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Operative management of clavicle fractures by LCP

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Abstract

Background and objectives: Clavicle fractures are common and seen across all age groups. The traditional conservative treatment has shown higher incidences of fracture malunion, nonunion, and patient dissatisfaction. Clavicle fracture accounts for 2.6% to 4% of adult fractures and 35% of injuries of shoulder girdle. The annual incidence of midclavicular fracture is 64 per 100 000 population. Breaks of the shaft form 70% to 80% of all clavicular fractures; lateral fractures contribute to 15% to 30% of the total and medial fractures accounts for 3% and are relatively rare. There are various methods for treating clavicular fractures such as K-wire or Knowles pins, Steinman pin, plating and conservative methods.

We have taken up this study to understand the results and problems associated with clavicular fractures and to evaluate the functional outcome after fixation of clavicular fracture with LCP.

Materials and Methods: A prospective study was done at Sri Siddhartha Medical College, Hospital & Research Center during the period from September 2014 and September 2016. In this study 30 patients with the clavicle mid shaft fracture were chosen between 18 and 60 years by purposive sampling technique and were treated with LCP. The clinical and radiological results were evaluated according to constant and Murley scoring and plain radiographs. Union was evaluated clinically and radiographically. Complications were recorded.

Results: We had the highest number of patients in the age group of 21-30 years. 16 patients (53.3%) achieved radiological union in 12 weeks. Plate prominence (10%) and restriction of shoulder movements (10%) were the commonest complications encountered. 77% of the study subjects showed excellent outcome.

Conclusions: This study showed radiologically and clinically satisfactory results. Overall operative treatment with LCP for clavicular shaft fractures can be used to obtain stable fixation and excellent outcome.

Keywords: Clavicle, Fractures, Locking Compression Plate

Introduction

Clavicle is the bony link from thorax to shoulder girdle and contributes to movements at shoulder girdle. Clavicle fracture is a common traumatic injury around shoulder girdle due to their subcutaneous position.

The majority of clavicle fractures 70-80% occur in mid shaft of the bone where the typical compression forces applied to the shoulder and the narrow cross section of the bone combined and result in bony failure.

Fractures of the clavicle have been traditionally treated non-operatively. In the past few years several publications have described about poor outcomes like malunion and nonunion (15%) and poor functional outcome after conservative treatment of severely displaced midshaft clavicular fractures. They account for 2.6% to 4% of adult fractures and 35% of injuries or more fracture occurring of shoulder girdle.

The clavicle is an S-shaped bone that acts as a strut between sternum and glenohumeral joint. It also has a suspensory function of shoulder girdle. The shoulder hangs from clavicle by coracoclavicular ligament^[1].

The annual incidence of mid clavicular fracture is 64 per 100 000 population. lateral third fractures contribute 15% to 30% and medial fractures which account 3% and are relatively rare. Open clavicular fracture is an absolute rarity, found in only 0.1% to 1% of cases^[2].

Management of clavicular fracture traditionally has been closed reduction, the present consensus that great majority of clavicular fracture heal without non operative treatment is no longer valid.

The amount of pain and disability during first three weeks of conservative treatment has been underrated and a common view that nonunion does not occur is wrong.

There are various methods for treating clavicular fractures such as intramedullary K-wire or Steinmann pins and plating. We have taken up this study to gain deeper understanding of the results and problems associated with clavicular fractures and to evaluate the functional outcome after fixation of clavicular fracture with LCP.

Materials and methods

A prospective study was done at Sri Siddhartha Medical College, Hospital & Research Center during the period from september 2014 and september 2016. In this prospective study, 30 patients with the clavicle mid shaft fracture were chosen between 18 and 60 years by purposive sampling technique and were treated with LCP. The clinical and radiological results were evaluated according to constant and Murley scoring and plain radiographs. Union was evaluated clinically and radiographically. Complications were recorded. Functional assessment was conducted at 2 months, 3 months, 6 months with the use of the constant scores. General information like name, age, sex, occupation and address were noted. Then a detailed history was elicited regarding mode of injury like fall on the shoulder, Road traffic accident, direct injury to shoulder and fall on outstretched hand. Enquiry is made to note site of pain and swelling over the affected clavicle. Clinical examination (both local and systemic) done.

1. On inspection the following points were noted. Patients with fracture clavicle often support the flexed elbow of the injured side with the other hand. Abnormal swellings present in the middle third for middle third clavicle fracture and in the lateral third for lateral third clavicle fracture should be looked for. The condition of the skin over the clavicle was noted for any abrasion, laceration and contusion.
2. On palpation the following points were noted palpation of the entire length of the affected clavicle for tenderness in the medial middle third or in the lateral third fracture. The clavicle was also palpated for any abnormal mobility and crepitus.
3. Movements
The movements of the affected side shoulder was restricted due to pain. The distal neurovascular status of the affected upper limb was examined and also the associated injuries along with fractured clavicle were noted.

Routine investigation

Hb%, Total count, Differential count, RBS, Blood urea, Serum creatinine and ECG Were done. HIV, HBsAg, HCV, screening tests were done before surgery on all Subjects.

1. Fracture anatomy assessed with X-rays.
2. Diagnosis was done after clinical and radiological assessment.
3. Written informed consent was taken for surgical procedure
4. All patients were operated as early as possible once the patient was declared fit for the surgery by the physician.
5. Surgery – Open reduction and internal fixation with LCP.

Inclusion criteria

Adult male and female patients above 18 years who require surgical intervention for displaced clavicle fracture were included.

Exclusion criteria

1. Pathological fractures
2. Undisplaced fractures
3. Associated head injury
4. Associated with neurovascular injury
5. Established non-union from previous fracture
6. Associated acromioclavicular joint dislocation
7. Any medical contraindication to surgery or general anesthesia (heart diseases, renal failure)

Aims and objectives

Primary objective

To study the operative management of clavicle fracture by Locking Compression Plate (LCP).

Secondary objective

1. To determine the functional outcome of the clavicular fractures treated with open reduction and internal fixation with LCP.
2. To access the duration of union.
3. To access the complications associated with clavicular fractures and their management.

Surgical procedure

1. Under general anesthesia patient was put in supine position on OT table with a towel under the shoulder.
2. Entire upper limb from base of neck to hand was prepared and draped.
3. About 7-9 cms, incision was made in the anterior aspect centering of clavicle over the fracture site.
4. The skin subcutaneous tissue and platysma were divided without undermining the edges.
5. The overlying fascia and periosteum were next divided. The osseous ends were freed from surrounding tissue.
6. Minimal soft tissue and periosteum dissection was done.
7. Fracture fragments were reduced and precontoured locking compression plate was applied over the superior aspect of the clavicle. At the junction of the medial and middle third of the clavicle, the inferior surface is exposed so that a protective instrument can be inserted during drilling (3.2mm drill bit was used for 4mm locking screws and 2.8mm drill bit was used for 3.5mm cortical screws) to prevent injury to neurovascular structure underneath it.
8. The precontoured locking compression plate was fixed to the medial and lateral fragment with 4.0 mm locking screw or 3.5mm cortical screw at least three screws in medial and lateral fragment were applied.
9. Wound was closed in layers after ensuring meticulous hemostasis and sterile dressing was applied. The Average duration of surgery was 55 minutes.

Post-Operative care

Patients were kept nil orally for 4 to 6 hours post-operatively. Intravenous fluids were given as needed. Antibiotics were continued for 7 days.

Analgesics and tranquilizers were given according to the needs of the patient.

The operated upper limb was immobilized in an arm pouch.

Check X- rays were taken to study the alignment of fracture fragments.

The wound was inspected at 3or 4th postoperative day.

Suture/staple removal was done on 10th postoperative day.

Patients were discharged with the arm pouch.

Rehabilitation of the affected arm was started at the end of 2

weeks.

The operated upper limb was immobilized in an arm pouch. Check X- rays were taken to study the alignment of fracture fragments. The wound was inspected at 3or 4th postoperative day. Suture/staple removal was done on 10th postoperative day. Patients were discharged with the arm pouch. Rehabilitation of the affected arm was started at the end of 2 weeks. At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction was limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed.

Follow up: Follow up was done at 8, 12 and 24 weeks.

1. Local examination of the affected clavicle for tenderness, instability, deformity and shoulder movements were assessed.
2. X-rays were taken at each follow up visits to know about progressive fracture union and implant position.
3. Rehabilitation of the affected extremity was done according to the stage of fracture union and time duration from day of surgery.
4. Patients were followed up for 6 months.
5. The functional outcome was assessed by Constant and Murley score [3].

Criteria for functional results

Functional outcome was evaluated using the constant shoulder score, which is scored from 0 to 100, with a lower score representing a higher level of functional disability

Statistical tests

Descriptive statistics such as mean, standard deviation and proportion were calculated. Statistical Methods: Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean, SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance.

1. Dependent variables should be normally distributed,
2. Samples drawn from the population should be random, cases of the samples should be independent.

Student 't' test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters.

Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, Non-parametric setting for Qualitative data analysis.

Statistical software: Data collected was entered in Microsoft excel and analyzed in epiinfo 3.4.3, SAS 9.2, SPSS 15.0, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and Environment ver.

2.11.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc [4, 5].

Results

In a study of 30 cases of clavicle fractures treated with locking compression plate. In this study the average age was 36 years. Rehabilitation of the affected arm was started at the end of 2 weeks.

At 4 to 6 weeks gentle active range of motion of the shoulder was allowed but abduction was limited to 80 degrees. At 6 to 8 weeks active range of motion in all planes were allowed.

In this study we have included patients ranging from the age of 18-60. Among them we had the highest number of patients in the age group of 21-30 years (43.3%). The mean age was 36 years with the standard deviation being 6. (table 1)

In the present study among 30 patients, 27 (90%) were males and 3 (10%) were females.(table 2).

In our study the majority of the subjects were self-employed (23.3%). Factory workers and farmers constituted 16.7% each. Business men, government employees and house-wives each contributed to 10% of the total. 6.7% were students and 3.3% were bankers and lecturers. (Table 3).

In our study the mode of injury was RTA and fall constituted 50% each. (Table 4)

In our study left sided fracture was noted in 19 patients (63.3%) where as 11 patients (36.7%) had clavicular fractures on the right side. (table 5).

In the present study according to the Robinson classification, 2A2 category was seen in 3.3%, 2B1 was seen in 80%, 2B2 was seen in 16.7% of the subjects. (Table 6).

In the present study 66.7% of the subjects had 1-2 day's time interval between trauma and surgery with mean time of 4 days and standard deviation of 4. (Table 7).

In the present study 3.3% of the patient had hospital stay of 1-3 days. 63.3% had a stay of 4-6 days, 20% stayed for 7-10 days, 6.7% were admitted for 11-16 days and 6.7% were hospitalised for 17 or more days. Mean hospital stay was of 7 days with standard deviation of 5 days. (Table 8)

In our study most of the patients ie, 16 (53.3%) of them achieved radiological union in 12 weeks and 11 patients (36.7%) achieved union in 24 weeks. 3 patients (10%) had non-union. (Table 9).

In our study, 10 patients had complications. Plate prominence and restriction of shoulder movements were noted in 10% of the study subjects. 7% of the patients had nonunion. Plate breakage and infection were noted in 3% of the patients. (Table 10).

In our study as per the Constant and Murley scoring system, in 23 patients (77%) the functional outcome was Excellent, 4 patients (13%) fell under Good category, 2 patients (7%) had Fair functional outcome while 1 patient (3%) had Poor outcome.(table 11).

Table 1

Age in years	No. of patients	%	MEAN AGE (YEARS)	STANDARD DEVIATION
<20	1	3.3	36	6
21-30	13	43.3		
31-40	6	20.0		
41-50	7	23.3		
51-60	3	10.0		
Total	30	100.0		

Table 2

Gender	No. of patients	%
Female	3	10.0
Male	27	90.0
Total	30	100.0

Table 3

Occupation	No. of patients	%
Self employed	7	23.3
Factory worker	5	16.7
Farmer	5	16.7
Business	3	10.0
Govt. employee	3	10.0
House wife	3	10.0
Student	2	6.7
Banker	1	3.3
Lecturer	1	3.3
Total	30	100.0

Table 4

Mode of Injury	No. of patients	%
Fall	15	50.0
RTA	15	50.0
Total	30	100.0

Table 5

Side affected	Total
Left	19(63.3%)
Right	11(36.7%)
Total	30(100%)

Table 6

Robinson Classification	Total
2A2	1(3.3%)
2B1	24(80%)
2B2	5(16.7%)
Total	30(100%)

Table 7

Time interval between trauma and surgery in days	Total	Mean(days)	Standard Deviation
1-2	20(66.7%)	4	4
3-7	7(23.3%)		
8 or more	3(10%)		
Total	30(100%)		

Table 8

Duration of stay in hospital in days	Total	Mean(days)	Standard Deviation(days)
1-3	1(3.3%)	7	5
4-6	19(63.3%)		
7-10	6(20%)		
11-16	2(6.7%)		
17+	2(6.7%)		
Total	30(100%)		

Table 9

Time of radiological union in weeks	Total	Mean (weeks)	Standard deviation
12	16(53.3%)	16	6
24	11(36.7%)		
Nonunion	3(10%)		
Total	30(100%)		

Table 10

Complications	Total
Infection	1(3%)
Plate breakage with nonunion	1(3%)
Plate prominence	3(10%)
Restriction of shoulder movements	3(10%)
Nonunion	2(7%)

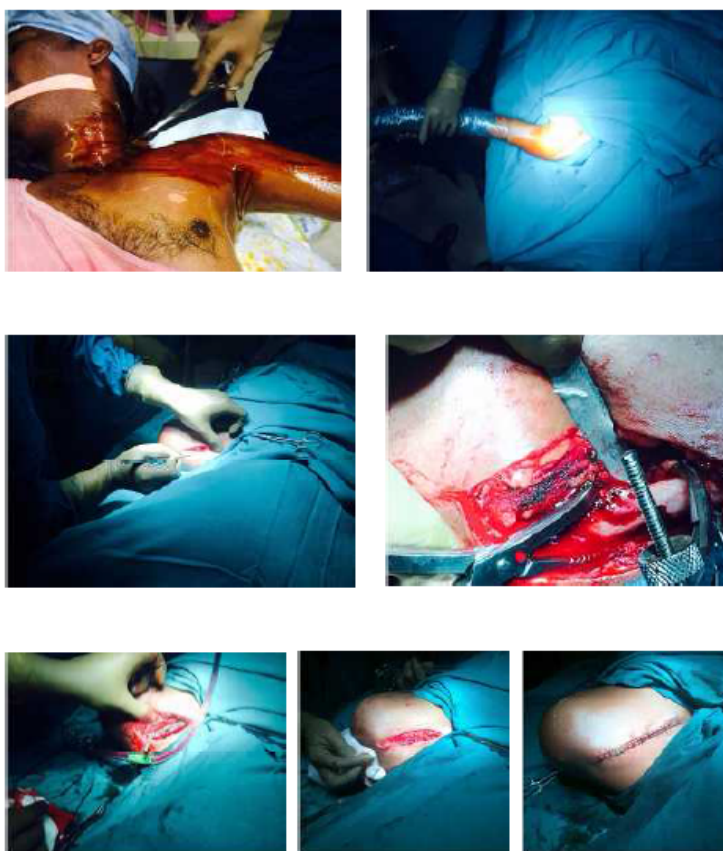
*10 out of 30 patients had complications

Table 11

Result	Total
Excellent	23(77%)
Good	4(13%)
Fair	2(7%)
Poor	1(3%)
Total	30(100%)

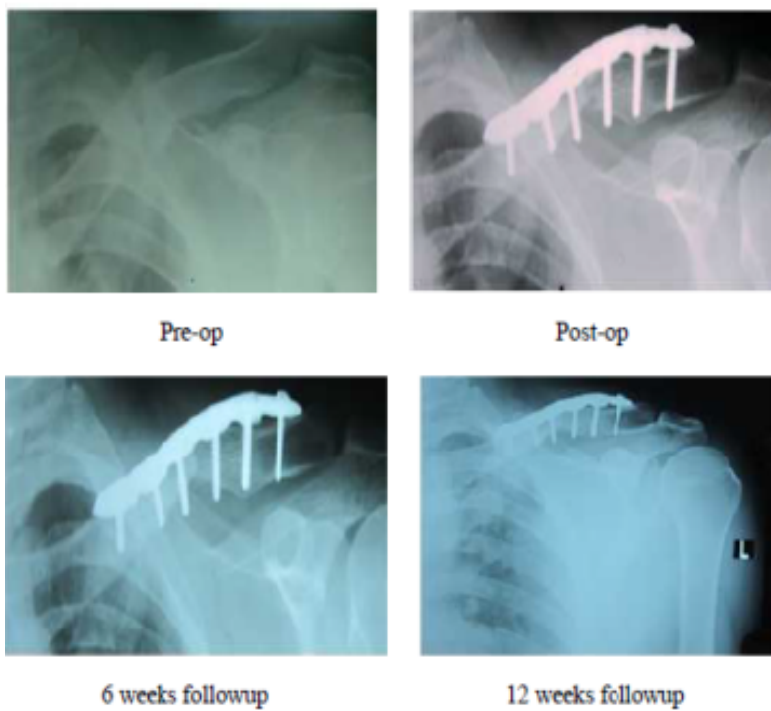
CLINICAL PHOTOGRAPHS

Intraoperative photographs



Case1:

X-rays showing radiological union (Pt. No.1)



Photographs showing good range of movements (Pt. No.1)



Case3:

X-rays showing radiological union (Pt. No.3)



Pre-op



Post-op



6 weeks followup



12 weeks followup

X-rays showing plate breakage (Pt. No.27)



Clinical photograph of a patient showing plate prominence (Pt. No.10)



Photographs showing good range of movements (Pt. No.3)



Non union (case 13)



Non union (case 22)



Discussion

Age distribution of patients studied

1. In this study we have included patients ranging from 18-60 years of age, amongst them we had the highest number of patients in the age group between 21-30 years and mean age was 36 years with standard deviation of 6.
2. In a similar kind of study conducted by Ramkumar Reddy *et al.* [6] most were in the age group between 19-39 years (66%) while 2 patients were above the age of 50. Average age was 33.8 years.
3. In a study conducted by Ramesh *et al.* [7] among 20 patients, 45% were in the age group of 21-30 years. The youngest patient was 19 years and the oldest was 60 years old.
4. In a study conducted by Bostman *et al.* [8] the average age of the patients was 33.4 years. The youngest patient was 19 years and the oldest patient age was 62 years old.

Sex distribution

1. In the present study among 30 patients, 27 (90%) were males and 3 (10%) were females.
2. In a study conducted by Ramkumar *et al.* [6] all the 30 patients were Males.
3. In the study by Bostman *et al.* [8] the males were most commonly affected, that is 73.79% compared to female patients who constituted 26.21%.

Mode of injury

1. In our study the mode of injury was RTA and fall constituted 50% each.
2. In a study by Ramkumar *et al.* [6] the mode of injury in 56% cases were road traffic accidents and in 44% patients it was due to a fall.
3. Ramesh *et al.* [7] observed that 60% of fractures were seen because of RTA and the rest 40% were due to a fall.

Type of fracture

1. In the present study according to the Robinson classification, 2A2 type was seen in 3.3%, 2B1 was seen in 80%, 2B2 was seen in 16.7% of the subjects.
2. Ramkumar *et al.* [6] stated that patients with Robinson Type-2 B1 were 56.6% and Type-2 B2 were 43.7%.
3. In a study by Ramesh *et al.* [7] Robinson Type- 2B1 were seen in 80%, Type-2B2 constitutes another 20%.

Time interval between trauma and surgery in days

1. In the present study 66.7% of the subjects had 1-2 days' time interval between trauma and surgery, 23.3% had 3-7 days' time interval and 10% had 8 or more days.
2. In a study by Ramkumar *et al.* [6] 93.3% patients were operated within 5 days and 6.7% were operated after 5 days.
3. In Ramesh *et al.* [7] study 75% of patients were operated

within 7 days and 25% of the patients were operated with an interval of 7-10 days.

Duration of union

1. In our study most of patients ie, 16 (53.3%) of them achieved radiological union in 12 weeks and 11 patients (36.7%) achieved union in 24 weeks and 3 patients (10%) had nonunion. With the mean interval for duration of union being 16 weeks with standard deviation of 6.
2. In a study conducted by Ramesh *et al.*,^[7] the union was achieved in a mean interval of 9 weeks.
3. In a study conducted by H.Jiang *et al.*,^[9] the union was achieved in a mean interval of 12 weeks.
4. Lazarus MD *et al.*,^[10] stated that radiological unions occurred approximately between 6 to 12 weeks. All the latera third clavicle fracture (4 patients) united at the end of 12 weeks.

Functional outcome of the clavicular fractures treated with open reduction and internal fixation with LCP

1. In our study as per Constant and Murley scoring system 23(77%) of the study subjects showed Excellent, 4(13%) of them showed Good, 2 patients (7%) had Fair while 1(3%) had Poor functional outcome. Even the patients who had nonunion were assessed with Constant and Murley scoring because the functional outcome assessed

by the scoring is independent of clinical or radiological union.

2. Reddy *et al.* ^[6] observed that functional outcome according to Constant and Murley score is excellent in 19 patients (63.3%) and good in 11 patients (36.7%).
3. Ramesh *et al.*,^[7] observed that functional outcome according to Constant and Murley score is excellent among 85% of the study group.
4. McKee *et al.*,^[11] In a multicentre trial, Canadian Orthopaedic society had 132 patients with displaced mid-shaft fractures randomized to either nonsurgical treatment or primary plate fixation. Surgical treatment was found to be significantly superior to non-surgical treatment according to the functional tests used.
5. Functional outcome in the patients observed in our study is similar to the above stated studies and further justify our finding that operative management provides excellent results.

Complications associated with clavicular fractures

In our study we came across complications which included infection, plate breakage, plate prominence, nonunion and restriction of shoulder movements which constitutes around 33% of the total number of patients. Complications in other studies are as follows (table12)

Table 12

Study	Complications
Ramesh <i>et al.</i> ^[7]	Plate loosening-1 Plate prominence-2 Delayed union-1
H. Jiang <i>et al.</i> ^[9]	dysesthesia in the area of incision - 10, hypertrophic scarring - 5, painful shoulder -2 limitation of shoulder movements - 1
Canadian Orthopaedic Trauma Society(COTS) ^[12]	wound infections – 3 patients hardware irritations (removal required)-5patients transient brachial plexuses injury-8 nonunions-2
Virtanen <i>et al.</i> ^[13]	refracture – 1 patient delayed unions – 3 patients
Present study	Deep infection-1 Nonunion-2 Plate breakage-1 Plate prominence-3 Restriction of shoulder movements-3

Conclusion

1. The anatomical reduction with reconstruction of clavicular length and alignment of shoulder girdle which is the goal of surgical treatment can be attained with LCP osteosynthesis of the clavicle. The strong fixation due to locking between the screw and plate, blood supply preservation due to minimal contact, fixation which can be achieved without tip of screw reaching the opposite bone cortex potentially reduces the risks of injury to the subclavian artery and brachial plexus and hence the plates are pre-contoured and do not require any contouring. It reduces the surgical time and makes this a more desirable option.
2. The functional outcome as assessed by Constant and Murley ^[3] scoring of clavicular fractured treated in our study with open reduction and internal fixation with LCP showed 77% of the study subjects having excellent outcome.

3. 53% achieved clinical and radiological union in 12 weeks, 37% achieved union in 24 weeks and 10% of them had nonunion including the one subject who had plate breakage.
4. Complications we encountered in our study included 3% deep infection, 3% plate breakage, 10% restriction of shoulder movements and 10% of the total study subjects had nonunion (including the one patient with plate breakage).
5. All the study subjects attained early mobilization.
6. So the present study recommends that operative management of clavicular fracture by LCP as a superior treatment modality.

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Declarations

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Ethical approval: Approved by ethical committee

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