



Original Research Article

Assessment of Functional Outcome of Mid-Shaft Clavicle Fracture Treated with RECON Plate and Screw Fixation Using Constant Murley Score

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Abstract: Background: Mid-shaft clavicle fractures are common injuries. Displaced fractures of the middle one-third of the clavicle treated conservatively have been associated with higher rates of malunion and nonunion. Operative fixation using plates has gained popularity due to improved functional outcomes and early return to activity. **Methods:** This prospective observational study was conducted over one year at a tertiary care teaching hospital. Thirty patients aged 18–80 years with displaced or comminuted mid-shaft clavicle fractures (closed or Gustilo-Anderson type I open) were treated with open reduction and internal fixation using a 3.5 mm reconstruction plate. Functional outcomes were assessed using the Constant–Murley Shoulder Score at 6, 12, and 24 weeks postoperatively. Radiological union, complications, and return to pre-injury activity were also evaluated. **Results:** The mean Constant–Murley scores improved from 75 at 6 weeks to 85 at 12 weeks and 92 at 24 weeks, indicating progressive functional recovery. Excellent functional outcomes were observed in the majority of patients, with the remainder achieving good to fair results. All patients returned to their pre-injury level of activity by an average of six weeks. No cases of infection, wound dehiscence, or implant failure were noted. **Conclusion:** Plate fixation of displaced mid-shaft clavicle fractures using a reconstruction plate provides stable fixation, early mobilization, and favorable short- to mid-term functional outcomes with minimal complications

Keywords: Mid-shaft clavicle fracture, Open reduction and internal fixation, Reconstruction plate, Constant–Murley score, Functional outcome, Plate osteosynthesis, Shoulder function.

INTRODUCTION

Clavicle or the collar bone, which is an S-Shaped long bone, is placed horizontally between the sternum and the scapula creating a strut between the two ^[1] The Latin word clavis, which means key, is where the name comes from. ^[2] The term "clavicula," which is a diminutive of "clavis," refers to the clavicle's size and ability to rotate on its axis, allowing the shoulder girdle to move freely. ^{[3][4]} Clavicle fracture accounts for around 2.6% of all fractures and 44% of shoulder girdle injuries. ^{[5][6]} About 81% of all clavicle fractures involves the mid-shaft, of which 48% are displaced and 19% are comminuted; lateral fractures account for roughly 17%, while medial fractures, which occur in 2% of cases, are very uncommon. ^[7] Only 0.1% to 1% of instances have an open clavicle fracture, making it

an extremely rare occurrence. ^[8] Men are more than twice as likely as women to have a clavicle fracture. The third decade of life is when the incidence peaks. ^[9]

Historically, non-operative treatment has been used for clavicle fractures. ^[10] Although Fixation techniques have changed, the incidence of non-union or malunion in displaced clavicle fractures following conservative therapy is more than previously thought. ^[11] Because non-surgical treatment is perceived as having worse clinical and functional outcomes compared to operative treatment, surgery is increasingly being regarded as the preferred treatment for displaced clavicle fractures. ^[12]

The safety and effectiveness of primary open reduction and internal fixation for displaced clavicle fractures have been the subject of several investigations, which have been found to have a high union rate and a low risk of complications. A locking compression plate can provide an acceptable result with a low risk of complications in many difficult clavicle fractures.^[13] For displaced comminuted clavicular fractures, primary internal fixation results in a predictable and prompt return to function.^[14]

Jorge Lorenzo, the 2012 MotoGP World Champion, is a fantastic illustration of this. In 2013, during a practice session for the Dutch Tourist Trophy, the Spanish motorcyclist fell off his bike and sustained a displaced mid-shaft clavicle fracture. Within 24 hours following surgery, he finished fifth in the Grand Prix after having his fracture fixed surgically with a plate.

MATERIALS AND METHODS

This is a Prospective observational study, conducted in the Orthopaedics department in a Tertiary Care Teaching Hospital over a period of one year. The study included patients aged 18 to 80 years with mid-shaft (middle third) clavicle fractures who were fit for general anaesthesia. Only closed fractures and Type I (Gustillo-Anderson) open fractures were considered for operative management. Patients were excluded if they were below 18 or above 80 years of age, had Type II or III open fractures, pathological fractures, or undisplaced fractures. Additionally, patients with associated head injuries, neuro-vascular injuries, established non-union from a previous fracture, and concomitant acromio-clavicular joint dislocation were also excluded from the study.

30 patients with Clavicle fractures satisfying the inclusion criteria were included in the present study. Routine investigations prior to general anaesthesia were done. The patients were taken for surgery as soon as the general condition was stable and patients were deemed fit for surgery.

Standard pre-operative protocols were followed for all patients. They were kept nil orally for eight hours prior to surgery, and intravenous fluids were administered as needed. An adequate quantity of compatible blood was reserved in anticipation of any emergency. The entire extremity was prepared for surgery, and tetanus toxoid (0.5 ml IM) along with a lignocaine test dose was administered. Tranquilizers were given when required. Written informed consent was obtained, and parenteral antibiotics—specifically a third-generation cephalosporin—were administered at the time of induction of anaesthesia.

Operative Technique:

Surgery is performed in the beach chair position with a sand bag placed between the scapulae with the head

turned to the opposite side. Typically a lazy 'S' shaped incision extending from the antero-inferior border of the clavicle on the medial side of the fracture (about 2.5-3.0 cm medial to the fracture) and to the postero-superior border of the clavicle on the lateral side of the fracture (about 2.5-3 cm lateral to the fracture) is utilized.(Fig 1) Following the initial 5-6-cm incision, subcutaneous and deeper dissection is carefully performed with the help of sharp and blunt dissection while achieving haemostats using cautery.(Fig 2) A medial window is created so that dissection is continued right up to the periosteum and bone on the medial part of the clavicle (medial to the fracture). Sub-periosteal elevation is performed so as to comfortably place small Hohmann retractors. Similarly deeper dissection is performed up to the periosteum of the lateral part of the clavicle, and Hohmann retractors are placed.(Fig 3) A blunt freer is now used to gradually deepen and dissect the central part of the incision over the fracture site while protecting the supra-clavicular nerve and its branches. Once the dissection has exposed the fracture, both ends of the bone are held with AO bone holding clamps for ease of control. The fracture site is now cleaned, the haematoma and interposing soft-tissues are cleared, and the fracture edges are curetted and freshened. Care is taken not to break any bone spikes that would provide rotational stability. Irrigation is now performed with copious amounts of saline and the fracture is reduced. Once the fracture is well reduced, a 3.5 Reconstruction Plate of appropriate length is selected and contoured intra-operatively according to the curvature of the bone.(Fig 4) The plate is then fixed on the superior surface using 3.5mm cortical screws of appropriate size.(Fig 5) Care is taken intra-operatively while drilling the holes for the screw placement as excessive inadvertent plunging can lead to pleural/vascular injury and has the potential to cause pneumothorax. Following the placement of the plate, adequacy of reduction as well as the screw lengths are confirmed using image intensifier. The wound is irrigated, the incision is closed in layers, and a sterile waterproof dressing is applied. Shoulder is immobilised in a shoulder immobilizer.

Routine post-operative care was provided, including monitoring of vital signs, maintaining adequate hydration, continuation of antibiotics, and administration of analgesics and sedatives as needed. Check radiographs were done to study the alignment of fracture fragments and clavicle length compared.(Fig 6) The wound was inspected on 3rd or 4th post-operative day. Sutures were removed on 10th postoperative day and rehabilitation was started. Gentle pendulum exercises to the shoulder in the arm pouch were allowed. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction was restricted to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed and

assessed with shoulder scoring system.(Fig 7) The patients were followed up at an interval of two weeks for first two months and then once every month upto 6 months. Check radiographs were taken during every

visit. Patients were clinically evaluated by widely accepted Constant Marley Shoulder Score to assess the functional outcome at 6 weeks, 12 weeks and 24 weeks (Table 1). [15]

RESULTS

The study predominantly involved young adults, with a mean age of 34 years, and a male preponderance (77%). Most injuries resulted from road traffic accidents (83%), with the left clavicle more commonly affected (67%). Closed fractures constituted the majority (90%).(Table 2) 21 out of 23 male patients and 4 out of 7 female patients demonstrated an excellent functional outcome.(Table 3) Additionally, 2 male patients and 1 female patient had a good outcome, while 2 female patients showed a fair outcome. (Table 3) Two patients presented with visible hardware and hypertrophic wound scars; however, both achieved excellent functional outcomes. All patients returned to their pre-injury level of activity within an average of six weeks. Notably, there were no cases of wound infection or wound dehiscence observed at any point during the course of the study.

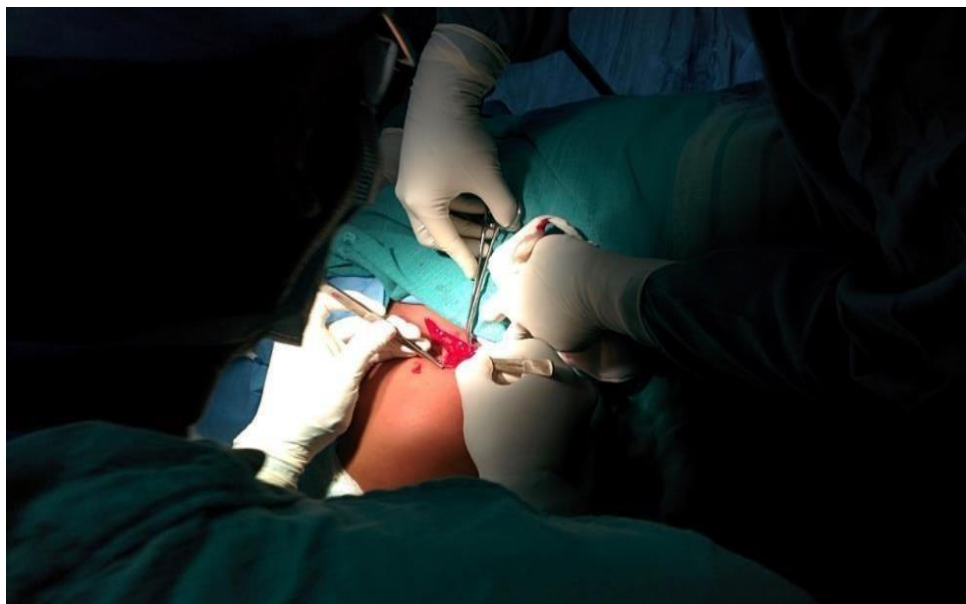


Fig 1. Lazy 'S' shaped incision

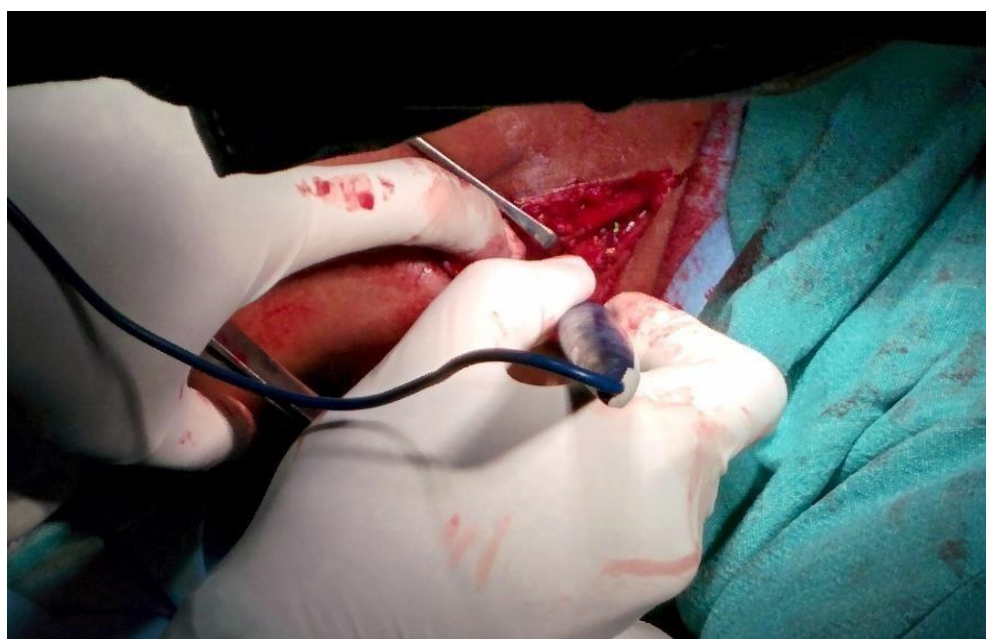


Fig 2. Skin and Subcutaneous tissue dissected out and haemostasis achieved

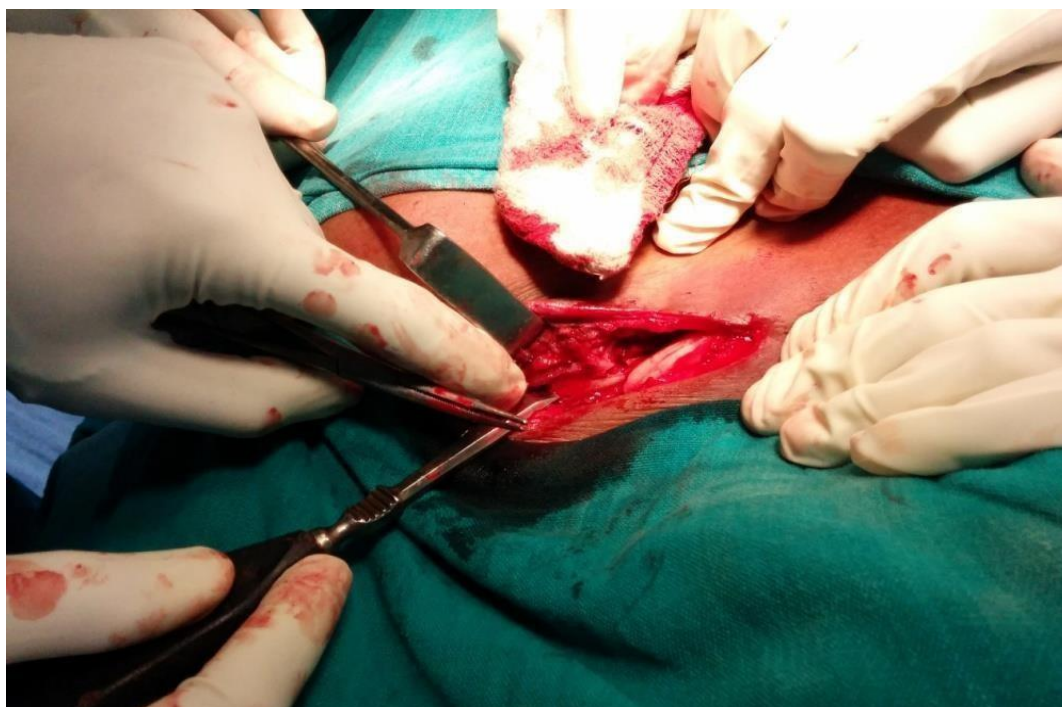


Fig 3- Periosteum was elevated preserving suprascapular nerves



Fig 4- Recon plate was bent with a plate bender while fracture was kept reduced using a pointed clamp.



Fig 5-Fracture reduced and fixed with RECON plate and screws

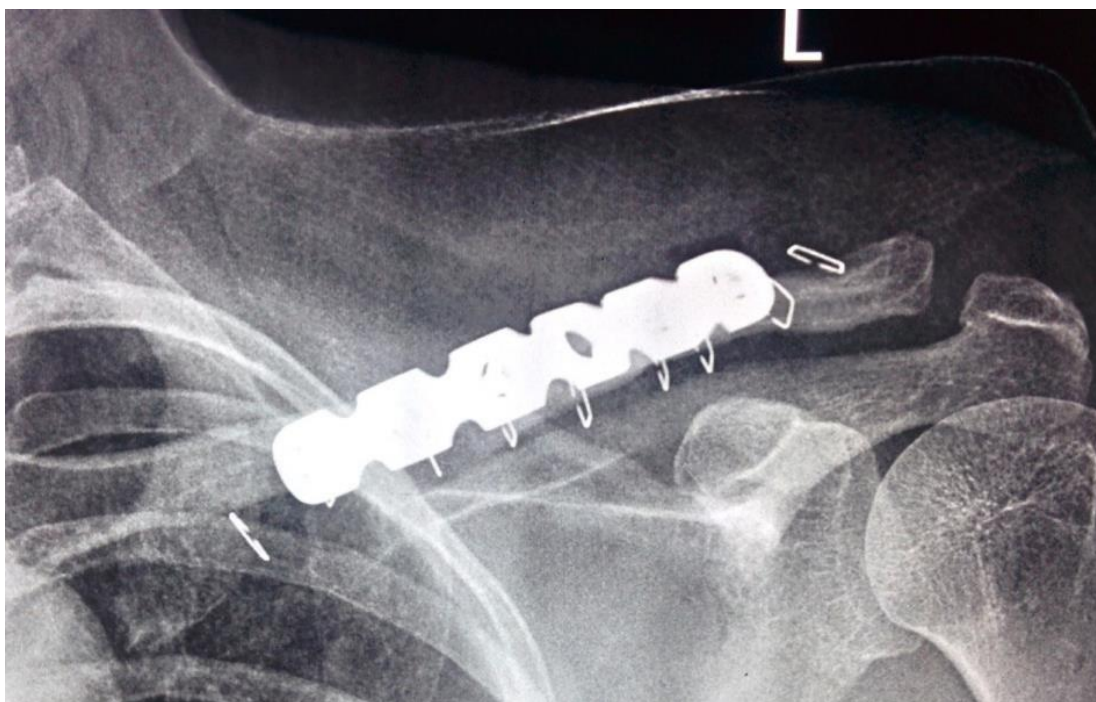


Fig 6-Immediate post operative radiograph showing fracture reduced with a 6 holed RECON plate and screws



Fig 7- Image showing full overhead abduction after 6 weeks

Patient's Details: 	Operation/Diagnosis: 	Date: _____ Side: R L
Examination: Pre-op 3 months 6 months 1 year 2 years _____ years		

A.- Pain (/15): Average (1 + 2) **A**

1. Do you have pain in your shoulder (normal activities)?
 No = 15 pts, Mild pain = 10 pts, Moderate = 5 pts, Severe or permanent = 0. _____

2. Linear scale:
 If "0" means no pain and "15" is the maximum pain you can experience, please circle where is the level of pain of your shoulder. (Points given are inverse to the scale. E.g. level 5 in the scale means 10 points)

Level of pain:

Points: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

B.- Activities of daily living (/20) Total (1 + 2 + 3 + 4) **B**

1. Is your occupation or daily living limited by your shoulder?
 No = 4, Moderate limitation = 2, Severe limitation = 0 _____

2. Are your leisure and recreational activities limited by your shoulder?
 No = 4, Moderate limitation = 2, Severe limitation = 0 _____

3. Is your night sleep disturbed by your shoulder?
 No = 2, Sometimes = 1, Yes = 0 _____

4. State to what level you can use your arm for painless, reasonably activities.
 Waist = 2, Xiphoid (sternum) = 4, Neck = 6, Head = 8, Above head = 10 _____

C.- Range of movement (leave this for the doctor or physiotherapist) (/40): Total (1 + 2 + 3 + 4) **C**

1.- FWD Flexion: 0 - 30 0 pts 31 - 60 2 pts 61 - 90 4 pts 91 - 120 6 pts 121 - 150 8 pts > 150 10 pts	2.- Abduction: 0 - 30 0 pts 31 - 60 2 pts 61 - 90 4 pts 91 - 120 6 pts 121 - 150 8 pts > 150 10 pts
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3.- External Rotation: Hand behind head & elbow forward 2 Hand behind head & elbow back 4 Hand above head & elbow forward 6 Hand above head & elbow back 8 Full elevation of arm 10	4.- Internal Rotation: (Dorsum hand to) Thigh 0 Buttock 2 SI joint 4 Waist 6 T12 8 Between shoulder blades 10
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D.- Power (/25): Points: average (kg) x 2 = **D**

First pull: Second pull: Third pull: Fourth pull: Fifth pull:
 Average pulls: _____

TOTAL (/100): A + B + C + D

TOTAL Score

Excellent =	90-100
Good =	80-89
Fair =	70-79
Poor =	< 70

Table 1: Constant Shoulder Score table showing parameters used to evaluate the score

Parameters	Details
Age Distribution	18 to 30 years: 10 patients (33%) 31 to years: 18 patients (60%) 46 to 60 years: 1 Patient (3%) 61 to 80 years: 1 Patient (3%) Mean age: 34 years Age range: 18–61 years
Sex Distribution	Male: 23 patients (77%) Female: 7 patients (23%)
Mode of Injury	Road Traffic Accident: 25 patients (83%) Assault: 5 patients (17%)
Side of Fracture	Right clavicle: 10 patients (33%) Left clavicle: 20 patients (67%)
Fracture Type	Closed fractures: 27 patients (90%) Type I open fractures: 3 patients (10%)
Functional Outcome	Male (n=23): Excellent: 21 Good: 2 Fair: 0 Poor: 0 Female (n=7): Excellent: 4 Good: 1 Fair: 2 Poor: 0

Table 2: Table showing Demographic data from the study

Follow-up duration	Mean Constant Shoulder Score	Remarks
6 weeks	75	Fair functional outcome and indicates early return to function
12 weeks(3 Months)	85	Good functional outcome and continued improvement in shoulder function
24 weeks(6 Months)	92	Excellent functional outcome and near full recovery

Table 3: Functional outcome as depicted by Mean Constant Score at 6 weeks, 3 Months and 6 Months

DISCUSSION

The Constant Shoulder Score was used to clinically evaluate the functional outcome of 30 patients who had clavicle plating over time by comparing it to the opposite normal limb. After six weeks, the mean Constant score was found to be 75, indicating a good immediate functional result with nearly all patients returning to their regular activities. After 12 weeks, the mean score was found to be 85 which improved to 92 after 24 weeks. Two patients out of 30 had a fair functional result, meaning they could do household

tasks. After six weeks on average, all patients resumed their pre-injury level of activity. Immediate post-operative relief of pain was significant after open reduction and internal fixation.

Altamimi et al. found that, at one year of follow-up, surgical fixation of a displaced fracture of the clavicle shaft leads to a better functional outcome and a lower rate of mal-union and non-union when compared to non-operative treatment. [16] In the operative group, hardware removal was the most frequent cause of recurrent intervention. The study concluded that in

active adult patients with displaced mid-shaft clavicle fractures, primary plate fixation is the preferred treatment of choice.

Similar results were found by McKee R.C. et al. In comparison to nonoperative treatment, they found that surgical treatment resulted in a considerably reduced rate of nonunion and symptomatic mal-union as well as an earlier functional recovery. [17]

Galdi et al. found that using a 2.7 mm anteroinferior plate for AO/OTA type B clavicle fractures resulted in better cosmetic outcomes and fewer secondary surgeries compared to the 3.5 mm plate, while still providing excellent functional results based on DASH and Constant scores. Both groups had similar union rates and time to union. [18]

But as of now, there isn't any proof that surgical intervention produces a much better long-term functional result than nonoperative treatment

CONCLUSION

Clavicle fractures, particularly those involving the midshaft, are common injuries that can significantly impair shoulder function and daily activities. Various treatment modalities exist, including non-operative management with slings or figure-of-eight brace, and operative interventions such as intramedullary fixation using pins or wires, and open reduction with internal fixation using plates. In our study, patients who underwent operative fixation using a 3.5 mm reconstruction plate demonstrated functional outcomes nearly comparable to the contralateral normal limb, as assessed by the Constant Shoulder Score—with mean values of 75, 85, and 92 at 6, 12, and 24 weeks, respectively. There were no major intraoperative or perioperative complications noted, and a significant reduction in pain was observed immediately after surgery. All patients returned to their pre-injury level of activity by an average of six weeks, reflecting a satisfactory short- to mid-term recovery. Hence, it is safe to conclude that plate fixation for displaced or comminuted mid-shaft fractures of clavicle is the recommended procedure due to its ability to provide rigid stabilization, early mobilization, reliable functional outcomes and early return to pre-injury level of activity in the short and medium term.. However, it is important to note that the study did not assess long-term functional outcomes, which limits conclusions regarding the durability of results over extended follow-up periods. Further studies with longer follow-up and comparative analysis of different treatment modalities are needed to guide optimal management strategies.

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