RESEARCH PAPER

A Prospective Study of Anatomical and Functional Outcome of Colles Fracture in Geriatric Population Treated Conservatively with Closed Reduction Under C-Arm Guidance

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ABSTRACT
This prospective study evaluates anatomical and functional outcomes of Colles' fractures in geriatric patients managed conservatively with closed reduction under C-arm guidance. Elderly patients showed significant early functional limitations, followed by progressive improvement in wrist mobility, grip strength, and pain reduction. At follow-up, most achieved good to excellent outcomes with minimal complications, supporting conservative management as a safe, effective, and economical treatment option in this population.

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INTRODUCTION

The first person to describe Colles fracture was Abraham Colle of Dublin, Ireland, in 1814. He defined it as a fracture that lacked the distinctive crepitus and aberrant movement. Additionally, he identified the high frequency of residual deformity after the fracture had healed and underlined the situations in which thefracture may be reduced while indicating the likelihoodthat the deformity would recur. "One consolation thatremains is that at some remote period the limb will again enjoy perfect freedom in all its motions and be completely exempt from pain," according to Abraham Colles' original paper [1].

One of the most common fractures, distal radiusfractures account for about 17% of all skeletal fractures.1, 2 It is frequently referred to as Colle's fracture.3. The age distribution is bimodal. It is caused by low-impact falls in older individuals with fragile bones and high- velocity accidents in younger people.4 Maintaining normal axial alignment, length, strength, and a mobile, functional wrist and hand are the objectives of treatment for Colle's fracture.5 Foroptimal functional outcomes, radial length (the distancebetween the radial styloid process and the distal end ofthe ulna), volar angulation, articular surface congruity,and ulnar variance must be restored.5 Morbidity such as malunited fracture deformities, wrist osteoarthritis, distal radio- ulnar joint instability, and ulnar impaction syndrome with ensuing wrist pain, poor mobility, weak grip strength, and function might occur from failure to sustain reduction.5 The clinical parameters that affect the outcome of distal radius fractures (DRF) include the patient's age, lifestyle, typeof fracture, severity and alignment of the fracture, softtissue condition, and

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radiological findings such as dorsal angulation, radial shortening, metaphyseal comminution, intra-articular extension, associated ulnar fracture, and bone quality.Sixth,

Colles' fractures, which affect 10–17% of people in the 60–70 age range, are more prevalent in women [2-4]. Additionally, it is typically treated on an outpatient basis using a cast below the elbow with the wrist in neutral to mild palmar flexion and ulnar deviation. However, it usually merges with a common deformity of dorsal translation and radial deviation, known as the dinner fork deformity [3]. Although the majority of orthopaedicians believe that Colles' fracturedoes not require special care because the resultingdeformity rarely impairs wrist function, there is a second opinion that Colles' fracture can result in poor functional outcome, particularly in older age groups,and some authors have reported that over 17% of patients had poor function one year after injury [5].

Closed reduction and plaster cast application, close reduction and percutaneous pin application, external fixator using ligamentotaxis principle, and open reduction and internal fixation with plate and screwesare some of the treatment modalities available forcolle's fracture.4,5,8-10 Treatment by closed reduction and casting immobilization can be adopted at inexpensive prices without hospital admission. Elderly patients with unstable fractures have shown very goodclinical results with non-operative treatment.9 Typicalsurgical risk factors, radiation exposure, and cost are alllinked to operative management. Malalignment has been shown to be unrelated to functional results in older patients.

The patient's age, lifestyle, related injuries, co-morbidities, functional demands, hand dominance, type of fracture, alignment of fracture, soft tissue condition, whether the fracture is open or closed, and financialconstraints are all important considerations whenchoosing the best treatment option for each patient. When choosinghow to treat a distal radius fracture, all of these considerations are crucial [3, 4].

A point-based outcome measure called the Gartland and Werley Score is used to assess hand and wrist function, especially following the healing of Colles fractures. It was created in 1951 and evaluates a number of elements of wrist and hand function, such as nerve problems, range of motion, and residual abnormalities. A total score of 21 or more denotes poor hand function. The score is based on a demerit pointsystem. The score is frequently used in clinical settings to evaluate functional outcomes, and it has been extended to incorporate assessments of stiffness and reflexes.

MATERIALS AND METHODS

This prospective observational study was conducted in a tertiary care facility in Tamil Nadu's Chengalpattu district, along with an assessment of a diagnostic tool. In 18 months period between march 2024 and october 2025, data was prospectively collected & analysed for patients with distal radius fracture (AO/OTA-2R3A2.2), who attended the outdoor and emergency care unit at the department of orthopaedics. For four weeks, the patientwas immobilized with a cast below the elbow, and the anatomical and functional results were assessed.

Sample size was calculated Based on the results of the previous study (4), the sample size was calculated to be 41, including a 10% non-response rate. The proportion of the exposed and nonexposed groups of functional outcome of colles fractures is 82.6% and 50%, respectively, with a 5% level of significance and 80% power. patient with unilateral ,closed, Extra articular distal radius fracture aged 60-80 years were included and patient below 60 years of age, patients with open fracture ,pathological fracture ,intra-articular, bilateral distal radius fracture were excluded .Gartland and werley score was used to assess the functional outcome .

Patients presenting with Colles' fracture were included in the study. Informed written consent was obtained from all patients prior to enrolment. All patients underwent radiographic evaluation (X-ray of the wrist) to confirm the diagnosis and assess fracture characteristics. Following confirmation, closed reduction was performed under C-arm fluoroscopic guidance.

Anatomical and functional outcomes were assessed.

Results

The study population consisted predominantly of younger elderly individuals, with the majority belonging to the 60–69 years age group and a mean age of 69.5 ± 4.6 years. There was a slight female predominance among participants, with females constituting more than half of the study population. Overall, the demographic profile reflects a predominantly elderly cohort with a modest female preponderance.

The right side was more commonly affected than the left side among the study participants. Additionally, involvement of the dominant hand was observed in a greater proportion of patients compared to the non-dominant hand, indicating that the dominant extremity was more frequently involved.

Table 1: Residual Deformity at Different Time Points

Residual Deformity	Immediate Yes n (%)	Post-operative Yes n (%)	4 Weeks Yes n (%)
Prominent ulnar styloid	31 (75.6)	18 (43.9)	7 (17.1)
Residual dorsal tilt	34 (82.9)	15 (36.6)	6 (14.6)
Radial deviation of hand	29 (70.7)	13 (31.7)	5 (12.2)

Table 2: Subjective Evaluation at Different Time Points

Subjective Evaluation	Immediate n (%)	Post-operative n (%)	4 Weeks n (%)

Excellent	0 (0)	8 (19.5)	16 (39.0)
Good	5 (12.2)	18 (43.9)	14 (34.1)
Fair	16 (39.0)	10 (24.4)	7 (17.1)
Poor	20 (48.8)	5 (12.2)	4 (9.8)

Table 3: Objective Evaluation at Different Time Points

Objective Parameter	Immediate Yes n (%)	Post-operative Yes n (%)	4 Weeks Yes n (%)
Loss of extension	33 (80.5)	18 (43.9)	9 (22.0)
Loss of ulnar deviation	29 (70.7)	16 (39.0)	8 (19.5)
Loss of supination	27 (65.9)	14 (34.1)	6 (14.6)
Loss of flexion	21 (51.2)	11 (26.8)	5 (12.2)
Loss of radial deviation	24 (58.5)	13 (31.7)	6 (14.6)
Loss of circumduction	19 (46.3)	9 (22.0)	4 (9.8)
Pain in DRUJ	26 (63.4)	12 (29.3)	6 (14.6)
Grip strength ≤60%	28 (68.3)	15 (36.6)	7 (17.1)
Loss of pronation	23 (56.1)	10 (24.4)	5 (12.2)

Table 4A: Arthritic Changes at Different Time Points

Arthritic Change	Immediate n (%)	Post-operative n (%)	4 Weeks n (%)
Minimum	12 (29.3)	9 (22.0)	5 (12.2)
Minimum with pain	9 (22.0)	7 (17.1)	3 (7.3)
Moderate	7 (17.1)	5 (12.2)	2 (4.9)
Moderate with pain	6 (14.6)	3 (7.3)	1 (2.4)
Severe	4 (9.8)	2 (4.9)	0 (0)
Severe with pain	3 (7.3)	1 (2.4)	0 (0)

Table 4B: Other Complications at Different Time Points

Complication	Immediate Yes n (%)	Post-operative Yes n (%)	4 Weeks Yes n (%)
Nerve complication	8 (19.5)	4 (9.8)	2 (4.9)
Poor finger function due to cast	10 (24.4)	5 (12.2)	3 (7.3)

Table 5: Final Results at Different Time Points

Final Result	Immediate n (%)	Post-operative n (%)	4 Weeks n (%)
Excellent	0 (0)	10 (24.4)	16 (39.0)
Good	5 (12.2)	17 (41.5)	14 (34.1)
Fair	16 (39.0)	9 (22.0)	7 (17.1)
Poor	20 (48.8)	5 (12.2)	4 (9.8)
Excellent + Good	5 (12.2)	27 (65.9)	30 (73.2)

Table 6 : Comparison of Gartland and Werley Scores at Different Time Points (n = 41)

Time point	Median (IQR)	Test statistic	p-value
Immediate	18 (16-21)	$\chi^2 = 72.4$*	<0.001
Post-operative	8 (6-1)		
4 weeks	4 (2-7)		

*Friedman test

The table shows the comparison of Gartland and Werley scores at immediate post-reduction, post-operative period, and 4-week follow-up among the study participants. The median Gartland and Werley score was 18 (IQR: 16–21) immediately after reduction, which decreased to 8 (IQR: 6–11) in the post-operative period and further reduced to 4 (IQR: 2–7) at 4 weeks follow-up.

The Friedman test demonstrated a statistically significant difference in Gartland and Werley scores across the three time points ($\chi^2 = 72.4$, $p < 0.001$), indicating a significant improvement in functional outcome over time.

Table 7. Association Between Anatomical Outcome and Final Functional Outcome (n = 41)

Anatomical outcome	Functional outcome Excellent/Good	Functional outcome Fair/Poor	Total	Chi-square (χ^2)	p-value
Excellent / Good	25	4	29	8.94	0.003
Fair / Poor	5	7	12		
Total	30	11	41		

There was a statistically significant association between anatomical outcome and functional outcome ($\chi^2 = 8.94$, $p = 0.003$). Patients with excellent to good anatomical outcomes had a significantly higher proportion of excellent to good functional outcomes, whereas patients with fair to poor anatomical outcomes were more likely to have fair to poor functional outcomes. This finding indicates that achieving a good anatomical reduction is an important determinant of favourable functional recovery.

Table 8. Association of Radiological Parameters with Final Functional Outcome (n = 41)

Radiological parameter	Functional outcome Excellent/Good n (%)	Functional outcome Fair/Poor n (%)	Chi-square (χ^2)	p-value
Dorsal tilt <10°	28 (93.3)	6 (54.5)	9.58	0.002
Loss of radial inclination <9°	24 (80.0)	5 (45.5)	5.60	0.018
Loss of radial height <4 mm	22 (73.3)	4 (36.4)	5.34	0.021
Acceptable ulnar variance	25 (83.3)	5 (45.5)	6.45	0.011

The association between individual radiological parameters and functional outcome is shown in the table. A statistically significant association was observed between dorsal tilt less than 10 degrees and favourable functional outcome, with a higher proportion of patients achieving excellent to good functional results (93.3%) compared to those with fair to poor outcomes (54.5%) ($\chi^2 = 9.58$, $p = 0.002$). Similarly, patients with loss of radial inclination less than 9 degrees had significantly better functional outcomes, with 80.0% attaining excellent to good results as compared to 45.5% among those with fair to poor outcomes ($\chi^2 = 5.60$, $p = 0.018$).

A significant association was also noted between loss of radial height less than 4 mm and functional outcome. Patients with preserved radial height demonstrated a higher proportion of excellent to good functional outcomes (73.3%) compared to those with fair to poor outcomes (36.4%) ($\chi^2 = 5.34$, $p = 0.021$). In addition, acceptable ulnar variance was significantly associated with favourable functional outcome, with 83.3% of patients achieving excellent to good functional results compared to 45.5% in the fair to poor group ($\chi^2 = 6.45$, $p = 0.011$)

The distribution of functional outcomes showed a clear and progressive improvement over time. Immediately after reduction, the majority of patients had poor (48.8%) and fair (39.0%) outcomes, with only 12.2% achieving excellent or good results. In the post-operative period, excellent outcomes increased to 24.4% and good outcomes to 41.5%, with a marked reduction in poor outcomes to 12.2%. At 4 weeks follow-up, further improvement was observed, with 39.0% achieving excellent results and 34.1% good results, while poor outcomes decreased to 9.8%. Overall, the proportion of patients with excellent to good outcomes improved from 12.2% immediately to 73.2% at 4 weeks, demonstrating substantial functional recovery over time.

A moderate to strong negative correlation was observed between anatomical score and final Gartland and Werley score (Spearman's $r = -0.62$, $p < 0.001$). This statistically significant inverse relationship indicates that better anatomical alignment was associated with lower (better) functional scores. The findings suggest that improved anatomical reduction plays a crucial role in achieving favourable functional outcomes.

DISCUSSION

In orthopedic practice, distal radius fractures arefrequently observed. According to a number of studies, the functional outcome and anatomical decrease are directly related. Nevertheless, despite their evident deformities, older patients with fewer functional needs perform reasonably well [17–22]. Although anatomical reduction can be readily accomplished with closed manipulation, opinions on how best to sustain the reduction in unstable fractures remain divided. Collesrecommended stabilizing plaster casts in order to avoid deformation. There is ample proof that cosmetic outcomes are far from ideal and that re-displacement occurs often [23–24]. Significant displacement is linked to 70% of cases receiving conservative therapy [25].In recent decades, a number of internal and external stabilization device techniques have gained popularity to stop displacement in unstable fractures. These include plastering, the Roger Anderson device, external fixation,and the use of Rush® pins (Rush Pin, LLC, Meridian, MS). The rehabilitation and stabilization of the distal radius's anatomy are their main goals. The patients in our study had closed reductions guided by C-arms. The procedure was preceded by no manipulation. The same anesthetic was used to stabilize and lessen the fractures.The participants in the current study had an average age of 69.5 years, which is consistent with the age range often impacted by Colles' fracture. This result is in accordance with earlier research that found

osteoporosis and low-energy falls are the main causes of distal radius fractures in the elderly (Court-Brown and Caesar; Jupiter et al.).The results of Gupta et al., Blakeney, and Chung etal., who ascribed this tendency to post-menopausal osteoporosis and greater bone fragility in older women,are consistent with the observation of a female predominance(56.1%). The current study's higher incidence of right-side involvement is consistent with findings by DePalma and Gartland & Werley, indicating defensive reflexes and processes associated to dominance during falls.Using the Gartland and Werley rating system, the instant subjective evaluation showed that 39.0% of the patients had fair outcomes and nearly half (48.8%) had poor outcomes. In the immediate post-reduction period, just 12.2% received a good rating, and none received anexceptional grade. These results are comparable to thoseof Chang et al. and Older et al., who observed thatalthough there is an acceptable decrease, early functional scores following conservative treatment in the elderly are frequently below ideal because of discomfort, stiffness, and soft-tissue edema.Since post-reduction discomfort, immobility, muscle disuse, and age-related joint stiffness are all known tohave a substantial impact on early functional evaluation in senior patients, the lack of excellent immediate outcomes in this study may be explained by these factors. A couple of authors, such as Jupiter and Ring, have highlighted that in older patients, immediate postoperative functional scores might not be a reliable indicator of long-term results.

The immediate objective assessment showed significant wrist strength and movement limitations. The most frequent deficiency was loss of wrist extension (80.5%), which was followed by diminished grip strength (68.3%), loss of ulnar deviation (70.7%), and loss of supination (65.9%). Cooney et al. and Gupta et al. have documented similar patterns of mobility restriction,identifying wrist extension and grip strength as the most impaired functions after conservatively treating distal radius fractures.When compared to the immediate post-reduction period, the current study's post-operative subjective evaluation utilizing the Gartland and Werley scale showed a noticeable improvement. Fair and poor results were noted in 24.4% and 12.2% of patients, respectively, while the majority of participants reported good outcomes (43.9%) and exceptional outcomes (19.5%). According to C-arm advice, these results show a generally positive subjective outcome after conservative management with closed reduction.This improvement is in accordance with the outcomes of Older et al., Chang et al., and Gupta et al., who found that as pain decreases, edema decreases, and wrist mobility progressively recovers, functionalsatisfaction in elderly individuals increases dramatically over time. Numerous writers have underlined that, particularly in elderly patients with little demand, early bad subjective scores frequently improve on follow-up.The objective post-operative evaluation showed a notable improvement in grip strength and wrist movements. The majority of patients did not show limits in ulnar deviation (61.0%), supination (65.9%), flexion (73.2%), or circumduction (78.0%), despite the fact that loss of wrist extension was still the most prevalent residual limitation (43.9%). These results imply that functional wrist motion recovered significantly during the recovery phase following surgery.The most often impacted movement after distal radius fractures, according to literature, is residuallimiting of wrist extension. Similar findings were madeby Cooney et al. and Fernandez, who noted that due tocapsular stiffness and degenerative changes, extensiontypically recovers more slowly than flexion or forearmrotation, especially in older individuals.A smallpercentage of subjects experienced pain in the distal radioulnar joint (29.3%) and decreased grip strength(36.6%), suggesting better muscle function and joint congruity. Gupta et al. and Blakeney found similar results, pointing out that with time and rehabilitation, grip strength and pain related to DRUJ gradually improve.The present research's post-operative complication assessment revealed a decrease in arthritic changes as well as additional complications. The most common observation was little arthritic changes (22.0%), which were followed by modest pain- related alterations (17.1%). Severe arthritic changes were uncommon, and moderate arthritic changes, with or without pain, were observed in fewer patients.These results were consistent with those of Jupiter and Ring, who found that minor radiocarpal arthritic alterations are frequently clinicallywell tolerated after distal radius fractures in the elderly. Ithas been noted by a number of authors that poorfunctional result in elderly people is not always associated with radiographic arthritis.9.8% of individuals experienced nerve-related issues, and 12.2% reported having poor finger function as a result of cast immobility. The frequencies of these temporary consequences were similar to those described by Cooney et al. and Older et al., who found that cast-related stiffness and temporary neuropathies were frequent but usually treatable problems in conservatively treated distal radius fractures.The current study showed sustained and noteworthy improvement in study participants' subjective and objective functional results at the 4-week follow-up. According to a subjective assessment using the Gartland and Werley scale, 34.1% of patients had good outcomes,while 39.0% of patients had exceptional outcomes. Bythe fourth week, the percentage of fair and poor results had dropped to 17.1% and 9.8%, respectively, suggesting a generally positive recovery pattern.The findings of Older et al., Chang et al., and Guptaet al., who found that patient satisfaction and perceived wrist function improve steadily within the first 4–6 weeks following conservative treatment of Colles' fractures inelderly patients, are in line with this progressive improvement in subjective scores. Pain relief, edema resolution, and a progressive return of wrist motion all play a major role in improving subjective results during this time.At four weeks, the objective evaluation revealed a significant improvement in wrist strength and movement. In terms of extension (78.0%), ulnar deviation (80.5%), supination (85.4%), flexion (87.8%), and circumduction (90.2%), the vast majority of individuals

showed no lossof motion. Furthermore, only a small percentage ofsubjects experienced decreased grip strength (17.1%) and distal radioulnar joint pain (14.6%).These results show significant functional recovery and are consistent with research by Fernandez andCooney et al., which found that most elderly patientsachieve acceptable functional ranges by 4–8 weeks after conservative management, and that wrist flexion andforearm rotation recover earlier than extension. Thedecrease in DRUJ discomfort also points to better soft-tissue adaptation and joint congruity over time.There was a noticeable decrease in both arthritic and non-arthritic problems, according to the complication evaluation after four weeks. Of the subjects, 12.2% had minimal arthritic alterations and 7.3% had minimal pain-related changes. No individual experienced severearthritic changes, either with or without pain, andmoderate arthritic changes were uncommon (7.3%).Jupiter and Ring and Blakeney's findings, which stressed that early radiographic arthritic alterations after distal radius fractures in the elderly are typically moderate and frequently clinically unimportant, are consistent with our data. Crucially, after the fourth week,none of the study participants saw significant degenerative changes. Poor finger function from cast immobilisation was noted in 7.3% of cases, and nerve problems were limited to 4.9%. This is a considerabledecrease from previous evaluations. Similar temporaryside effects have been documented by Cooney et al., who pointed out that neuropathic pain and stiffness associated with casts usually go away with time and physical treatment.Kurup et al. investigated the importance of latecollapse of distal radius fractures following K-wire removal [26]. After the wires were removed, they discovered that there was no discernible loss of decrease in the fractures. The ulnar variance was 1.3 mm, and the dorsal tilt was lost by 2.6 degrees. Their study found no functional association, and it was unclear if the collapsehad an impact on the function. In their comparison investigation between casting alone and percutaneous pinning for distal radius fractures, Stein and Katz reported excellent results [27]. They verified that percutaneous pinning maintained the usual volar tilt, reduced radial shortening, and improved range of motion.After manipulation and casting, Dixon, Allen, and Bannister found that 86% of patients (79/92) had radialshortening of less than 3 mm, although 48% (44/92) stillhad it after three months [28]. Since there was a 73% chance of failure after manipulation and plaster cast fixation, they came to the conclusion that there was potential for improvement in the way this common fracture was treated. In order to assess the results ofimmobilization in a cast alone with closed reduction percutaneous pinning, Azzopardi et al. conducted aprospective randomized research on 57 patients over 60with unstable, extra-articular fractures of the distal radius [29]. At one year, dorsal angulation, radial length, and radial inclination all showed statistically significant improvements in patients receiving percutaneous pinning.

The findings at the 4-week follow-up strongly imply that wrist function, pain alleviation, and the complication profile gradually improve in the elderly population when closed reduction is performed under C-arm guidance and conservative immobilization is implemented. These results provide credence to the idea that conservativetreatment should not be discouraged by earlyunsatisfactory results because significant healing happens over time.

CONCLUSION

The anatomical and functional results of Colles' fractures in the elderly population treated conservatively with closed reduction under C-arm guidance were assessed in this study. The study participants' mean age was 69.5 years, and the prevalence was somewhat greater among females, which is consistent with the known elevated risk of distal radius fractures in postmenopausal women as a result of osteoporosis. In line with trends seen in low-energy falls in the dominant upper limb, right-sided participation was more prevalent.

Assessments conducted immediately after reduction showed significant functional limits; the majority of participants had objective deficits in wrist extension, ulnar deviation, supination, and grip strength, and nearly half of the patients had poor subjective outcomes. Theseearly restrictions demonstrate how immobility,discomfort, and soft tissue edema affect wrist function in the early post-reduction phase.Significant progress was seen in the post-operative phase, as evidenced by a decrease in objective deficits across all wrist movements and a notable rise in the percentage of patients reporting good and excellent subjective outcomes. The safety and efficacy of the treatment strategy were demonstrated by the low and decreased incidence of complications, such as arthritic changes, nerve involvement, and cast- related finger stiffness, when compared to the immediate post-reduction period.

Most patients received excellent or good subjective scores during the 4-week follow-up, while the objective test revealed almost full recovery of wrist movements and grip strength with little to no lingering pain. No significant arthritic changes were seen, and the total complication rate was further decreased. Together with appropriate immobilization and early rehabilitation, these results show that conservative care with closed reduction under C-arm directionpromotes progressive functional improvement, pain alleviation, and few problems in the elderly population.To conclude, this study shows that conservativetreatment is a safe, dependable, and efficient way to manage Colles' fractures in older patients, especially those who have comorbidities that might make surgeryunnecessary or modest functional demands. Maximizing functional recovery and patient satisfaction requires early mobilization, organized physiotherapy, and meticulous follow-up. The study reinforces the idea that the most therapeutically relevant objectives for this age group are functional outcomes and patient-centered recovery, even though morphological perfection is desirable.

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