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Locking Compression Plates in Proximal Ulna Fractures: A Study on Functional Outcomes

©Kandavel Dwaraganath, Rohit Ravikumar, Chandhuru Arun Kumar*, Arumugam Subramanian

Saveetha Institute of Medical and Technical Sciences (SIMAT), Chennai, India

* Chandhuru Arun Kumar, Saveetha Institute of Medical and Technical Sciences (SIMAT), Thandalam, Chennai, Tamilnadu-602105, India, drarunc16@gmail.com

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Abstract

Background: Proximal ulna fractures, such as olecranon and Monteggia fractures, can be challenging to treat.

Objective: To assess the effectiveness of locking compression plates (LCP) in stabilizing and promoting early mobilization in these fractures.

Materials and methods: This is a prospective study conducted at Saveetha Medical College and Hospital from January 2022 to December 2023. Patients with compound fractures, pediatric fractures, proximal bilateral forearm fractures, and those considered medically incompetent for surgery were excluded from the study.

Results: Of 20 patients with olecranon and Monteggia fractures, the majority had comminuted olecranon fractures. Most cases did not have associated injuries, while a few had radial head or coronoid injuries. Fracture union times varied, with some cases taking 12, 16, or 18 weeks to heal. Most patients achieved good elbow range of motion, exceeding 100° in 75% of cases. One patient experienced an exposed implant, one developed an infection, and 3 cases had restricted terminal pronation and supination. Functional outcomes assessed using the Mayo Elbow Performance score were excellent in 16 patients and good in 4 patients.

Conclusions: That comminuted olecranon and proximal ulna fractures can be effectively treated with LCP, resulting in good union and excellent clinical outcomes.

Keywords: proximal ulna, Monteggia fracture, locking compression plate, fracture, Mayo score

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Пластины с угловой стабильностью при переломах проксимального отдела локтевой кости: исследование функциональных результатов

©К. Двараганатх, Р. Рохит, Ч. Арун Кумар*, А. Субраманиан

Институт медицинских и технических наук Савита, Ченнаи, Индия

* Ч. Арун Кумар, Институт медицинских и технических наук Савита, нагар Савита, Тандалам, Ченнаи, 602105, шт. Тамилнад, Индия, drarunc16@gmail.com

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Резюме

Актуальность: Лечение переломов проксимального отдела локтевой кости (перелома локтевого отростка и перелома Монтеджи) может вызывать сложности.

Цель исследования: Оценить эффективность применения пластин с угловой стабильностью (locking compression plates, LCP) для стабилизации данных переломов и ранней мобилизации.

Материалы и методы: Проспективное исследование проходило на базе Медицинского колледжа и больницы Савита в период с января 2022 г. по декабрь 2023 г. Критерии исключения: открытые переломы, переломы у детей, двусторонние переломы проксимальных отделов предплечья и отсутствие медицинских противопоказаний для операции.

Результаты: В исследовании приняли участие 20 пациентов с переломами локтевого отростка и переломами Монтеджи, у большинства участников были оскольчатые переломы локтевого отростка. В большинстве случаев не было сочетанных повреждений, но у нескольких пациентов наблюдались повреждения головки лучевой кости или венечного отростка локтевой кости. Сроки консолидации переломов варьировали: в некоторых случаях потребовалось 12, 16 или 18 недель. У большинства пациентов удалось достичь хорошей амплитуды движения в локтевом суставе: у 75% пациентов она превышала 100 °.

У некоторых пациентов наблюдались осложнения: инфицирование или обнажение имплантов и ограниченная пронация. Функциональные результаты оценивали по шкале Mayo Elbow Performance Score: у 16 пациентов были отличные результаты, а у 4 – хорошие.
Заключение: Оскольчатые переломы локтевого отростка и переломы проксимального отдела локтевой кости возможно эффективно лечить с помощью LCP и достигать хорошей консолидации переломов и отличных клинических результатов.
Ключевые слова: проксимальный отдел локтевой кости, перелом Монтеджи, пластина с угловой стабильностью, перелом, шкала Мэйо
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Introduction

Olecranon fractures are common orthopedic injuries typically caused by motor vehicle crashes, assaults, or sideswipe injuries. They account for 10% of all elbow fractures.[1] Treatment protocols for olecranon fractures vary depending on the severity, ranging from simple transverse fractures to comminuted and unstable fractures.[2] Comminuted fractures result from direct trauma, while indirect fractures are caused by falls on an outstretched hand. These fractures are less common in children compared with supracondylar humerus fractures due to the strength of the olecranon in children.

Monteggia fractures arise from a fall on an outstretched hand with extreme pronation, resulting in a fracture of the proximal third of the ulna along with dislocation or fracture-dislocation of the radial head. In children, conservative treatment may be sufficient, but adults often require surgical fixation.[2] The mechanism of injury typically involves a fall with hyperpronation or hyperextension, leading to the biceps pulling the radial head out of the radiocapitellar joint and causing a fracture of the ulna. Rigid internal fixation of the ulna along with closed reduction of the radial head demonstrated superior outcomes in these fractures. Continued radiocapitellar instability is commonly due to malreduced or comminuted ulna fractures that fail to restore the ulnar length, necessitating examination of the radiocapitellar joint for soft tissue interposition or ligament repair.

This study aims to assess functional outcomes of treating proximal ulna fractures (olecranon and Monteggia fractures) with locking compression plates (LCP).

Methods

This prospective study was conducted in the Department of Orthopaedics at Saveetha Medical College and Hospital from January 2022 to December 2023 and included 20 male and female adult patients with comminuted olecranon fractures and Monteggia fractures.

Patients with compound fractures, pediatric fractures, proximal bilateral forearm fractures, and those considered medically incompetent for surgery were excluded from the study. All the participants provided written informed consent. A total of 20 patients underwent surgery, and their functional outcomes were recorded.

Surgical Procedure

A midline posterior incision is used for fixation of proximal ulna. Incision extends from 2.5 cm proximal to olecranon and curved laterally at olecranon and continued distally along the subcutaneous border of ulna. Distal end point depends upon the fracture. Monteggia fractures have longer incision than comminuted olecranon fractures. Subcutaneous tissue cut and retracted. Fascia opened along the line of incision and plane of dissection deepened between flexor carpi ulnaris and extensor carpi ulnaris and fracture site exposed. Fracture hematoma was evacuated. Fracture site was exposed and ends cleared. Accurate anatomical reduction was achieved using clamps or provisional k wires. Then the olecranon locking compression plate was applied on the posterior surface and fixed with minimum of 3 proximal and 3 distal screws. Thorough wash was given and wound closed in layers with suction drain.

Plate Specifics

The plate is side-specific, available with 5-11 holes (5, 7, 9, or 11). Notches can be contoured to adapt to the bone anatomy. Combination screw holes can accept both locking and nonlocking screws. Proximal locking screws enable locking in the proximal cancellous bone. There are 2.7-mm locking screws for the notches and 3.5-mm locking and nonlocking screws for the plate shaft (Figure 1).

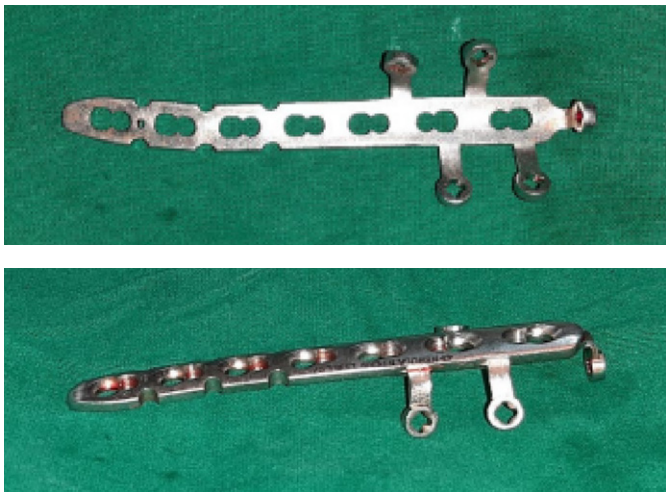

Figure 1. Contoured olecranon locking compression plate
Рисунок 1. Премоделированная пластина для локтевого отростка с угловой стабильностью

Follow-up

Rehabilitation and physiotherapy are crucial for achieving optimal range of motion, strength, and function of the elbow after surgery. During the first follow-up at 3 weeks after the surgery, the surgical scar was examined for swelling, discharge, or tenderness, and the range of motion of the joint was assessed. The prominence of the implant on the ulna, being a subcutaneous bone, was also checked during the follow-up visits. The patients were instructed to perform elbow mobilization exercises and active flexion-extension and pronation-supination without putting too much strain on the joint.

The second follow-up was scheduled at 6 weeks, and radiological evaluations and elbow performance scoring were conducted. The third follow-up took place at 12 weeks, and the patients were clinically and radiologically assessed. Subsequent follow-ups were scheduled at 6 and 9 months, and at the end of one year to monitor the progress and ensure optimal recovery. The patient's clinical outcome were evaluated by the Mayo Elbow Performance score, which considers the range of motion, pain during activities, elbow joint stability, and daily living activities.

Results

The study population comprised 16 men (80%) and 4 women (20%), yielding a male-to-female ratio of 4:1. The patients were classified into 3 age groups: 20-40 years (10 patients, 50%), 40-60 years (9 patients, 45%), and over 60 years (1 patient, 5%) (Figure 2).

Of 20 cases, 11 (55%) fractures occurred on the right side, while the remaining 9 (45%) cases occurred on the left side. Ten (50%) patients were injured in road traffic accidents, 7 (35%) patients were injured in falls, and 3 (15%) patients were injured in assaults (Table 1).

Fractures were categorized as comminuted olecranon (75%) and Monteggia (25%). In this series, 14 cases (70%) did not have any associated injury; 4 cases (20%) were with a radial head injury; 1 patient (5%) had a coronoid injury, and in 1 case (5%) there was polytrauma.

The majority (90%) of patients underwent surgery within the first 14 days since admission, while only 10% had surgery after this period due to complex polytrauma conditions. The mean time to surgery was 9 days, ranging from 3 to 28 days. There were 9 cases with a fracture union time of 12 weeks, 6 cases with a fracture union time of 16 weeks, and 5 cases with a union time of 18 weeks. We observed no cases of nonunion (Figure 3).

In this series, 15 patients (75%) had elbow range of motion exceeding 100°, while the remaining 5 cases (25%) had range of motion between 50° and 100°. The 5 cases

Table 1
Mode of injury
Таблица 1
Механизм травмы

Mode of injury	No. of cases	Percentage (%)
Road traffic accident	10	50
Fall	7	35
Assault	3	15

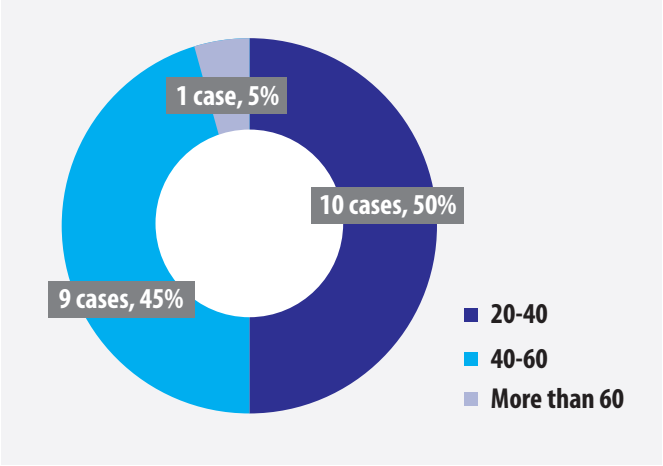

Figure 2. Age distribution
Рисунок 2. Распределение пациентов по возрасту

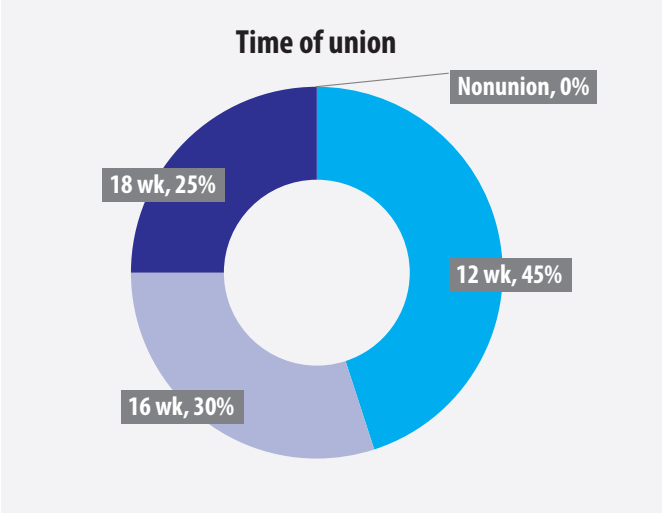

Figure 3. Fractures union time
Рисунок 3. Сроки консолидации переломов

Figure 4. Preoperative X-ray: olecranon fracture
Рисунок 4. Предоперационная рентгенограмма: перелом локтевого отростка

with limited range of motion were only 6 months old during follow-up. Figure 6 shows an olecranon fracture fixed with LCP, and Figure 8 demonstrates a patient's functional outcome.

Complications were observed in the treatment of some patients, including infected implants, exposed implants, and pronation restrictions (Figure 9). Statistical data revealed that three-fourths of patients did not experience any

Figure 5. Preoperative 3-dimensional computed tomography of the injured elbow
Рисунок 5. Предоперационная 3D компьютерная томография травмированного локтя

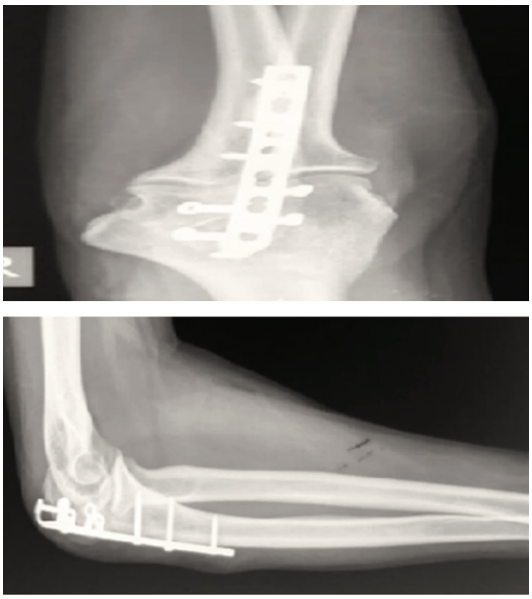

Figure 6. Immediate postoperative result
Рисунок 6. Непосредственный послеоперационный результат

Figure 7. Implant exit after 18 months
Рисунок 7. Смещение пластины спустя 18 месяцев

Figure 8. Assessment of postoperative range of motion
Рисунок 8. Оценка послеоперационной амплитуды движений

Figure 9. Postoperative complication: exposed implant
Рисунок 9. Послеоперационное осложнение: обнажение пластины

complications (Table 2). Among the few who did, three had pronation restriction, one had a superficial infection, and one had an exposed implant. Patients with infected implants received one week of intravenous antibiotics and regular dressing, leading to the resolution of the infection. The patient with an exposed implant had the implant removed after it was observed at the 12-month postoperative period. Three patients had pronation and supination restrictions and underwent physiotherapy, which resulted in positive outcomes.

Patient's clinical outcome was assessed by the Mayo Elbow Performance score (Table 3) based on their arc range of motion, pain during activities, stability of elbow joint, and activities of daily living.

Discussion

Treatment of proximal ulna fractures can be challenging due to the need for articular reconstruction and maintaining joint congruity. Conservative treatment may lead to post-traumatic arthritis and stiffness in the elbow. To avoid these issues, a stable joint with early mobilization is essential. Stable restoration of the joint line, longitudinal and rotational axes, and prevention of early-onset osteoarthritis are the main objectives of surgical treatment. This also creates the best possible environment for early functional rehabilitation.

Certain types of fractures, such as comminuted olecranon fractures, Monteggia fractures, and fractures proximal to the sigmoid notch, cannot be effectively treated with tension band wiring (TBW).

TBW is a commonly employed technique for the repair of displaced olecranon fractures, particularly those exhibiting transverse fracture patterns.[3,4] TBW is constrained by inadequate reduction and compression, together with the activation of contractions in the sigmoid notch.[5,6] These fractures impede the transformation of tensile stresses into compressive forces in the elbow and necessitate stabilization with anatomical plates.

Table 2
Complications
Таблица 2
Осложнения

Type of complications	No. of cases	Percentage
No complications	15	75%
Infected implant	1	5%
Exposed implant	1	5%
Limited pronation and supination	3	15%

Table 3
Results based on Mayo Scoring
Таблица 3
Результаты по шкале Мэйо

S.No	Mayo Performance	Elbow Score	No. of patients	Percentage
1	Excellent	90-100	16	80%
2	Good	75-89	4	20%
3	Fair	60-74	0	0%
4	Poor	<60	0	0%

Moreover, implant-related problems, including chronic pain or skin perforation caused by the K wires, were observed in 20% to 75% of patients,[7-9] resulting in hardware removal rates exceeding 80%.[8,10-12]

In these instances, plate osteosynthesis proved to be more advantageous, offering enhanced stability in fracture fixation.[13-17] Despite the availability of various plate types, the one-third tubular plate, low-contact dynamic compression plate, reconstruction plate, and LCP are the most frequently employed. The AO has launched the Olecranon Limited Contact Dynamic Compression Plate (LC-DCP) to address the fixing difficulties related to these complex fractures. This plate offers a solution for attaining stable fixation and facilitating appropriate healing in challenging fractures.

Wegmann et al (2016)[18] demonstrated that a locked-angle plate system provides superior biomechanical stability in the treatment of comminuted fractures of proximal ulna compared with a one-third tubular plate or a 3.5-mm reconstruction plate. Moreover, cadaveric study conducted by Buijze et al (2010)[19] indicates that the LCP functions as a "internal fixator," optimizing decreased loss while improving stability at the fracture site. Egol et al (2004)[20] have previously addressed this issue.

The mean duration for union in our sample was 14.7 weeks, with a range of 12 to 18 weeks. In another study by Khann Gagan, radiographic union occurred within 9 to 26 weeks. 75% of patients had more than 100 degrees' arc of motion in flexion, and 90% did not experience pain during movements. Instability was rare, and 85% of patients were able to perform all their routine daily activities.

Our study encountered some complications. One patient had an exposed implant and required an exit procedure. Three patients experienced restricted pronation

and supination, which were managed with mobilization and physiotherapy. The majority of cases (75%) did not have any complications during their final follow-up. In a study by Papagelopoulos and Morrey, only two cases of non-union were reported out of 196 fractures treated at the Mayo Clinic over a 10-year period. In our investigation with restricted sample size, we did not find any occurrences of non-union in the fractures.

Conclusions

Our study found that comminuted olecranon and proximal ulna fractures can be effectively treated with LCP, resulting in good union and excellent clinical outcomes. Fracture reduction is achieved through a posterior midline incision while maintaining articular congruity and anatomical alignment. Triceps insertion is preserved, and bone grafting was not required in any of our cases. Early mobilization is possible as the extensor mechanism is not disturbed. Aggressive postoperative mobilization and physiotherapy are essential for achieving optimal outcomes and preventing joint stiffness. Plating eliminates the need for postoperative casting and reduces the risk of fracture displacement. Patients in our study achieved an average elbow flexion of 110°, allowing them to resume daily activities and return to normal life quickly. While our study included a small group of 20 patients, further research with a larger sample size and longer follow-up will provide more comprehensive insights into benefits and drawbacks of this treatment approach.

Author contributions

Concept and design: Dwaraganath, Arun Kumar
Manuscript drafting: Subramanian
Statistical analysis and administrative support: Rohit, Arun Kumar
Critical revision of the manuscript: Dwaraganath, Subramanian
Supervision: Arun Kumar

Вклад авторов

Разработка концепции и дизайна: К. Дварагантх, Ч. Арун Кумар
Подготовка текста: А. Субраманиан
Проведение статистического анализа и административная поддержка: Р. Рохит, Ч. Арун Кумар
Критический пересмотр текста: К. Дварагантх, А. Субраманиан
Научное руководство: Ч. Арун Кумар

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Author credentials

Kandavel Dwaraganath, MS, DNB, Assistant Professor, Department of Orthopaedics, Saveetha Institute of Medical And Technical Sciences (Chennai, India). https://orcid.org/0009-0002-1896-4265

Ravikumar Rohit, MS, Assistant Professor, Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences (Chennai, India). https://orcid.org/0000-0003-3599-3762

Chandhuru Arun Kumar, MS, Associate Professor, Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences (Chennai, India). https://orcid.org/0000-0002-5316-2906

Arumugam Subramanian, DNB, Assistant Professor, Department of Orthopaedics, Saveetha Institute of Medical and Technical Sciences (Chennai, India). https://orcid.org/0009-0004-6995-7916

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Сведения об авторах

Дварагантх Кандавел, MS, DNB, ассистент-профессор, кафедра ортопедии, Институт медицинских и технических наук Савита (Ченнаи, Индия). https://orcid.org/0009-0002-1896-4265

Рохит Равикумар, MS, ассистент-профессор, кафедра ортопедии, Институт медицинских и технических наук Савита (Ченнаи, Индия). https://orcid.org/0000-0003-3599-3762

Арун Кумар Чандхуру, MS, ассоциированный профессор, кафедра ортопедии, Институт медицинских и технических наук Савита (Ченнаи, Индия). https://orcid.org/0000-0002-5316-2906

Субраманиан Арумугам, DNB, ассистент-профессор, кафедра ортопедии, Институт медицинских и технических наук Савита (Ченнаи, Индия). https://orcid.org/0009-0004-6995-7916

Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.