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A novel Minimally Invasive Reduction and Osteosynthesis System(MIROS)inmanagementoftibialfractures

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Abstract
Objective: *This Study was performed to assess the functional and radiological outcomeof MIROS in the management oftibia fractures and to study the end results of benefit ofMIROSwithconventionaltreatmentoptions(popcast,plateand screwsand nailing).*
Methods: *In total, 25 patients with tibia fractures (proximal,middle, distal 1/3rd shaft)weretreated withMIROS.Pre-operativelyanteroposteriorandlateralradiographswereobtainedinallcasesandcomputedtomographyscansinpatientswiththemostcomplexfractures to rule out intra articular extension. Follow-up evaluations were carried out atthree, six, 12 and 16 weeks and six months postoperatively, using* ***Johner and Wruh's[4]criteria****.*
Results: *This study shown that operative time as well as hospital stay following MIROSis less in contrast to other conventional methods. Even though MIROS is not as rigid asintramedullary nailing system, partial and full weight bearing as well as functional andradiological outcome following MIROS is as similar as other conventional treatmentmethods.*
Keywords
Incisionless,minimallyinvasivereductionandosteosynthesissystem(MIROS),Johnerandwruhcriteria,Clamps,dexterity,tibiafractures.

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I. Introduction

Themostcommonlyfractured majorlongboneisthetibia.Furthermore,duetoinsufficientmusclecoverage,thetibia'sbloodsupply[10]ismorevulnerable.Whentreating tibiafractures[8], special care is required because complications (wound infections, delayed union, and non-union)arecommon.Toselect thebestcourseofactionfor agiventypeandpatternofinjury,extensiveexperienceis required. Thelengthofthetibiaisn'talwaysmaintainedbyimmobilisationinaplastercast[1].

Conventional plate Osteosynthesis complications include wound infections, non-unionor delayed union,and skin disintegration necessitating bone grafting. External fixation may poseproblems such as bulkyframes, frequent pintract infections, malunion, pin loosening, andnon-union resultingto chronicosteomyelitis.It has been noted thatIMILnailing[2] has a higher rate of malunion because it's difficultytoplacetwodistallockingscrews.

Therisktothepatientisnow unquestionablyincreasedbyhugeincisions.Infectionrisksare frequently increased by extensive exposure and lengthy surgical process. Additionally, traditionalopen surgery slows healing both biologically (due to injury to structures like the periosteum, whichresults in a delay in callus formation) and clinically (because toan increase in nociceptive stimuli,whichresultsinadelayinfunctionalrecovery).

Becauseofthis,modernresearchisshiftingtoward"minimallyinvasive"proceduresthat replace conventional approaches that need "open large exposures". These techniques aredifficult to execute and require specialised dexterity and equipment. MIROS[3] (MinimallyInvasive Reduction and Osteosynthesis System) is an elastic metaphyseo-medullary fixation,retained by small external clamps. This system allows a rapid and not very aggressiveosteosynthesis, with little and almost no tissue damage, fully respecting the modern concept ofsurgeryforconservation ofsofttissue(SparingSurgerytissue).

The advantages include a shorter operating time, faster recovery and healing, and a lowerincidence of complications (such as bleeding, pressureulcers, infections, and so on). We conducted aprospectivestudytoevaluate theresultsoftreatingshaftoftibiafractureswiththeMinimallyInvasiveReductionandOsteosynthesisSystem[3](MIROS) usingSpecializedMIROSKwiresandclamps.

AIMSANDOBJECTIVES:

1. To assess the **functional and radiological outcome** of MIROS in themanagement of shaft oftibiafractures.
2. To study the **end results of benefit** ofMIROSwithconventionaltreatment options (popcast, plate and screws and nailing) with respect to **quick healing, mobility, stability and reducedcomplications.**

II) MIROS[5,6,7]:

Primary unitisthespecialKwires(66%surface-smoothwhile33%isrough).
SecondaryunitsaretheTangariclamps.
Tertiary units are the instrumentation used for wire insertion, wire bending, and theirattachment tothe clamps. Tertiary instrumentation also includes the tightening system which firmly locks the wires totheclampproducingastable elasticfixation.

TheMIROSwires

Availableinfourdiameters(1.5 mm,2mm,2.5mmand 3mm) sothatthewirethickness is correctly matched to the bone size. Available in three lengths 150mm, 300mm and 500mm.
The wires have a flute bevel tipfor easy penetration and by rotating the wire, one canensure its passage through the diaphyseal medulla without creating any false tracks. The laser marksopposite to the bevel will allow the surgeon to reposition thewire into penetrative axis andprogressive axis.

TheTangariClamps

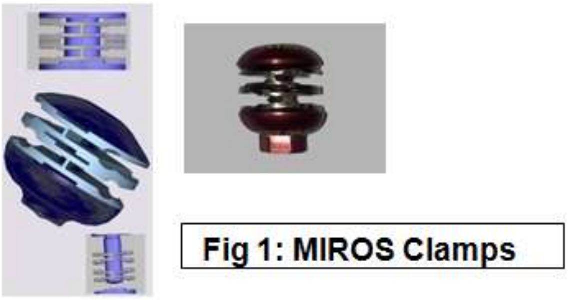


Fig 1: MIROS Clamps

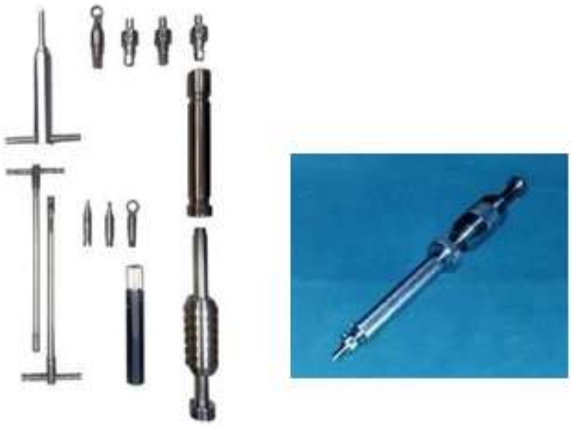
The Tangari clamps are unique in the aspect that they provide an absolutely stable clamp/wire interface,whichisthemostimportantaspectofthissystem.Theseclampshavethefollowingadvantages:

1,Theyareavailableinvarioussizestosuitthewiredimensionsapplicabletoaparticularbone.
2, Twopairsofwirescanbefixedinanyangleor axis withreferencetotheothertomakethesystemversatile.
3,Acombinationofmaterialsensuresthatthe Tangariclampsfulfilaretheconditionsforwhichtheyweredesigned.
4,Clampsare lightweight,sturdy, strong,aestheticallypleasingandsmallerthansimilarfixationclampsusedinconventionalexternalfixators.

Instrumentation[5,6,7]:

Mirosisequippedwithadedicatedinstrumentationforpointing,progressionandflexionofkirschnerwiresinthebone(Tangari1999).

Fig2:MIROSSpindleandclamptightner



Followingaretheinstruments:
1,Themostimportantisatooldesignedforpointing,perforation,progression, andbendingofmetalwiresintheboneandcartilage.(Tangari1999).
2,Wirecutters
3,Clamptighteners
4,Pliers
5, Vicegrips

PRINCIPLESOFMIROS[5,6,7]:
MIROSisasystemwhichcanbeusedinthreemodes.

1. Internalsynthesis
2. Externalsynthesis
3. Hybridsynthesis

WithMIROS,Kwiresareusednotonlytomaintainthealignmentofthefragmentsbutalsotocauseinter-fragmentary compression. The wire thinness and elasticity guarantees the formation of the callus,as well as their harmlessness in crossing growth plates and their mini- invasiveness (closed synthesis).The specialdesign of the clamps operates at two levels,and the overlapping rotating grooves produce aprecisemechanoeffect,allowingthe wirestobe clampedinanyanglefroma360degreearc.

II. MaterialsAndMethods:

This study was conducted in the department of Orthopedics, Government MedicalCollege,Anantapur,AndhraPradeshbetweenNovember2020toNovember2022.PatientsattendingOPDandcasualtyareselectedforthestudy,aftergettingtheirinformedconsent.

Inclusioncriteria:

- Ageofthepatient18yearsandabove.
- Bothmalesandfemales
- Allproximal1/3rd,midshaftanddistal1/3rdshaftoftibialfractures
- Closed fracturesExclusioncriteria:
- Patientswithlessthan18yearsofage
- Associatedheadandneurovascularinjury,
- Patientsmedicallyunfitforsurgery.
- Patientsnotwillingfor surgery

SURGICALPROCEDURE:
Positionofthepatient: Supineposition.
Anesthesia: Regionalanesthesia (Spinalanesthesia,epiduralorcombined epidural+spinalanesthesia).

Wiresusedintibiais2.5mm.Intibia,intaller orheavierindividualsathickerwirecanbeused. However to maintain elasticity and to fall in line with the MIROS principles, the maximumpermissible wirethicknessis3mm.

STEP1:FRACTUREREDUCTION:

The fracture is first reduced by closed means. The reduction is checked under aC-Arm.One must remember that accurate reduction is very important, and one must make best attempt atfracture reduction. Use of bent wire held in the MIROS spindle can be used as a joystickto finetunethereductionincertaincases.

STEP2:OBLIQUEANDHORIZONTALTERMINALS:

Once the fracture is reduced and the reduction is checked under C- Arm, preparations aremadeto insert thewires.Thefirstwireisinsertedintothespindleandabout 8 cmisallowed toprotrude fromthetip.Thewireisbenttoa30degreeanglewiththeflute totheinside.Thiswaythesurgeon can controlwhether the wire should be in a penetration mode or ascent mode. The bent wire isnowinsertedfromthemedialside,(epicondyleormalleolus),andbygentlescrewingunscrewingmotions slowly advanced until the tip touches the opposite cortex. Once the resistance is felt on thewire, the spindleis rotated so that the flute comes inwards, and now the wire assumes a progressionmode.

The spindleisloosened and 10 cm of wire is now exposed beyond its tip. With gentleseesaw movements the wire is advanced inthe medulla as it is observed under the C- Arm. It is advanced slowlyuntil it reaches the superior quadrant of the bone near the proximal joint. Care must be taken not topenetrate the joint. The spindle is loosened, and the protrudingwire is left for the time being as the secondwire is now mounted. This wire is now inserted from the lateral epicondyle after suitable pre bending, asdoneontheoppositeside,andisalsoadvancedinthesamemannerasitisprogressedupwards.

The wire is advanced as proximal as possible without perforating the superior joint. This wire too isleftprotrudingforthemoment.Thethirdwiretobeinsertedisthetransversewirewhichistranscondylar.Thelevelis0.5c msuperiortotheentrypoints onmedialandlateralsides.

STEP3:CLAMPAPPLICATION:

The MIROS system usuallydoes not use any power tools, and the special spindle withits quick release mounting, tightening and loosening of the wires is enough to help the surgeon tomanually advance the wire to the desired distance. Now the protruding wires are clamped and theforcesareappliedinsuchamannerastomakeitresembleasuspensionbridge.Theintramedullarywireabutsagainstthe oppositecortex,and thetransversewireandtheclampsensurethatthetensioneffectismaintainedwithoutlooseningduringtheentirecourseoft reatment.Once the clamps are tightened and the elastic stability of theframe is checked, the protruding wiretips are cut and bent. The pin entry and exit points are now cleaned and providing ointment isapplied.Stickyporesbandagesarepastedfrompinexitsites.

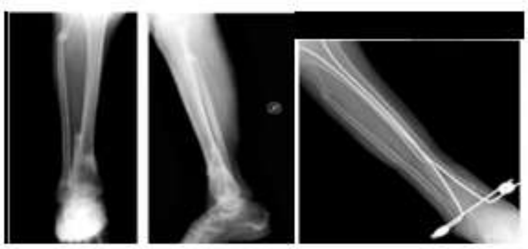


Fig3.Preop andpostopxraysshowingMIROSfixationoftibia.

POSTOPERATIVECAREANDMANAGEMENT:

Thedeltasynthesisencouragesearlyresumptionofjointfunction.Intheoperation theatre itself the stability of the montage can be assessed and the joint canbe out to fullrange of motion under the C-arm and we can ensure that there is no distraction or disruption of thefracture reduction. Weight bearing in lower limb synthesis depends on the fracture pattern, andstability after the frame. Stable constructs are allowed to partial weight bear from second day andslowlyprogresstofullweightbearingasthefractureunites.

Constructs which are not very stable, are kept non weight bearing until the fracture becomes stickyand then slowly partial weight bearing is allowed. During the entirecourse of treatment, the patient isencouragedtomovethejointinthevicinitytothefullextent,andthisensuresthenecessarytelescopicmicro-motiontoallowcompressionandfarceunion.

FRAMEREMOVAL:

This is done when the bone has solidly united and the support is no longer necessary tohold it or prevent deformation. The patient should have beenwalking full weight bearing withoutpain for at least two weeks prior to the frame removal. Radiologically also a complete union mustbe seen before we decide to remove the frame. A visit to the operating rooms or anesthesia is notneeded for removal of the MIROS system. The patientmay need a mild sedation if he is of theapprehensivetype.Theclampsarefirstremoved.Thewiresarethenpulled outonebyone.

FOLLOWUP:

Patients were followed up periodically on an outpatient basis (3rd, 6thweeks, 2 ,3,4,5and 6thmonth)andinbetweenifrequired.Complaintswerenotedandclinicalandradiologicalassessmentweredone,forpain, deformity,gait,shortening,rangeofmotionofknee,ankleand subtalarjointsandradiologicalunion.

Weight bearing: Oftenat>3-4weeks,dependingonthetypeoffractureandevidenceofunion,partialweightbearing(PWB)isrecommended. Afterthereissolidunionandradiologicallyapparentbridgingcallus,mostlyat10–12weeks,fullweightbearing(FWB)ispermitted.
Itwasdoneusing**Johnerand Wruh's criteria** andgradedaspoor,good,fairorexcellent.

III. Results:

The average age of patients in this research was **48.12 years** old on average. In thisstudy,tibialshaftfractureswere prevalentinpatientsaged61to70years.
Malesoutnumber femalesinourresearch. 56%oftheparticipantsinthecurrentresearcharemales,whereas44%arefemales.
Inthisstudy,52%ofpatientshadinjurytotheirlefttibiaand48% ofpatientshadinjurytotheirrighttibia.
Roadtrafficaccidentswerethe mostcommonmodeofinjuryinthisstudy,accountingfor 18 out of all patients' tibial shaft fractures. They contributed 72% of tibia fractures in thisstudy.
Thedistalthirdofthetibiawas theanatomicalregionwherefracturesoccurredmostfrequently.Thisconstitutes 52%oftibialshaftfractures inthisstudy.
Inthisstudy,outof25,10patients(40%)haddiabetesascomorbidity.

MIROSprovestoprovide**shorthospitalstay**throughthisstudywhencompared tootherconventionalsurgicalprocedures.(Average–7.4days).
Fromthisstudy,itisclearthatMIROSfixationtook**lessoperativetime**thanotherknownconventionalsurgicaltechniques.(Averagetime – 27.5minutes).
Inour study,inmostofthepatients, radiologicalunionseenat16weeks(64%).Meantimeforradiologicalunionis 16.5weeks.
Inour study,fullweightbearingbeganin10 patientsattheeighthweek(80%) in7 patientsat the tenth week (28%), in 4 patients at the twelfth week (16%), and in 4 patients at the sixteenthweek(16%).
Inourresearch,complicationswereassessedatdifferentperiods oftime.e.g.,Pintract(site)infectionthroughoutfollowup period.
Nonunionattheendof9months.
Persistentpain[9],adjacentjointstiffness,implantloosening,malunionanddelayedunionateveryregularfollowup.
Asperourstudy, MIROSfixationoftibiafracturesmostoftenlygivesexcellentresults(52%)asperJohnandWruhcriteria offunctionaloutcomeanalysis.

IV. Discussion:

25 patients who were hospitalised to the orthopaedic wards of the GovernmentMedical College in Anantapur are included in our study. The Minimally Invasive Reduction andOsteosynthesis System (MIROS) is used to treat a wide range of fracture types in this series by closedreductionandinternalfixation.
Our study is correlated with earlier studies by Yih Shiunn Lee et al[11]. (2008)(averageage:43.1years),Norketal[12](averageage42years)and Mahmoodetal.[13](Averageage:46.8years).
In their study, C M Court Brown et al[14] (1990) found that the male incidence was around81.3% and the female incidence was roughly 18.7%. Maleprevalence was 82% and female incidence was18%,accordingtoGJHooperetal[15](1991).
Comparing our series to that study, 75% of cases were attributed to high energy trauma,according to a research by Barbieri et al.[16] in 1990, while 70% of cases were attributed to RTA in aprospectiveanalysisbyNandakumaretal.[17]in1988.,LawrenceB.Boneetal.[18] (1986)noteda90%frequencyofroadtrafficaccidentsintibialshaftfractures.

Inour study,averageHospitalstayis7days.
Asitisasurgerywithnoincision, thereisnotmuchwoundcareneededexceptregularpinsiteinspectionandpinsitecare. So,hospitalstay islessincontrasttopatientsunderwentotherconventionalsurgical techniques.
Theaverageoperatingtimeis27.5minutes.
Inourstudy,fullweightbearingbeganin10patientsattheeighthweek(40%),in7 patients at the tenth week (28%), in 4 patients at the twelve-week (16%), and in 4 patients at thesixteenthweek(16%).
At the 6-months follow-up in this study, 64%of patients had excellentfunctionalstatus,28%hadgoodfunctionalstatus,and8%hadfairfunctionalstatus.Functionalresultsinourstudyareindependentofpatientage,sex,orinjurytype.
The majority of fractures in ourstudy united at 16 weeks (16 patients). 16.5 weeks onaveragemakeupaunion.
This research by Lawrence B. Bone et al[18]. (1986) found that the average uniondurationwas19weeks. AccordingtoCourtBrownetal[14]. (1990),thetypicaluniontimewas16.7weeks.
Even though, MIROS is a new andemerging technique, the results regarding timetaken for radiological union is comparatively equal to other studies done using intramedullarynailing.

V. Conclusion:

MIROS is a minimally invasive and effective technique in treating fractures of shaft oftibia fractures especially in elderly age with associated co morbidities which interfere with woundhealinginconventionalmethods.

Fracturebiology(i.e–periostealbloodsupplyandfracturehematoma)isundisturbedinMIROSwhereitis violatedinopenreduction.
MIROStechniquegivesexcellentshortandlongtermresults.Itallowsearlymobilizationpostoperatively.
Kneeandanklerangeofmotionexercisesstartedonfirstpostoperativeday,thispreventsadjacentjointstiffnessandCRPS.
Postoperativelylimbis notimmobilizedinPOPslaborCast.
The results are comparable to conventional plating or intramedullary nailing.Cheapermeansoffixationcomparedtoother knownconventionalsurgicalimplants.
Re-operation rateiszerocomparedtoplating/nailingwhereimplantsneedtoberemovedafterunioninyoungpatients.
The complications of reaming (fat embolism /iatrogenic fractures / damageto endostealbloodsupply)aswellasinternalfixation(strippingofperiosteum)isavoided.
Especially in elderly age where wound healing in lower leg is very slow and wound healingcomplications (infections and skin necrosis) in lower leg is more, MIROS serves best option as thismethodispurelyincisionless. So,MIROScanpreferredoverotherconventionalsurgicaltechniquesinElderlyagewithDistalthird shaft of tibia fractures with or without associated comorbidities. (MIROS gaveexcellent functionaloutcomewithgoodpatientcomplianceinthesetypeoffractures duetofollowingreasons).
-Shortoperativetime(compared tootherconventionalsurgicalmethods).

- No incisionneeded(lessbloodloss)(Noscarrelatedcomplications).
- Less hospital stay (becauseless wound carecompared tootherconventionalsurgicaltechniques)
- Lesspsychosocialissues(compared tobigfixatorslikeinexternalfixation)
- Lesschancesofadjacentjointstiffening,disuseosteopeniaandCRPS(comparedtoconservativemanagement).
- Less to no wound complications (skin necrosis, infection and delay in healing) in distalthirdlegregion due todecreasedbloodsupplyandespecially in elderly agewith or without comorbidities**.(MIROS–Purelyincisionless).**

CASEILLUSTRATIONS:
1)A 19 year old male sustained Right sided closed shaft of tibia and fibula # (middle 1/3rd) due toRTA. Pre op (A), Immediate post Op (B), After frame removal (C) , Clinical images – range ofmovements(D,E,F).

A B C D E F

2.A32yearsoldmalesustainedclosedleftsided bothbonesfractureduetoRTA.

Preop(G),ImmediatepostOp (H),Afterframeremoval (I),Clinicalimages–rangeofmovements(J,K,L).

G H I J K L

References

[1]. CharleyJ.fracturesoftheshaftoftibia.Theclosedtreatmentofcommonfractures,Edinburg,ChurchillLivingstone.1961,209-249.
[2]. HabernekH,KwansyO,SchmidLetal.Complicationsofinterlockingnailingforlowerlegfractures.JournalofTrauma,1992;963.
[3]. M. Tangari A.U. Minniti De Simeonibus.. Su un nuovo sistema di sintesi percutanea: “lasintesi Delta” (About a newsystemofpercutaneous synthesis:“the Delta synthesis”)..G.I.O.T.2007;33:60-65.
[4]. WruhsO, JohnerR.Classificationoftibialshaftfracturesandcorrelationwith resultsafterrigidfixation.ClinicalOrthop.1983;178.
[5]. TangariM.PersonaletecnicadiapplicazionedelSistemaEpibloc.Giornale ItalianodiOrtopediaeTraumatologia2002;28:2-10.
[6]. DiSegniF.Considerazionisull’usodeifilidiKirschner.LoScalpello2002;16:87-90.
[7]. TangariM,DiSegniF,LarosaF,CaporaleMF(2005):Originalitecnicheminінvasiveintraumatologia.Bologna:TimeoEditore,p. 11-29.
[8]. Rockwood CA, Green DP, Bucholz RW, et al. (1996): Rockwood and Green’s FracturesinAdults. 6th ed. Philadelphia, New York: Nature and Science 2016;14(12)http://www.sciencepub.net/nature244Lippincott-Raven,P.2095,2096.
[9]. VaistoO,ToivarenJ, KannusP, JarvinanM. Anteriorkneepainafterintramedullary nailingoffracturesof tibial shaft: An eight-year follow-up of a prospective, randomizedstudy comparing two different nail-insertiontechniques.JournalofTrauma2008June;64(6):1511-6.
[10]. LoweicFAPeterson,JosephMjame,GeorgeENelsonJr,PatricJHekky.Bloodsupplyofhumantibia.JBJS1960Jun;42A:625-35.
[11]. Yih-Shiunn Lee, Ting-Ying Lo, and Hui-Ling Huang.. “Intramedullary fixation of tibial shaftfractures:acomparisonoftheunlockedandinterlockednail”..IntOrthop.2008Feb;32(1):69–74.
[12]. NorkSE,SchwartzAK,AgelJ,etal:“Intramedullarynailingofdistal metaphysealtibialfractures”,J.Bone JtSurg.,2005;87-A:1213–21.
[13]. AMahmoodetal:Outcomeofexperttibialnailingfordistalthirdtibialfractures:PublishedByOrthopaedicProceedings:PrintISSN1358-992X:PublishedonlineSeptember2012.
[14]. CourtBrownCM,ChristieJ,McQueenMM.Closedintramedullarytibialnailing.JournalofBone&JointSurgery.1990;72B:605-611.
[15]. HooperGJ,KidellPG,PennajID.Conservativemanagementorclosednailingfortibialshaftfracturesrandomized prospective trial. Journal of Bone & Joint Surgery. 1991; 73B:83-85.
[16]. BarbieriR,SchenkR,KovalK,AuroriB(1996) Surgeryfor distaltibialfracture.ClinOrthop 332:16-22.
[17]. Nandakumar Bhairi et al: ProspectiveStudy of Surgical Management of Distal TibialFractures inAdultsJTraumaTreat2017;6:2DOI:10.4172/2167-1222.1000375.
[18]. Lawrence B Bone, Kenneth D Johnson. Treatment of tibial fractures by reaming andintramedullarynailing.JournalofBone&JointSurgery.1986:68A:877-8.

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