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Radiation Exposure Intra-Operatively In Treating Humerus Shaft Fractures – A Comparative Study between Plating And Nailing Group

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Abstract
Introduction*: C-Arm Use In Orthopaedic Surgery Is Increasing Rapidly As Surgery Transitions To Minimal-Access Surgery. With Less Direct Visualization, Surgery Is Being Conducted With Fluoroscopic Guidance. Fluoroscopy Is The Heart Of The Most Of Interventional Procedures, Where Prolong Lower Intensity Beam Is Used. The Number Of Orthopedic Procedures Requiring The Use Of Fluoroscopic Guidance Has Increased Over The Recent Years . It Is Now Accepted That Closed Operative Procedures Are The Treatment Of Choice In Many Types Of Complex Fractures Because Of Their Lower Infection And, Smaller Incision Wounds And Relatively Low Morbidity At Implant Removal. Interventional Procedures Considered The Medical Imaging Exposures, Imparting The Highest Radiation Doses To The Patients. Medical Specialists And Other Health Professionals Working Interventional Suites Are Subjected To High Level Of Scattered Radiation*
Aim And Objectives: *To Compare The Amount Of Radiation Exposure Intra Operatively In Treating Humerus Shaft Fractures In Patients Between Plating And Nailing Group Along With The Operating Surgeons.* ***Methodology:*** *40 Patients Are Selected Randomly Who Had Sustained Humerus Shaft Fractures ; Each One Is Selected For Either Plating Or Im-Il Nailing Based On Pick A Chit System/Computer Generated. Informed Written Consent Will Be Obtained By Each Study Subject Demographic Data Was Collected By Each Patient Using A Proforma And Documented. C-Arm Used Was Same In All The 40 Cases (Allengers® : Hf 59/59r Series; Image Intensifier With Modular Trolley). Standard Lead Aprons Used In All Cases By Surgeons And Operative Room Staff (Kiran- Coat Apron Lead Equivalent 0.35mm Pb) ; Dosimeter To Measure The Amount Of Radiation.* ***Results:*** *Based On The Intra-Operative Number Of C-Arm Shots Taking In Fixing The Fracture In Plating And Nailing Groups. That Is In Plating Group As The Fracture Site Use Of Fluoroscopy Was Minimal And In Closed Nailing Group Use Of C-Arm Was Maximum (P Value <0.001)*
Keywords: *Radiation Exposure; Humerus Shaft Fractures*

I. Introduction

Fluoroscopy Is The Heart Of The Most Of Interventional Procedures, Where Prolong Lower Intensity Beam Is Used. The Number Of Orthopedic Procedures Requiring The Use Of Fluoroscopic Guidance Has Increased Over The Recent Years[1]. It Is Now Accepted That Closed Operative Procedures Are The Treatment Of Choice In Many Types Of Complex Fractures Because Of Their Lower Infection And, Smaller Incision Wounds And Relatively Low Morbidity At Implant Removal [2]. Interventional Procedures Considered The Medical Imaging Exposures, Imparting The Highest Radiation Doses To The Patients. Medical Specialists And Other Health Professionals Working Interventional Suites Are Subjected To High Level Of Scattered Radiation[3]

Radiographs Are A Form Of Ionising Radiation And Produce A Large Amount Of Energy Which Causes The Ejection Of An Orbital Electron, Resulting In A Molecule Becoming Positively Charged Or Ionised. In Tissues, Ionised Atoms Can Cause Complex Molecules To Split Or Can Form Highly Reactive Free Radicals, Which May Then Produce Chemical Damage Within The Cells Which Is Proportional To The Energy Absorbed By The Tissue From The Radiographs.

The Standard International (Si) Unit Of Radiation Is The Gray (Gy) And Is The Energy Absorbed In Joules Per Unit Mass Of Material Expressed In Kilograms. The Gy Does Not Give The Complete Picture Of The Damage Caused By Radiation. Heavily Ionising Radiation Or Highly Charged Particles Cause Much Greater Local Ionisation And Hence Greater Local Biological Damage. The Unit That Takes Account Of This Is The Sievert (Sv). The Millisievert (Msv) Is A Unit Of Measure Of Absorbed Radiation In Human Tissue.Use Of An Image Intensifier Has Become An Essential Part Of Orthopaedic Practice And There Has Been Concern Regarding The Exposure To Radiation Of The Surgeon And The Patient During Fluoroscopically-Guided Procedures.[4-5]it Is Widely Recognised

That Exposure To Radiation Over Many Years Is Associated With An Increased Incidence Of Adverse Effects, Including Cataracts And The Development Of Malignancies. Radiation Is Known To Inhibit Mitosis By Producing Irreparable Double Strand Breaks In Dna, Or By Creating Structural Changes By Damaging The Nucleus, Thus Producing Potential Genetic Mutations. Human Cells Are Believed To Be Resistant To Malignant Change, And No Studies Have Shown Toxic Effects Resulting From Long-Term Exposure To Low-Dose Radiation. Nevertheless, Risks Are Still Assumed.[7,8]the Exposure To Radiation Of Radiologists And Cardiologists Has Been Monitored For Many Years. [9] Fluoroscopy Is Commonly Used During Orthopaedic Operations On The Upper And Lower Limbs. The Exposure To Radiation During A Variety Of Fluoroscopically-Assisted Musculoskeletal Procedures Has Been Evaluated Previously.[10] Fluoroscopy May Produce A High Dose Of Radiation (As Much As 0.004 Gy/Min).[9] Doses Can Differ Significantly Between Fluoroscopic Machines Because Of Differences In Design Or Calibration, Beam Collimation And The Output Of Radiation.[10,11] Interest In Protection From Radiation Has Recently Increased In The Medical Profession. The Responsibility Of The Orthopaedic Surgeon To Minimise The Exposure Of Patients To Radiation Has Been Previously Emphasised. Such Responsibility Also Extends To The Protection Of Themselves And Other Staff. Individuals Performing Or Assisting In Fluoroscopically-Guided Procedures May Well Be Exposed To High Doses Of Radiation. The Dose Of Radiation Received By A Surgeon Depends On That Given To The Patient, Its Duration, The Distance From The Source Of Radiation, Coning, And The Degree Of Shielding Of The Surgeon.[15] The Hands Of The Surgeon Are Most Likely To Be Directly Exposed During Fluoroscopic Screening And The Potential Effect Of Radiation To The Skin Of The Hands Is A Limiting Factor.[10,11]

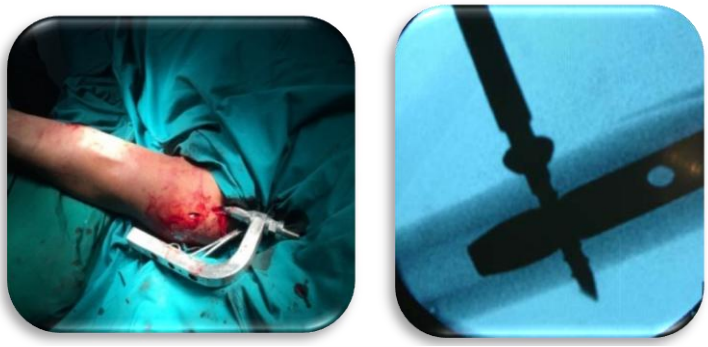
II. Aim And Objectives

To Compare The Amount Of Radiation Exposure Intra Operatively In Treating Humerus Shaft Fractures In Patients Between Plating And Nailing Group Along With The Operating Surgeons

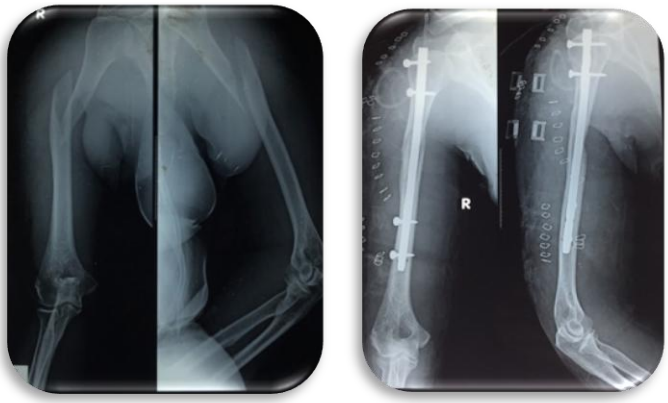
III. Materials And Methods

The Study Was Carried Out In Yenepoya Medical College Hospital After Obtaining The Ethical Committee Clearance. The Study Was Conducted Between February 2014- October 2015. A Structured, Pre-Prepared Case Performa Will Be Used To Enter The Clinical History, Physical Examination Findings And Investigations Findings. Those Who Will Meet The Inclusion And Exclusion Criteria Will Be Included In The Study To Compare Radiation Exposure In Patients Treated For Humerus Shaft Fractures With Either Nailing Or Plating Technique.

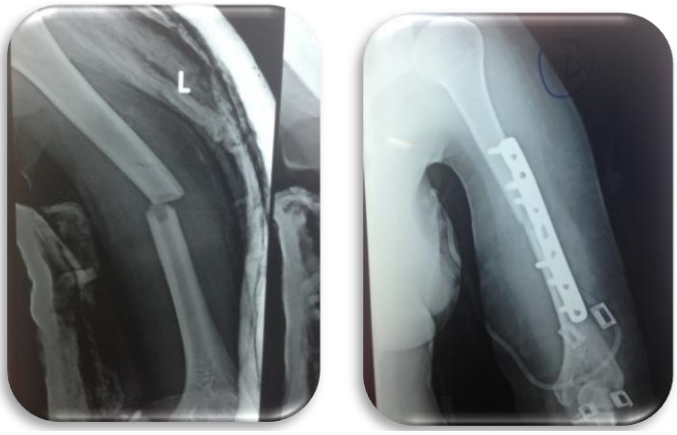
40 Patients Were Prospectively Randomised Into Two Groups For Comparative Study. 20 Patients Were Treated By Surgical Management In Each For Dynamic Compression Plating And Interlocking Nailing Respectively. Once The Patients Were Randomized, Pre-Operative Planning And Investigations Were Done And The Patients Were Posted For Open Reduction And Internal Fixation With Dcp Or Interlocking Nailing. In Plating Group, 4.5mm Narrow Dcp Was The Plate Of Choice. The Patients With Proximal 3rd Shaft Fractures Antero-Lateral Surgical Approach Was Used . And For Distal Third Humerus Shaft Posterior Triceps Splitting Approach Was Used .Midshaft Humerus Were Treated Either Of These Approaches Depending On Fracture Pattern And Radial Nerve Palsy Following Injury.[12,13,14] In This Study Group 13 Patients Had Midshaft Humerus Fractures. 6 Patients Had Distal 3rd Humerus Shaft Fracture Out Of Which 5 Had Radial Nerve Palsy Following Injury(Pre-Operatively). 1 Patient With Proximal Third Humerus Shaft Was Treated With Plating . All The Patients Taken Under The Study Had Minimum Of 6 Months Follow Up.In Nailing Group Standard Humerus Imil Nail Were Used Of Sizes 6,7,8,Mm Sizes And All The Patients Were Treated Using Antegrade Humerus Nailing By Splitting The Rotator Cuff. [12,13,14] None Of The Patients Were Treated With Retrograde Nailing. In This Group, 10 Were Midshaft Humerus Fractures, 9 Were Proximal 3rd Humerus Fractures. 1 Patient With Distal 3rd Was Treated With Nailing. All The Patients Taken Under The Study Had Minimum Of 6 Months Follow Up.



Intra-Operative Pictures Of Humerus IM-IL Nailing.



Pre And Post Operative Radiograph In Nailing Group



Pre And Post Operative Radiograph In Plating Group

C-Arm Used Was Same In All The 40 Cases .

Model: Allengers® : Hf 59/59r Series; Image Intensifier With Modular Trolley (Fig 2.1)

Fig 2.1

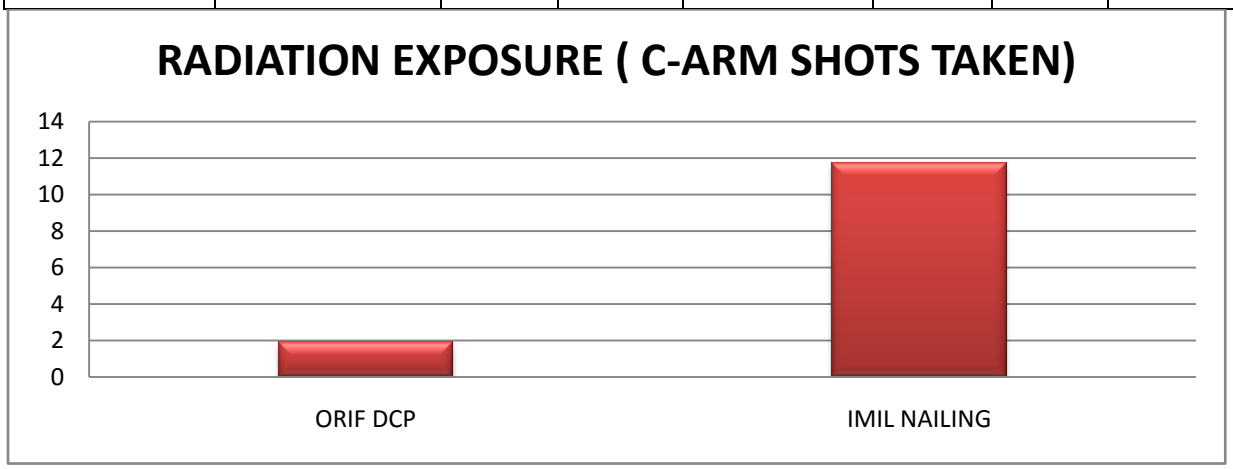
Standard Lead Aprons Used In All Cases By Surgeons And Operative Room Staff ; Kiran- Coat Apron Lead Equivalent 0.35mm Pb(Fig 2.2) ; Dosimeter To Measure The Amount Of Radiation.

Fig 2.2

In Plating Group Only To Confirm The Fracture Site Stability Post Fixation C-Arm Imaging Was Used Or In Few Complex Cases Screening Is Done For Checking Reduction. In Nailing Group From The Fracture Reduction To Inserting Guide Wire , Nail And Distal Locking Screws Fluoroscopy Was Used . Amount Of Radiation Emitted During Each Shot Was Found To Be 0.004 -0.010gy/Min. Which Was Measured By Dosimeter Intra-Operatively During Every Case When C-Arm Shots Were Taken.

IV. Results

	Surgical Procedure	N	Mean	Std. Deviation	T	Df	P Value
Radiation Exposure (C-Arm Shots Taken)	Orif Dcp	20	1.9	1.21	-11.7	23.313	**<0.001**
	Imil Nailing	20	11.75	3.567			



Graph Depicting Radiation Exposure Based On Number Of Shots Taken Intra-Operatively

There Was No Much Use Of C-Arm Intra-Operatively During Plating . Exposure To Radiation Was Maximum In Patients Who Were Treated With Nailing

Based On The Intra-Operative Number Of C-Arm Shots Taking In Fixing The Fracture In Plating And Nailing Groups. That Is In Plating Group As The Fracture Site Use Of Fluoroscopy Was Minimal And In Closed Nailing Group Use Of C-Arm Was Maximum (P Value <0.001)

V. Discussion

The Most Notable Concern With Long-Term Exposure To Low-Level Radiation Is The Induction Of Malignancy.The Average Environmental Radiation Dose Equivalent From Cosmic Rays, External Sources, And Ingested Radioactive Materials Is Approximately 3 Msv Per Year.[15]

P. J. Singh, N. S. Perera, R. Dega Conducted A Study Where 80 Procedures Required The Use Of Fluoroscopy (Mean 6.8 Cases/Month). There Were 51 Elective And 29 Trauma Procedures. There Were 18 Fractures Of The Ankle, Calcaneum And Tibial Pilon, 24 Midfoot And Hindfoot Fusions, And 38 Miscellaneous Procedures.The Screening Time Per Procedure Was A Mean Of 37.4 Seconds (0.6 To 197). The Longest Screening Times Were With Open Reduction And Internal Fixation Of Hindfoot Fractures And Elective Fusions Of The Ankle.The Cumulative Exposure To The Tld Rings Of The Surgeon From The 80 Procedures Was 2.4 Msv. The Mean Monthly Exposure Was 0.2 Msv (0.01 To 0.8) And Mean Radiation Dose Per Operation Was 0.03 Msv. (Pearson's Correlation R = 0.92 (0.72 To 0.98), *T*-Test P < 0.0001). [16]

H. Osman Et Al Conducted A Study With Total Of 56 Procedures Of Four Different Orthopedic Surgeries Were Performed In Three Different Centers In Khartoum-State. A Calibrated 72 Thermoluminescence Dosimeter (Tlds) Had Been Used To Measure Orthopedists Hand's Radiation Doses. The Mean Fluoroscopic Exposure Factors For All Procedures Were 72.4 Kvp ±13, 1.4 Ma±0.6 And 0.79 ±0.1 Mins, The Mean Radiation Dose For The Hands Of Orthopedist Was 0.27 Mgy Per Procedures ±0.09. Compared Results With Previous Studies, The Present Results Were Lower Than Previous Studies. Radiation Dose Reduction Techniques Are Recommended When Heavy Load Co-Exist. [17]

In Our Study 40 Patients Who Were Admitted For Humerus Fracture Shaft Fixation Were Considered .The Radiation Exposure To Patient And Operating Surgeons In Treating Such Fractures Using Two Different Treatment Modalities That Is By Open Reduction And Internal Fixation With Plating And Closed Intra-Medullary Interlocking Nailing. In Plating Group Only To Confirm The Fracture Site Stability Post Fixation C-Arm Imaging Was Used Or In Few Complex Cases Screening Is Done For Checking Reduction. In Nailing Group From The Fracture Reduction To Inserting Guide Wire , Nail And Distal Locking Screws Fluoroscopy Was Used . Amount Of Radiation Emitted During Each Shot Was Found To Be 0.004 -0.010gy/Min. Which Was Measured By Dosimeter Intra-Operatively During Every Case When C-Arm Shots Were Taken. That Is In Plating Group As The Fracture Site Use Of Fluoroscopy Was Minimal And In Closed Nailing Group Use Of C-Arm Was Maximum (P Value <0.001). And Max Radiation Exposure Was To The Patients And Minimal To Operative Room Personnel As They Were Using Lead Aprons . But Operating Surgeons Hand Was Exposed To Radiation .

VI. Conclusion

Considering Treatment Of Humerus Shaft Fractures . Patients And The Operating Surgeons Are At High Risk Of Radiation Exposure During The Procedures . In Minimal Invasive Closed Technique There Is Definitely More Radiation Exposure In The Patients Treated With Intra-Medullary Interlocking Nailing When Compared To Plating Group. Therefore Open Reduction And Plating Is A Better Option To Prevent Radiation Exposure To Patient Along With Surgeons In Treating Humerus Shaft Fractures . As Always Nail Is A Load Sharing Device And In Upper Limb It's No Much Of Significance As In Lower Limbs . Fallacies Of Study Are We Have Only Considered Patients Underwent Humerus Shaft Fracture Fixation. Also Not Much C-Arm Usage Is Required As We Completely Open Up The Fracture Site In Plating Technique.

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