro studies indicated that either two lag screws or two parallel plain plates provide adequate fixation for high condylar neck fractures.

*Conclusion.* Current clinical research biases lag screw usage more towards condylar process – high condylar neck fractures while miniplates are more commonly used in high condylar neck fractures. There is a severe lack of published studies regarding treatment outcomes of high condylar neck fractures.


**Keywords:** condylar fracture; lag screw; miniplate; mandibular fracture; condylar neck.

## INTRODUCTION

The mandible is particularly affected during trauma events because of its prominent and exposed position. In fact, mandibular fractures range from 36 to 70% of all facial bone fractures according to epidemiological review (1). Condylar region fractures, especially high condylar types, are of significant interest not only because they comprise a major part of total mandibular fractures – 45 %, but also because treatment of such injury proposes a significant challenge for the clinician (2). Condylar region fractures carry a tremendous functional and aesthetic impairment to the patient, ranging from functional and symmetric disturbances to, in the worst of the scenarios, ankylotic changes of the temporomandibular joint (3).

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For non-displaced fractures, conservative approach by maxillomandibular fixation is considered (4). Open reduction and internal fixation method is typically reserved for cases where normal occlusion and ramus height cannot be restored (5). Extraorally or intraorally, fixation of the fracture fragments can be achieved with either lag screws, or osteosynthesis miniplates (6). Lag screw fixation achieves reduction of the fragments via compressive forces applied along the screws' long axis, though the usage of a single screw introduced limited resistance to rotational force (7). Fixation of fragments with miniplates provides stability by resisting compressive and tensile forces, though this relies on relatively small and malleable hardware (8).

As both fixation methods are acceptable, the specific usage of miniplates and lag screws in borderline cases of condylar region fractures may overlap in terms of indications and effectiveness from both a feasibility perspective and clinical outcomes. The present review analyzes the intricacies of usage and clinical outcomes of each of the methods.

## MATERIALS AND METHODS

### Systematic review protocol

This systematic review aimed to evaluate the usage patterns and outcomes of lag screw and miniplate fixation techniques in cases of condyle region fractures. The systematic review protocol was established and documented in advance. Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) Statement was followed in the process of systemically analyzing relevant articles (9). A comprehensive search of Science Direct, Springer Link and PubMed databases was performed, supplemented by a manual internet search. Keywords "lag screw", "miniplate", "condylar fracture", "high condylar neck fracture", "fixation" were utilized. This review included human subject studies and *in vitro* studies published in the previous ten years.

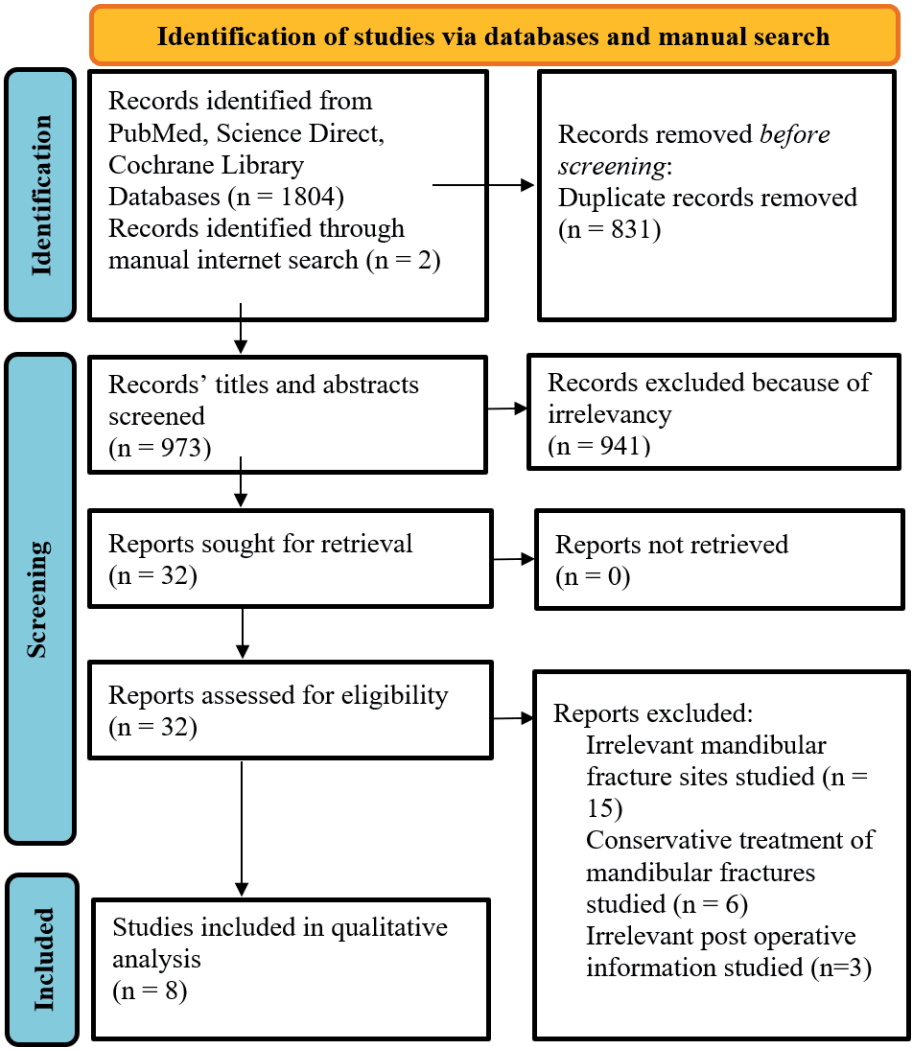


**Fig.** PRISMA flowchart

### Focus question

Focus question was developed according to the PICOS study design method: Population (P), Intervention (I), Comparison (C), Outcome (O). In patients with high condylar neck region fractures, does lag screw fixation compared to miniplate fixation lead to better functional outcomes? PICOS question formulation is presented in Table 1.

### Search strategy

Two researchers conducted evaluation of the search results. Articles were screened and excluded after filter application and investigating titles and abstracts. For the final stage analysis, full-text analysis was conducted on articles that met the eligibility criteria: studies published in the English language evaluating patient outcomes after open reduction and internal fixation by lag screw of miniplate of high condylar neck region *in vivo*; *in vitro* studies examining mechanistic functional outcomes of internal high condylar neck region fracture fixation by lag screws or miniplates. Due to the limited number of human trials available in this niche surgical literature, all human studies, regardless of design, were included. Letters, editorials, systematic reviews, animal studies, literature reviews and meta-analyses were excluded from this review.

### Risk of bias

The systematic selection of studies was followed by assessment of study protocols applying JBI Critical Appraisal Checklist for risk of bias evaluation according to appropriate questionnaire type based on study type (10).

## RESULTS

### Study selection and characteristics

The initial database search yielded 1806 records. After filter application and duplicate removal, the pool of relevant studies shrunk to 973. Abstracts and titles were

**Table 1.** Research question formulated using the PICO method

| P (Population) | Patients with high condylar neck region fractures |
|---|---|
| I (Intervention) | Lag screw open reduction and internal fixation method |
| C (Comparison) | Miniplate open reduction and internal fixation method |
| O (Outcome) | Functional and aesthetic outcomes |
| PICO | In patients with high condylar neck region fractures, does lag screw fixation compared to miniplate fixation lead to better functional outcomes? |

screened, and 32 potentially relevant studies were retrieved for full text analysis. 24 studies were rejected. The final pool consisted of 8 studies. The study search and selection process are demonstrated in PRISMA flow diagram (Figure).

A total of 8 studies were included in the qualitative data synthesis process. 4 studies described fixation of high condylar process region fractures by means of lag screws, the other half described fixation by titanium miniplates. 6 studies were human studies, two of them Randomized Controlled trials, one prospective clinical trial, two case reports and one case series. Within the human studies, a total of 48 patients were examined. 2 studies were *in vitro* studies, one of finite element analysis type, another of physical biomechanical type; one per fixation method.

For risk of bias assessment, we utilized The Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies, Quasi Experimental studies and Case-Controlled studies, based on the study type (10). The analyzed studies had low to medium levels of bias. Medium risk of bias was observed due to treatment providers and outcome assessors not being blind to treatment assigned, although such blinding is not possible in these specific trials (11, 12). A thorough assessment of the risk of bias is provided in Table 2.

**Lag screw fixation**

LSF was utilized in one prospective clinical trial and one case study, both of which reported on patients with high condylar fractures of a sagittal-type, and one case series on two patients with high condylar fractures with a transverse fracture of the condylar head-neck region (Table 3). All three studies examining LSF reported adequate anatomical reduction achieved in postoperative evaluations (13-15). Mouth opening (MO) at different follow-up periods was reported by two studies, both reported good MO at 1 month follow-up (>35 mm), while Raghani *et al*. observed slightly reduced MO immediately postoperatively (13, 15). Regarding occlusion, all three studies reported normal occlusion at 30 days follow-up (13-15). One study showed that two of four patients had mild malocclusion immediately postoperative, while the other two observed normal occlusion (13-15). Deviation on MO was reported by two studies – no deviation was seen in the two patients examined by Shukla *et al*., while Raghani *et al*. reported deviation in two patients out of four immediately postoperative, though by the 30-day follow-up no deviation was seen in either study (13, 14). No TMD symptoms were reported in any of the included studies. Soft-tissue healing was satisfactory with only one facial nerve paresthesia, which gradually resolved (15).

**Miniplate fixation**

Miniplate Fixation (MPF) was utilized in two randomized clinical trials and one case report, all studies involved patients with high condylar fractures of transverse type (Table 3). All three studies examining MPF reported adequate anatomical reduction achieved in postoperative evaluation (11, 12, 16). A progressive increase in MO with no functional limitation at later follow-up was reported across studies (11, 12, 16). Early postoperative MO ranged between 25-30 mm; MO improved to 33–35mm by the first month, and a stable >35mm interincisal MO at 3 months or later (11, 12, 16). Absence of malocclusion was reported in Kumar's study; only one of twenty patients showed malocclusion, which was later attributed to a fractured miniplate (11). While two studies noted no abnormal mandibular movement patterns during opening, one study observed that six of twenty patients had lateral deviation at 1 week follow-up, which gradually diminished (11, 12, 16). Three of twenty patients in one study developed soft tissue healing complications, which were managed by local wound care and systemic medication, whereas the other two studies reported no such complications (12).

**Table 2.** Assessment of included studies utilizing the JBI tool questionnaire

| Study/Question | JBI tool | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kozakiewicz *et al.*, 2017 | QE | Y | ? | Y | Y | Y | Y | Y | Y | Y | - | - | - | - |
| Raghani *et al.*, 2019 | CS | Y | Y | Y | Y | ? | ? | Y | Y | - | - | - | - | - |
| Shukla *et al.*, 2024 | CR | Y | Y | Y | Y | Y | ? | Y | Y | - | - | - | - | - |
| Araujo *et al.*, 2020 | CR | Y | Y | Y | Y | Y | Y | Y | Y | - | - | - | - | - |
| Kawai *et al.*, 2023 | CR | Y | Y | Y | Y | Y | Y | Y | Y | - | - | - | - | - |
| Ganguly *et al.* 2021 | RCT | Y | ? | Y | ? | N | Y | N | Y | Y | Y | Y | Y | Y |
| Kumar *et al.*, 2021 | RCT | Y | ? | Y | ? | N | Y | N | Y | Y | Y | Y | Y | Y |
| J. Okulski *et al.*, 2024 | QE | Y | ? | Y | Y | Y | Y | Y | Y | Y | - | - | - | - |

Abbreviations: QE – quasi-experimental; CS – cross-sectional; CR – case report; RCT – randomized clinical trial; Y – yes; N – no; ? – unclear; – – inapplicable.

***In vitro* studies**

A finite element analysis by Kozakiewicz *et al*. examined the differences between one, two, or three lag screws in LSF of high condylar neck fractures. The authors showed that relative displacement between the fracture fragments was 558±245 μm for one lag screw, 218±81 μm for two screws, and 217±144 μm for three screws (17). It was observed that one screw fixation produced a peak 464 MPa of stress at the screw neck, compared with 319 MPa for two screws and 222 MPa for three-screw fixation (17).

In a biomechanical study using polyurethane mandible models,

Okulski *et al*. examined mechanical stability of various miniplate models for fixation of high condylar neck fractures. The authors found that fixation with two parallel titanium straight plates resulted in the highest mechanical strength (14.02±1.24 N), approximately double that of the second-best option, the Delta TriLock plate (18).

## DISCUSSION

According to AOCMF classification, the reference line for the condylar head is a tangent to a sphere, the sphere being laterally and superiorly limited by the lateral pole (19). In a sagittal fracture passing vertically through the condylar head, involvement of condylar neck is almost inevitable, except in cases where the fracture does not intersect with the reference line (17). In all clinical reports where lag screw fixation was utilized, the technique was selected for fractures involving a sagittal fracture pattern (20, 21). This finding is in alignment with current clinical data, which shows that lag screws are well utilized for sagittal split fractures of the condylar region, as compressive fixation along the long axis of the screw is mechanically favorable (22). From a clinician's standpoint, this preference reflects basic principles of surgical access – when the fracture involves a medially displaced condylar segment, miniplate placement on the medial aspect becomes technically unfeasible, therefore, lag screws provide the most efficient means of achieving stable fixation.

Miniplates, in contrast, were more favored in high condylar neck region when transverse fracture direction is seen. However, as noted by Kozakiewicz, not all transverse fractures mandate miniplate fixation just as well as not all fractures involving condylar head surface imply lag screw fixation (17). Optimal choice is mostly determined by the fracture direction and the morphology of the fractures. It is therefore logical to consider basing treatment choices on the surgeon's assessment of mechanical stability and operative feasibility, balancing the directional forces acting on the fracture with the accessibility of the surgical field.

Both fixation methods proved to restore function in majority of patients, with MO of more than 35mm was achieved and normal occlusion established within three months period, with only a few complications reported. Such findings align with previous studies, that showed limited MO to be uncommon findings, and in most cases having returned to functionally healthy at 3 months follow-up (23, 24).

Interestingly, while an in-vitro study by Okulski *et al*. favored double straight-plate fixation for its mechanical properties, only one of the studies employed double straight plates, and a fracture of a Y-plate was seen in another (18). Furthermore, Ganguly *et al*., who employed delta plates in one of the subgroups, found clinical recovery to be superior when compared to double straight miniplates (12). These findings suggest that the success of a treatment modality is not determined solely on mechanical rigidity of fixation and emphasize that surgical selection and execution remain cornerstones of postoperative outcomes.

The main limitation of the present review lies in the substantial heterogeneity and quality of available evidence. A wide range of studies were included, from randomized clinical trials to case reports, most of the studies had small patient cohorts and the method of reporting findings and outcomes – MO, occlusion, deviation was highly variable. Moreover, the exact terminology and

**Table 3.** Summary of clinical data and outcomes of lag screw and miniplate fixation in high condylar region fractures

| S | T | n | FX | FR | MO (n; FU) | RF | OC | Deviation | TMD | POC | Q11 | Q12 | Q13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | PCT | 4 | LS | SG | 25–35 mm (n=3) PO, >35 mm (n=1) PO; >35 mm (n=4) 1mo–2yr | + | MCO (n=2) PO; 1mo–2yr: normal (n=4) | Slight (n=2) PO; none (n=4) later | None | None | - | - | - |
| II | CS | 2 | LS | SG | - | + | Normal (n=2) | None (n=2) | – | None | - | - | - |
| III | CR | 1 | LS | SG | >35 mm (n=1) 1mo | + | Normal 1mo | None (n=1) | None | Facial n. paresthesia (n=1); resolved | - | - | - |
| IV | CR | 1 | MP | TV | 30 mm (n=1) PO; 40 mm (n=1) 9mo | + | Normal (n=1) | None (n=1) | – | None | - | - | - |
| V | RCT | 20 | MP | TV | 28.7±2.25 mm 1wk; 33.9±2.19 mm 1mo; 39.1±3.35 mm 3mo* | + | Normal (n=20) | Deviation (n=6) 1wk, resolved later | – | Tissue healing complications (n=3) | Y | Y | Y |
| VI | RCT | 20 | MP | TV | 35.35±6.53 mm 3mo** | + | MCO (plate fracture) (n=1) | None (n=20) | None | None (n=20) | - | - | - |

Abbreviations: S – study; n – number of patients; T – study type; FX – fixation; FR – fracture direction; FU – follow-up; RF – reduction and fixation; OC – occlusion; TMD – temporomandibular disorders; LS – lag screw; MP – miniplate; MCO – malocclusion; PCT – prospective clinical trial; CS – case series; CR – case report; RCT – randomized clinical trial; SG – sagittal; TV – transverse; PO – postoperative; POC – postoperative complications; wk – week; mo – month; yr – year; n – number of patients; + – adequate anatomical reduction achieved; – – not reported.

* Pooled descriptive values from Group A (n=10) and Group B (n=10), both using MP fixation (12).

** Pooled descriptive values from Group A (n=10) and Group B (n=10), both using MP fixation (11).

Included studies: I – Raghani*et al.*, 2019; II – Shukla*et al.*, 2024; III – Araujo*et al.*, 2020; IV – Kawai*et al.*, 2023; V – Ganguly*et al.*, 2021; VI – Kumar*et al.*, 2021 (11–16).

classification of fractures limit the ability to draw direct comparison between studies.

Overall, current evidence shows that both methods – lag screw and miniplate fixation are valid options in the surgical management of high condylar region fractures. The decision shall not only rely on rigid anatomical classification, but also on basic three-dimensional assessment of fracture morphology. Further refinement of indications and technique standardization is essential to improve compatibility between studies.

## CONCLUSION

Current clinical research indicates a pattern of choice of fixation method – lag screw fixation is more frequent in condylar process and sagittal-type fractures involving high condylar neck, while miniplate fixation remains the favorable choice for transverse fractures of the high-neck region. Even though both methods demonstrate comparable functional outcomes and adequate anatomical reduction when applied according to the pattern of fracture, the existing literature remains limited. The overall lack and heterogeneity of clinical data, as well as dubious classification, highlights the need for standardized prospective large sample size studies focusing specifically on treatment outcomes of high condylar neck fractures.

## CONFLICT OF INTEREST

The authors declare to have no conflict of interest.

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