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Clinical outcome of modified Nicoll's grafting in gap management of both boneforearm ,a retrospective study.

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ABSTRACT

Background:

Nonunion with a gap following a fracture of forearm in adult always associated with deformity chronic regional pain syndrome and stiffness and contracture of hand. Various methods of treatment available in the literature are cortical tibial graft (Boyd), ulnar segment graft (Miller and Phalen), iliac crest graft (Spira), cancellous insert graft (Nicoll), vascularized fibular graft (Jupiter).Using autogenous graft like iliac crest and fibula is easy but there are no guideline for it .

In our present study we will search for the functional outcome of diaphyseal bone gaptreated with tricorticocancellous bone block grafts with improvise techniques of creating medullary tunnel with in the graft for better union.

Materials and Methods:

A total of 20 forearm bones (either radius or ulna or both) in 11 patients with a gap of 1.5–6 cm were treated by debridement and tricorticocancellous bone block graft under dynamiccompression plate (3.5mm) and 9 case with 6cm to 8cm gap treated by free fibulabetween july2017and july 2022

We have seen the improvised tunnelling by brill bit within the iliac crest graft help in early healing. There were 11 male and 9 female patients. 8 patients had open and 12 patients had closed fractures initially. Time of presentation since the original injury varied from 9 months to 12 months. 10 patients had already undergone one to three operations.

Results:

All our case showed union at both host graft junctions. The mean duration of union was 16.5 weeks (range, 14–24 weeks).

Patients were followed for a minimum period of 1 years (range, 6moths –2 years). Results were based on the status of union and range of motion (ROM) for elbow/wrist and grip strength at the final follow-up.

Complications observed were the reactivation of infection (n = 1) and CRPS -1 two cases,

Finger flexion contructure in a 6 months old case. . Maximaum case functionaly active came back to there normal life with in 2 to three months of the final grafting

Conclusion:

The tricorticocancellous strut bone grafting under optimal compression plate fixation, provides a promising solution to difficult problem of an atrophic nonunion of forearms bones with bone loss.

Keywords: diaphyseal bone gap, absolute fixation, tricortical bone graft .

I. INTRODUCTION

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Both bone forearm in adult has three joints. Proximal radio ulnar,distal radioulnar and interosseous joint. Any lenth discrepancy during fixation of bone can cause wrist pain and deformity.

Gap nonunion following a fracture of both bones of the forearm, both aseptic and septic, is a peculiar problem have to mange by structural support bone gaftwith out significant shortening and lengthening ,ortherwise wrist function and normal ulnar varience ,supination pronation will hamper (1).

Nonunion with a gap following a fracture of forearm in adult always associated with deformity chronic regional pain syndrome and stiffness and contracture of hand.

Nonunion is often the result of old fracture, following resection of primary or secondary bone tumors, healed osteomyelitis with gap nonunion, or a complication of complex fractures with failed primary fixation. use of cortical tibial graft with screws,[2] grafts using ulnar segment held by screws,[3] use of iliac crest graft to fill the bone gap and fixation with an intramedullary nail,[4] cancellous insert grafts with plate fixation,[5,6] bone transport in forearm bones using the principles of Ilizarov,[7] using fibula as an intercalary bone graft and with a tibial cortical bone graft fixed opposite to a plate,[5,8] and vascularized fibular iliac bone graft.[9]

Using autogenous graft like iliac crest and fibula is easy but there are no guideline for it .

In our present study we will search for the functional outcome of diaphyseal bone gap treated with tricorticocancellous bone block grafts fixed by plating, with improvise techniques of creating medullary tunnel with in the graft for better union.

II. REVIEW OF LITERATURE:

Ununited diaphyseal forearm fractures with segmental defects: plate fixation and autogenous cancellous bone-grafting,[1] use of cortical tibial graft with screws,[2] grafts using ulnar segment held by screws,[3] use of iliac crest graft to fill the bone gap and fixation with an intramedullary nail,[4] cancellous insert grafts with plate fixation,[5,6] bone transport in forearm bones using the principles of Ilizarov,[7] using fibula as an intercalary bone graft and with a tibial cortical bone graft fixed opposite to a plate,[5,8] and vascularized fibular iliac bone graft.[9]

The salvage procedures such as centralization of one bone as a treatment of segmental bone defect in forearm bones is also described.[10,11]

Davey[12] modified Nicoll's technique and used blocks of the corticocancellous bone with a single cortex from the iliac crest, augmented with plate fixation under compression. Ring[13] used nonstructured autogeneous cancellous bone graft with plate fixation in patients with a diaphyseal nonunion of radius and/or ulna and reported good results when the soft tissue envelope is compliant having limited scars, and consists largely of healthy muscles with a good vascular supply.

B S SVenkateswarlu 'work on Infected Gap Non Union of Radius Treated with Modified Nicoll's Technique (13)

Here, intra medullary nailing is preferred over plating which was originally described by Nicoll. At two years follow up.

Prof (Dr) Anirudhha Sengupta et all work on this recenty on 2017 he told ,the tricortical cancellous bone graft under optimal compression provides a good solution for the management of gap non-union of both bone forearm for deficit up to 3 cm with no evidence of infection. (14)

we improvise this iliac crest tricortical graft custom made by making a hole in the central area simulating medullary cavity in a hope of better vascularity to the graft for healing.

The present study on adult patients forearm bones with segmental bone defects will be treated by tricorticocancellous bone graft under optimum compression with dynamic compression plate.

III. METERIALS AND METHODS-

This prospective study will be conducted between july2017and july 2022.

At Medical college Kolkata department of orthopaedics .As a tertiary treatment centre we used to get referral complicated cases from all district of Bengal at our OPD.

We have a plan to treat atrophic nonunion with a gap in adult, with prior surgical procedures with some useful residual functions of wrist and fingers were included in the study.

Cases with a preoperative active infection, Volkmansischimiccontructre with no useful residual function of hand were excluded from the study.

After debridement of dead bone, unhealthy scar tissue along with old scar under tourniquet control ,We decide to fill the gap with iliac crest graft if it upto 5cm .if more than 5cm we used free fibular grafting. Five had isolated fracture of the ulna and three had isolated fracture of the radius.

Aims and objective was to evaluate clinical outcome of this modified Nicole's technique to measure graft bone union rate and possible complications.

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Operative procedure-

we must restore maximum lenth possible put plate in longest construct,then decide the defect of orther bone to maintain unlnar variation and proper wrist function

Under tournicatecontrole the fracture site will be exposed through standard surgical incisions in case of those non operated case manged congervatically.

Old scar ellipesd out with all the surrounding scarred tissue and sclerosed bone ends were excised till the fresh, visible blood-oozing surfaces were seen. Medullary cavity opened up with drill bit and freshened up by gentle to and frow movement of tap within the medullary cavity.

Forearm hold on gentle traction in normal ulnar varience anatomical position full supination, to measure the gap between the bony fragments.

A tricorticocancellous iliac crest bone block , 2–3 mm longer than the measured gap, was harvested and improvised by making a drill hole simulating medullary cavity to improve blood supply in the hope of early and better union rate.

The width of the graft was 2–2.5 cm .The prepared strut (corticocancellous bone block) putted as per local geometry of the bone .

The bone fracture end and plate hold with parrot beak plate and bone holding forcep then the gaft put in beteen the gap . plate fixed with 3.5 mm cortical screw as per AO principle and compression given in between the two host fractue fragment.

No screw on graft ,it may displaced it,spoil the whole construct and the alignment of plate. Bone graft is sandwithed and compressed by plate .Cancellous end of the tricorticocancelous graft put on introssious membrane side.

Post operative protocol-

Before putting final dressing on the operative side in every case passive manipulation of all small joints of hand including wrist mobilised to prevent post op stiffness .As every case of non union and multiple surgery predispose the chance of stiffness.

The patients will be encouraged to do active finger and shoulder exercises as soon as brachial anasthetic effect goes off and were followed at 4-week interval, clinically and radiologically, till the fracture united radiologically.

Post operative physiotherapy and wound care on bone grafting harvesting site and forearm done as per routine practice in orthopaedics.

Allow early movement of forearm . Range of motion and work ability recorded for post operative outcome assessment .

Thus we will modify Nicoll technique and used tricorticocancellous bone strut, to fill the bone gap, instead of wholly cancellous inserts used by Nicoll . Nicoll removed the superior cortical plate of the iliac crest as “lid” and thin “wafer-like” cortical plates from both surfaces of the ilium and retained this wholly cancellous insert in the gap with a bridge plate without fixing the graft.

We have used a part of the full iliac crest without removing any cortex, and stabilized the strut at the non union site by a Dynamic compression plate.

After debridement and Before putting graft and plate we clean the wound with Hydrogen peroxide and Normal saline to remove all remaingdebries from the surgical site.

Then we remove the tournicate of the limb under closed observation of anasthetic team after compression bangade over the wound packed with saline socked gauge.

We utilised this time by graft harvesting and closed of donner site wound.

Then we remove the compression bandage and the saline soaced gauge help beautifully for proper haemostasis of the bed..During closed few fibers closed contact of the graft site stiched by 2-0 vicryle to cover it with the hope of induction membrane or vascularised new periosteam formation help in early graft incorporation with the host bone .

The wounds were closed with 3-0 ethilone or skin stepler and the limb was immobilized in an arm pouch bag after proper and adequietcontrole compression bandage with sterile roller cotton and roller bangade over .Gamji or soft role not used as it act like trounicate if soakage occur.

Before putting final dressing on the operative side in every case passive manipulation of all small joints of hand including wrist mobilised to prevent post op stiffness .As every case of non union and multiple surgery predispose the chance of stiffness. The patients were encouraged to do active finger and shoulder exercises as soon as brachial anasthetic effect goes off and were followed at 6-week interval, clinically and radiologically, till the fracture united radiologically.

Post operative physiotherapy and wound care on bone grafting harvesting site and forearm done as per routine practice in orthopaedics.

Allow early movement of forearm.after radiological sign of union patient advised for joining his duty. Range of motion and work ability recorded for post operative outcome assessement .

Thus we have modified the Nicoll technique and used tricorticocancellous bone strut, to fill the bone gap, instead of wholly cancellous inserts used by Nicoll . Nicoll removed the superior cortical plate of the iliac crest as “lid” and thin “wafer-like” cortical plates from both surfaces of

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the ilium and retained this wholly cancellous insert in the gap with a bridge plate without fixing the graft. We have used a part of the full iliac crest without removing any cortex, and stabilized the strut at the non union site by a Dynamic compression plate.

Study Area:
MEDICAL COLLEGE, KOLKATA.

Study Period:
july 2017 to july 2022

Sample Size:
20 patients total.

Sample Design:
1) Patient Selection :
The study will be conducted among the adult gap non union of forearm
2) Inclusion Criteria :

- Non union with diaphyseal gap
- Bone loss in diaphyseal region

3) Exclusion Criteria :

- Gross infected wounds.
- Volkmann ischemic contracture of forearm.
- Nerve palsy.

Study Design:
Institution based prospective study.
Study Tools:
- Roentgenogram
- clinicoradiological assessment sheet.

Parameters to be studies:
Pre operative evaluation-

- Joint stiffness
- Deformity
- radiological evaluation of bone stock
- Estimation of diaphyseal Bone gap.

Post operative evaluation of

- infection.
- graft incorporation.
- Wrist and hand function.

PLAN FOR ANALYSIS OF DATA:
Data obtained from the study will be analysed using standard statistical methods.

Funding/sponsor: None
Conflict of interest statement: None


fig -1

ig-2

g-3

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fig -4

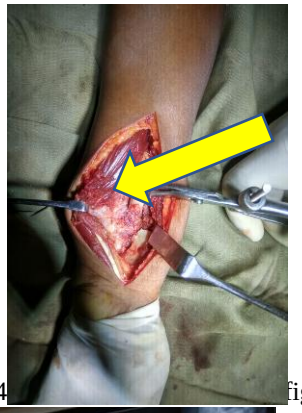
fig -5


fig-6

fig 7

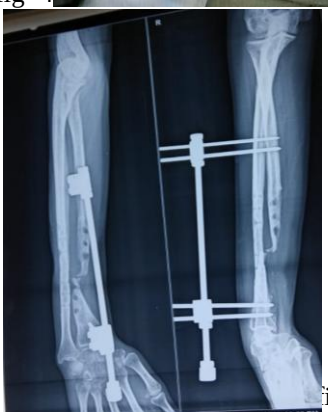
ig -8


fig-9


ig-10

fig -11

FIG-1,2, 5,7- showing custom made procedure of illiac crest grafting and improvise technique of creating intra medullary hole .

Fig -3 - intra operative illiac crest graft fixation .fig 4,7,8,12 pre op and post op x-ray plate Fig –5,9 post debridement intra op gap.

Fig -10,11 -fibular grafting donner site and fixation site.

V. RESULTS

The patients were followed for a minimum 6 months to 2years. The mean duration of the nonunion was 12months .

IV.

All cases showed union at both host graft junctions. The mean duration of the union was 8 week each follow up we document radiological union and functional improvement.

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One case got deep infection .we managed that case by debridement and aggrasive NS wash ,H2O2 wash and local vancomycine infiltration .with out removing the gaft and plate.
At 1.5 to 2 months 18 patients had full flexion of the elbow. 15 cases got back desired Supination and pronation .
Out of 20 case we have to use long free fibular graft in one patient.union of that case was after 3 months though he come back to his daily activity with in 2 moths. We advised for protected movement in where radiologically lack of union .

This technique of grafting is simple; it provides stability to fracture as well as bone graft. The presence of cortical bones on three sides provides optimal compression at both host graft junction without crushing/fracture of wholly cancellous block and enough strength till it is incorporated. Moreover, autografts do not have any risk of immunological response or transfer of disease, or the risk of pin tract infection and do not require a painful heavy ring fixator for bone transport. Functionally, all the patients had a better range of motion and grip strength, than before surgery, multiple surgical interventions prior to this final surgical intervention.
The only specific complication is the risk of pain over iliac crest, herniation of muscles at the donor site, which can be manage easily.
We got reactivation of infection in one case out of 20 case ,managedby aggrasive treatment.
Finger stiffness , wrist & elbow manged by early physiotherapy protocol.
Thus, this simple technique of tricorticocancellous bone grafting under optimal compression, augmented with intramedullary fixation, provides a promising solution to this difficult problem of atrophic nonunion with a gap.

Clinical finding delails- MASTER CHART-

Patient no	age	Bone affected	Previous surgery	Type of injury	Gap	Union time	Healing status	Elbow function	Wrist function	Complications
1	27	BB	No	closed	2cm	9weeks	healed	full	-10 FELX	CRPS-1
2	30	ULNA	No	closed	3cm	8 weeks	healed	full	-10 FLEX	NO
3	26	RADIUS	No	open	3cm	10 weeks	healed	full	FULL	NO
4	27	UNLA	yes	closed	4cm	18 weeks	healed	-10	FULL	NO
5	45	ULNA	yes	open	2.5cm	12 weeks	healed	-20	-1O PRONATION	NO
6	38	ULNA	yes	closed	3cm	12 weeks	healed	-20	-10 SUPINATION	NO
7	40	RADIUS	no	open	4cm	10weels	healed	full	-10 PRONATION	NO
8	26	BB	no	closed	2.5cm	12 weeks	healed	full	FULL	CRPS-1
9	28	BB	yes	open	3cm	20 weeks	healed	-20	FULL	INFECTION
10	30	ULNA	no	open	4cm	20 weeks	healed	-10	FULL	INFECTION
11	32	RADIUS	yes	open	2.5cm	9 week	healed	-10	-10 EXTEN	NO

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						s			TION	
12	40	RADIUS	no	close d	3cm	12 week s	healed	full	-10 FLEXSO N	NO
13	25	RADIUS	yes	close d	2.5c m	12 week s	healed	-10	FULL	NO
14	23	ULNA	yes	close d	5cm	8 week s	healed	full	-10 PRONA TION	NO
15	25	UNLA	yes	open	4cm	8 week s	healed	-10	-10 PRONA TION	NO
16	29	RADIUS	no	open		8 week s	healed	-20	FULL	NO
17	25	BB	no	close d		10 week s	healed	-10	FULL	NO
18	26	BB	yes	open		12 week s	healed	FULL	-10 PRONA TION	NO
19	26	ULNA	no	close d		10 week s	healed	full	-20 SUPINA TION	NO
20	29	RADIUS	no	open		9 week s	healed	full	FULL	CRPS-1

VI. DISCUSSION

Nonunion of the bones of the forearm occurs when inadequate fixation leads to movement and abrasion at the site of the fracture, resulting in bone loss.

The Nicoll bone grafting technique is less successful in treating long defects for two reasons. First, it depends on the compression of a straight piece of bone graft. The longest piece of straight graft which we were able to obtain from the iliac crest was 5cm.

When pieces are longer than 5 cm, the ends tend to curve, making it difficult to obtain adequate compression. Secondly, there is a high rate of complications if there is chronic infection at the site of the fracture. The success of this technique depends on the consolidation of the corticocancellous bone graft. Some osteogenic cells may survive transportation and contribute to the formation of new bone.

Because of its trabecular nature, cancellous bone facilitates this process better than cortical bone. The distance over which creeping substitution can reliably occur is uncertain, since it depends on revascularisation from each end of the graft. For defects longer than 5cm we used straight fibular grafts.

Non union case in every where in our body local anatomy distorted and development of fribroustissues.repeted surgery also make the filed more challenging for re exploration.

Most difficult part in both bone forearm non union is unequal gap.In such case we should not go for too much shortening of bone because it can cause functional tendon lenth failure .that cases we must restore maximum lenth possible put plate in longest construct.then decide the defect of orther bone to maintain unlnar variation and proper wrist function.

Although the Nicoll bone-grafting technique is rarely used, it remains effective 45 years after it was described. Its lack of complexity makes it suitable for use by general orthopaedic surgeons in district hospitals.

CONCLUSION-Hence we recommend utilise this modified bone grafting technique as a salvage procedure for gap non union in fore arm may be due to resultant effect of sclerosed bone debridement,segmental loss, bone loss due to previous surgery, previous implant failure ,and after bone tumor resection.

Source of Support: Nil
Conflict of Interest: None.

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