



**Original Article**

## **Functional Outcome of Total Hip Replacement in Patients with Avascular Necrosis (AVN) With Sickle Cell Anemia as A Contributing Factor in Tribal Areas**

**Dr. Kushagra Dave<sup>1</sup>, Dr. Chirag Kotwal<sup>2</sup>**

<sup>1</sup> 3rd Year PG Resident, Department of Orthopaedics, Zydus Medical College and Hospital Dahod.

<sup>2</sup> Assistant Professor, Department of Orthopaedics, Zydus Medical College and Hospital Dahod.

 **OPEN ACCESS**

**Corresponding Author:**

**Dr. Kushagra Dave**

3rd Year PG Resident, Department of Orthopaedics, Zydus Medical College and Hospital Dahod.

*Received: 14-12-2025*

*Accepted: 26-12-2025*

*Available online: 08-01-2026*

### **ABSTRACT**

The Study Aims At Studying About The Evaluation Of The Radiological As Well As Clinical Outcome Of Total Hip Replacement As A Treatment Modality And What Impact It Would Have On The Quality Of Life Of The Patient, Especially In Carrying Out Daily Routine Activities. It Is A Prospective Study Which Consists Of 40 Patients Having Avascular Necrosis Of Hip, The Study Being Conducted At Zydus Hospital Dahod, Which Is A Multispeciality Hospital. The Patient Was Post Operatively Followed Up Till 1 Year Of Post Operative Duration And After Evaluating The Patients Clinically And Radiologically, We Arrived At A Conclusion That Hip Replacement Is One Of The Best Treatment Options With Patients Having Sickle Cell Disease And Suffering From Hip Avascular Necrosis And Contributes Effectively In Upgrading And Enhancing Their Quality Of Life.

**Copyright © International Journal of Medical and Pharmaceutical Research**

**Keywords:** Sickle Cell Disease, Avascular Necrosis, Total Hip Replacement.

### **INTRODUCTION**

Sickle Cell Disease (Scd) Is A Common Autosomal Recessive Disorder, Caused By A Point Mutation In The B-Globin Chain Of Haemoglobin1. 17.15 Percentage Of Prevalence Of Sickle Cell Anaemia With 14.55 Percentage Carrying The Sickle Cell Trait And 2.61 Percentage Having Sickle Cell Disease, When The Data Was Taken For A Study In Dahod, Gujarat. This Hemoglobinopathy Affects The Shape Of Red Blood Cells That, Under Low Oxygen Tension, Are Susceptible To Sickling And Hence Impede The Blood Supply To The Human Tissues.(1,2)Skeletal Manifestations Of Scd Are Also Prevalent, Including Avascular Necrosis (Avn) Of The Femoral Head, Osteoporosis, Pathological Fractures And Infections, Namely Septic Arthritis And Osteomyelitisbony Deformities Such As Marrow Hyperplasia, Thinning Of Trabeculae And Cortices, As Well As Sclerotic Areas That Obliterate The Femoral Canal, Are Frequently Encountered(2,3,4) Symptomatic Avn In Sicklers Has A High Probability Of Progressing To Hip Osteoarthritis (Oa), Usually In The Third Or Fourth Decade Of Life;1 Bilateral Hip Involvement Reaches 20–30%(2,5). X Rays Are Often Normal In Early Stages Of Avn With Eventually Radiolucency Seen In The Subchondral Bone, While MRI Is The Most Sensitive And Specific Imaging Test Showing Hanges Like Double Line Sign On T2 Weighted Imagesclassifications For Evaluating Hip Avascular Necrosis Are Ficat And Arlet Classification And Steinberg Classification. Following Are The Ficat And Arlet Classification (1) Followed By Steinberg Classification (2)

Stage	Findings
0	Radiography: normal MRI: normal Clinical symptoms: none
1	Radiography: normal or minor osteopaenia MRI: bone marrow oedema Bone scan: increased tracer uptake Clinical symptoms: groin/hip pain
2	Radiography: mixed osteopaenia and/or sclerosis and/or subchondral cyst-like changes, without any subchondral lucency MRI: geographical signal change Bone scan: increased uptake Clinical symptoms: pain and stiffness
3	Radiography: crescent sign (subchondral lucency/fracture) and eventual cortical collapse MRI: femoral head collapse, joint preserved Clinical symptoms: pain and stiffness, limp
4	Radiography: end-stage with evidence of secondary OA MRI: femoral head collapse and OA Clinical symptoms: pain and limp

Stage	Findings
0	No symptoms
1	Normal radiograph MRI non-specific Mild pain in the affected hip, or pain with internal rotation
2	Normal radiograph MRI diagnostic Worsening or persistent pain
3	Increased sclerosis or cysts in the femoral head Subchondral collapse (crescent sign) Flattening of the femoral head
4	Normal joint space

## MATERIALS AND METHODS

Patients Admitted To Department Of Orthopedics In A Tertiary Care Hospital In A Tribal Area With Diagnosis Of Avn Were Included In The Study After Taking Into Consideration A Predefined Inclusion And Exclusion Criteria For The Study. Sample Size Of 40 Was Considered Following Formula And Admission Registry Of Our Hospital. Patients Were Recruited To The Study After Approval From Institutional Ethical Committee And Informed Consent Of Patients. A Detailed History Wastaken And Thorough Clinical Examination Was Done In All Patients. All Patients Were Assessed With Harris Hip Score And Points Were Allocated For Each Components Of The Score, Which Formed Base Line Statistics For Our Study. Further Patients Were Followed Up Till 1 Year Post Operatively Patients Who Could Not Turn Up To The Hospital Were Contacted Over Telephone And Outcome Was Assessed Through Set Of Questionnaire Based On Harris Hip Scorethis Was A Prospective, Observational, Longitudinal Study In Which Patients Admitted In Orthopaedic Ward Of A Tertiary Care Hospital With Clinical And Radiological Diagnosis Of Avascular Necrosis Of Head Of Femur Were Included. With Appropriate Statistical Methods We Determined The Minimum Sample Size To Be 40 Cases. Patients With Complaints Of Pain In Walking And Pain Localized To Groin Area Were Examined Further For Limited And Painful Passive Range Of Motion Of The Hip, Especially Forced Internal Rotation, Limitation Of Passive Abduction, Pain During Straight-Leg Raise Against Resistance, Pain During Passive Internal And External Rotation Of The Extended Leg (Log Roll Test). X Ray - Anteroposterior And Frogleg Lateral Views Of Both Hips Was Taken.

Earliest Radiographic Findings Include Femoral Head Lucencydiagnosis Wasconfirmed By MRI Imaging Of The Affected Hip. A Detailedhistory Was Taken. Special Attention Was Paid To The Possibility Of Steroid And Alcohol Intake. All Patients Selected For The Study Underwent Clinical Examination, Relevant Blood Test, Imaging Followed By Surgical Intervention Through Total Hip Replacement. Patients Were Classified In To Ficat And Arlet Staging. Patients Were Prescribed Nsaid And Given Physiotherapy. Further, Patients Who Satisfied Inclusion Exclusion Criteria Were Enrolled For The Study After Obtaining Informed Consent From Them. Appropriate

#### Inclusion Criteria

1. Age More Than 50 Years
2. Stage 3 And 4 Hip Avn ( Ficat And Arlet Classification)
3. Patient Willing To Give Consnet For Surgery

#### Exclusion Criteria

1. Age More Than 75 Years
2. Stage 1 And 2 Hip Avn
3. Patients Not Giving Consent
4. Patients Unfit For Surgery

<b>Harris Hip Score</b>		Hip ID: Study Hip: <input type="checkbox"/> Left <input type="checkbox"/> Right Examination Date (MM/DD/YY): / / Subject Initials: _____ Medical Record Number: _____																			
Interval:																					
<b>Pain (checkone)</b> <p><input type="checkbox"/> None or ignores it (44)  <input type="checkbox"/> Slight, occasional, no compromise in activities (40)  <input type="checkbox"/> Mild pain, no effect on average activities, rarely moderate pain with unusual activity, may take aspirin (30)  <input type="checkbox"/> Moderate Pain, tolerable but makes concession to pain. Some limitation of ordinary activity or work. May require occasional pain medication stronger than aspirin (20)  <input type="checkbox"/> Marked pain, serious limitation of activities (10)  <input type="checkbox"/> Totally disabled, crippled, pain in bed, bedridden (0)</p> <b>Limp</b> <p><input type="checkbox"/> None (11)  <input type="checkbox"/> Slight (8)  <input type="checkbox"/> Moderate (5)  <input type="checkbox"/> Severe (0)</p> <b>Support</b> <p><input type="checkbox"/> None (11)  <input type="checkbox"/> Cane for long walks (7)  <input type="checkbox"/> Cane most oftime (5)  <input type="checkbox"/> One crutch (3)  <input type="checkbox"/> Two canes (2)  <input type="checkbox"/> Two crutches or not able to walk (0)</p> <b>Distance Walked</b> <p><input type="checkbox"/> Unlimited (11)  <input type="checkbox"/> Six blocks (8)  <input type="checkbox"/> Two or three blocks (5)  <input type="checkbox"/> Indoors only (2)  <input type="checkbox"/> Bed and chair only (0)</p> <b>Sitting</b> <p><input type="checkbox"/> Comfortably in ordinary chair for one hour (5)  <input type="checkbox"/> On a high chair for 30 minutes (3)  <input type="checkbox"/> Unable to sit comfortably in any chair (0)</p> <b>Enter public transportation</b> <p><input type="checkbox"/> Yes (1)  <input type="checkbox"/> No (0)</p>	<b>Harris Hip Score</b> <table border="0"> <tr> <td style="text-align: left;"><b>Stairs</b></td> <td><input type="checkbox"/> Normally without using a railing (4)  <input type="checkbox"/> Normally using a railing (2)  <input type="checkbox"/> In any manner (1)  <input type="checkbox"/> Unable to do stairs (0)</td> </tr> <tr> <td style="text-align: left;"><b>Put on Shoes and Socks</b></td> <td><input type="checkbox"/> With ease (4)  <input type="checkbox"/> With difficulty (2)  <input type="checkbox"/> Unable (0)</td> </tr> <tr> <td colspan="2" style="text-align: left;"><b>Absence of Deformity (All yes = 4; Less than 4 = 0)</b></td> </tr> <tr> <td colspan="2"> Less than 30° fixed flexion contracture <input type="checkbox"/> Yes <input type="checkbox"/> No  Less than 10° fixed abduction <input type="checkbox"/> Yes <input type="checkbox"/> No  Less than 10° fixed internal rotation in extension <input type="checkbox"/> Yes <input type="checkbox"/> No  Limb length discrepancy less than 3.2 cm <input type="checkbox"/> Yes <input type="checkbox"/> No </td> </tr> <tr> <td colspan="2" style="text-align: left;"><b>Range of Motion (Indicate none = 0)</b></td> </tr> <tr> <td colspan="2"> Flexion ("140") _____  Abduction ("40") _____  Adduction ("40") _____  External Rotation ("40") _____  Internal Rotation ("40") _____ </td> </tr> <tr> <td colspan="2" style="text-align: left;"><b>Range of Motion Scale</b></td> </tr> <tr> <td colspan="2"> 211° - 300° (5)      61° - 100 (2)  161° - 210° (4)      31° - 60° (1)  101° - 160° (3)      0° - 30° (0) </td> </tr> <tr> <td colspan="2" style="text-align: left;"><b>Range of Motion Score</b> _____</td> </tr> <tr> <td colspan="2" style="text-align: left;"><b>Total Harris Hip Score</b> _____</td> </tr> </table>	<b>Stairs</b>	<input type="checkbox"/> Normally without using a railing (4) <input type="checkbox"/> Normally using a railing (2) <input type="checkbox"/> In any manner (1) <input type="checkbox"/> Unable to do stairs (0)	<b>Put on Shoes and Socks</b>	<input type="checkbox"/> With ease (4) <input type="checkbox"/> With difficulty (2) <input type="checkbox"/> Unable (0)	<b>Absence of Deformity (All yes = 4; Less than 4 = 0)</b>		Less than 30° fixed flexion contracture <input type="checkbox"/> Yes <input type="checkbox"/> No Less than 10° fixed abduction <input type="checkbox"/> Yes <input type="checkbox"/> No Less than 10° fixed internal rotation in extension <input type="checkbox"/> Yes <input type="checkbox"/> No Limb length discrepancy less than 3.2 cm <input type="checkbox"/> Yes <input type="checkbox"/> No		<b>Range of Motion (Indicate none = 0)</b>		Flexion ("140") _____ Abduction ("40") _____ Adduction ("40") _____ External Rotation ("40") _____ Internal Rotation ("40") _____		<b>Range of Motion Scale</b>		211° - 300° (5)      61° - 100 (2) 161° - 210° (4)      31° - 60° (1) 101° - 160° (3)      0° - 30° (0)		<b>Range of Motion Score</b> _____		<b>Total Harris Hip Score</b> _____	
<b>Stairs</b>	<input type="checkbox"/> Normally without using a railing (4) <input type="checkbox"/> Normally using a railing (2) <input type="checkbox"/> In any manner (1) <input type="checkbox"/> Unable to do stairs (0)																				
<b>Put on Shoes and Socks</b>	<input type="checkbox"/> With ease (4) <input type="checkbox"/> With difficulty (2) <input type="checkbox"/> Unable (0)																				
<b>Absence of Deformity (All yes = 4; Less than 4 = 0)</b>																					
Less than 30° fixed flexion contracture <input type="checkbox"/> Yes <input type="checkbox"/> No Less than 10° fixed abduction <input type="checkbox"/> Yes <input type="checkbox"/> No Less than 10° fixed internal rotation in extension <input type="checkbox"/> Yes <input type="checkbox"/> No Limb length discrepancy less than 3.2 cm <input type="checkbox"/> Yes <input type="checkbox"/> No																					
<b>Range of Motion (Indicate none = 0)</b>																					
Flexion ("140") _____ Abduction ("40") _____ Adduction ("40") _____ External Rotation ("40") _____ Internal Rotation ("40") _____																					
<b>Range of Motion Scale</b>																					
211° - 300° (5)      61° - 100 (2) 161° - 210° (4)      31° - 60° (1) 101° - 160° (3)      0° - 30° (0)																					
<b>Range of Motion Score</b> _____																					
<b>Total Harris Hip Score</b> _____																					

#### Peri Operative Care

It Consists Of Components Inlucing The Pre Operative Care, The Intra Operative Care, And The Post Operative Care

##### 1. Preoperative Management

Assessment Of The Patient's Medical History And Physical Examination: Examine Comorbidities, Such As Smoking, Diabetes, High Blood Pressure, And Obesity.

Blood Tests (Cbc, Electrolytes, Coagulation Profile) Are Among The Investigations.

Chest X-Ray And Ecg (Especially For Elderly Patients).

If Necessary, Crossmatch Blood.

Imaging: Hip X-Ray, Potentially MRI/Ct In More Complicated Cases.

Optimization Of Medicine

Manage Long-Term Health Issues (E.G., Diabetes, Heart Disease).

Quitting Alcohol And Smoking.

Nutritional Evaluation And, If Necessary, Supplementation.

Prehabilitation: Muscle-Strengthening Physical Therapy.

Education Of Patients

Benefits, Risks, And An Explanation Of The Procedure.

Expectations For Post-Operative Mobility And The Recovery Process.

Utilizing Assistive Technology (Crutches, Walker).

Preventing Infections

Check For Infections (Dental Problems, Utis).

Decolonization And Mrsa Screening (If Hospital Protocol).

Before Surgery, Take An Antiseptic Shower For Your Skin.

## 2. Care During Surgery

Regional Anesthesia (Spinal/Epidural) Is Recommended To Lower The Risk Of Dvt And Blood Loss. If There Are Contraindications, General Anesthesia Is Used.

A Look At Surgical Considerations Aseptic Method.

If Necessary, Use Cement That Has Been Impregnated With Antibiotics.

Standard Or Minimally Invasive (Posterior/Anterior) Technique.

Ideally, The Duration Is Less Than Two Hours To Reduce Complications.

Drugs

Preventive Antibiotics: Cefazolin, Usually (Within 60 Minutes Of Incision).

Prophylactic Treatment For Dvt: Begin Intraoperatively Or Shortly Thereafter (E.G. Lmwh Or Doacs).

To Lessen Bleeding, Tranexamic Acid May Be Utilized.

## 3. Care Following Surgery

Instant Post-Op Surveillance

Vitals And The Limb's Neurovascular Condition.

Pain Management (Multimodal Analgesia Plus Opioids).

Keep An Eye Out For Infections, Bleeding, And Dvt/Pe.

Activation

Physiotherapy And Early Mobilization, Typically Within 24 Hours.

The Type Of Prosthesis And Surgical Technique Determine Weight-Bearing Status.

Avoid Pulmonary Complications, Dvt, And Pressure Sores.

Lmwh, Aspirin, Or Doacs For 10–35 Days After Surgery (Based On Risk Assessment) As Thromboprophylaxis.

Pneumatic Devices And Compression Stockings Are Examples Of Mechanical Devices.

Control Of Infections

Wound Care And Infection Monitoring Indicators.

Steer Clear Of Needless Catheterization.

Rehabilitating

Exercises For Rom And Strength.

Training For Gait.

Instruction On Hip Safety Measures To Prevent Dislocation (E.G., Avoid Internal Rotation, Adduction, And Flexion Greater Than 90°)

Surgical Technique

Total Hip Replacement (Thr), Also Referred To As Total Hip Arthroplasty, Is A Surgical Procedure In Which A Prosthetic Implant Is Used To Replace The Damaged Or Diseased Hip Joint. Different Surgical Techniques (Posterior, Lateral, Or Anterior) Can Be Used To Perform The Procedure, But The Fundamental Steps Are Always The Same.

Here Is A Thorough Rundown Of The Thr Surgical Procedure:

### 1. Anesthesia And Positioning

Position Of The Patient: Usually Supine Or Lateral Decubitus, Depending On The Surgical Technique.

Although Spinal (Regional) Anesthesia Is Frequently Chosen, General Anesthesia Is Also An Option.

### 2. Surgical Methods

Features Of The Approachbenefits And Drawbacks

The Rearcut Behind The Hip Jointmaintains Abductor Muscles, Which Are Commonly Usedincreased Risk Of Dislocation

Anterolateral Incision Across The Hip's Sidereduced Risk Of Dislocation And Good Exposurecould Harm Kidnappers  
Incision Made Directly In Front Of The Hipsparing Muscles, Quicker Recuperationtechnically Challenging

### 3. Cutting And Getting Out

Cut In The Skin According To The Method Selected. In This Instance, The Posterior Approach

Dissection Of The Subcutaneous Tissue To Reveal The Fascia And Muscles Underneath.

Muscle Retraction (Or, If Required, Partial Detachment) To Reveal The Hip Joint Capsule. To Gain Access To The Joint, A Capsulotomy Was Done.

#### 4. Dislocation And Resection Of The Femoral Head

Flexing And Externally Rotating The Leg Causes The Hip To Dislocate.

A Saw Is Used To Cut The Femoral Head At The Neck; Typically, A Template Is Used To Guide The Level Of Resection. The Head Of The Femur Is Extracted.

#### 5. Acetabular Positioning And Component Preparation

Reamers Of Progressively Larger Sizes Are Used To Remove Cartilage From The Acetabulum.

The Bony Rim Is Preserved With Care.

The Metal Shell Of The Acetabular Cup Is Inserted (Either:

Cementless: Screw-Fixed Or Press-Fit To Allow For Bone Growth.

If Bone Quality Is Low, It Should Be Cemented.

The Cup Is Lined With Metal, Ceramic, Or Polyethylene.

#### 6. Preparing The Femoral Canal And Inserting The Stem

To Accommodate The Stem, The Femoral Canal Is Opened And Reamed/Broached.

Trial Elements Are Added In Order To Verify:

Length Of The Legs

Motion Range

Consistency

Insertion Of The Last Femoral Stem:

In Good Bone, Cementless (Press-Fit).

In Osteoporotic Bone, Cemented.

The Stem Is Connected To The Femoral Head, Or Ball, Which Can Be Made Of Ceramic Or Metal.

#### 7. Final Checks And Reduction

Ball Into Socket (Hip Reduction). Leg Length And Stability Are Reevaluated.

To Check For Instability Or Impingement, Range Of Motion Is Tested.

#### 8. Conclusion

Irrigating The Injury. Soft Tissue And Capsule Repair.

Closure Of The Skin, Subcutaneous Tissue, And Fascia In Layers. A Sterile Dressing Was Used.

Depending On The Surgeon's Preference, A Drain May Be Used.

#### 9. The Start Of Postoperative Care

The Patient Was Moved To The Recovery Area. Early Mobilization, Thromboprophylaxis, And Pain Management Were Started.

Overview Of Implant Component Materials

Acetabular Shell Either Cobalt-Chromium Or Titanium

Acetabular Liner Metal, Ceramic, Or Polyethylene

Cobalt-Chromium Or Ceramic Femoral Head

The Femoral Stem Stainless Steel Or Titanium Alloy

Intra Operative Images

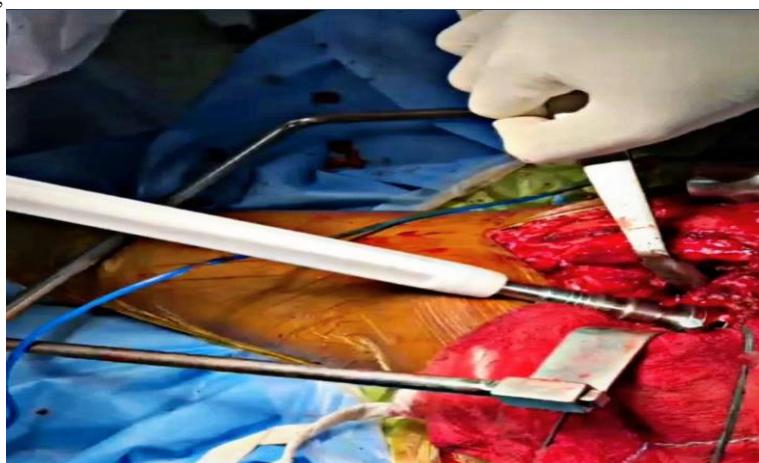
##### 1. Exposure



2. Femoral Head Retrieved After Neck Osteotomy



3. Acetabular Reaming



4. Stem Insertion



5. Inserting Head



6. Joint Reduction



Statistical Analysis

**Demographic Profile Of The Respondent**

**Table 1. Comparison Of Age, Blood Loss, And Harris Hip Score Between Stage 3 And Stage 4 Patients (Independent Samples T-Test)**

Variable	Stage	N	Mean	Sd	T(Df)	P-Value	Mean Diff	95% Ci Of Difference
<b>Age (Years)</b>	Stage 3	20	64.15	6.823	-0.106 (38)	0.916	-0.20	-4.01 To 3.61
	Stage 4	20	64.35	4.934				
<b>Blood Loss (ML)</b>	Stage 3	20	206.00	29.982	-0.622 (38)	0.538	-7.00	-29.77 To 15.77
	Stage 4	20	213.00	40.406				
<b>Harris Hip Score</b>	Stage 3	20	80.00	4.834	0.719 (38)	0.477	+1.00	-1.81 To 3.81
	Stage 4	20	79.00	3.920				

**Table 2. Association Between Radiological Stage And Categorical Variables**

Variable	Category	Stage 3 (N=20)	Stage 4 (N=20)	Total (N=40)	Test Used	P-Value
<b>Sex</b>	Male	17	9	26	Chi-Square	<b>0.008</b>
	Female	3	11	14		
<b>Diagnosis</b>	Left Hip Avn	10	10	20	Chi-Square	<b>1.000</b>
	Right Hip Avn	10	10	20		
<b>Duration Of Surgery</b>	Multiple Categories	—	—	—	Chi-Square	<b>0.696</b>
<b>Follow-Up</b>	12 Months	20	20	40	—	— (Constant Variable)
<b>Complications</b>	None	19	18	37	Fisher's Exact	<b>1.000</b>
	Infection	1	2	3		

Follow Up

The Patient Was Followed Up Till 1 Year Post Operatively At Interval Of 3 Months Regularly. Following Are The Details

Patient Was A 60 Year Old Female Known Case Of Sickle Cell Anaemia Having Left Sided Hip Pain Since 2 Years. Following Are The Radiological Details

Pre- Operative X Ray



Severe Arthritic Changes With Subchondral Collapse Of Bone

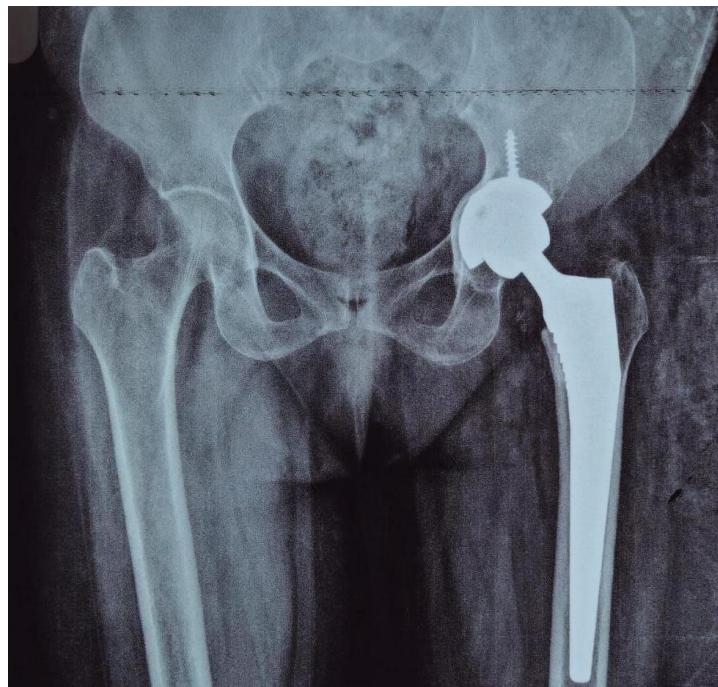
Immediate Post Operative Xray



3 Month Follow Up X Ray



6 Month Follow Up



1 Year Follow Up



#### Clinical Images

Patient Able To Do All Routine Work Sitting, Cross- Legged Sitting, Leg Raising, Knee Bending, Walking Initially With Walker And Eventually Without Support With Adequate Rehabilitation And Physiotherapy



## RESULT AND DISCUSSION

The Patient Was Able To Stand, Sit, Sit Cross Legged And Able To Lead A Normal Routine Life. There Was No Discrepancy In The Lower Limb Lengthwe Have Maintained Sequential Follow Up Of The Patient Upto 12 Months. Patient Was Able To Do Daily Routine Activities And Showed Improvement As Time Progressed With Adequate Post Operative Care And Physiotherapybased On The Evaluation Of The Results Of , We Came To A Conclusion That Total Hip Replacement Is One Of The Better Options When It Comes To Treat Patients With Avascular Necrosis Of The Femoral Head. Thr Can Relieve Pain, Improve The Function And Quality Of Life Of Patients With No Increase In Mortality Risk.

## CONCLUSION

Total Hip Replacement Is One Of The Most Effective Treatment Modalities When It Comes To The Hip Avascular Necrosis In Patients Suffering From Sickle Cell Disease. It Helps In Improving The Quality Of Life Of The Patient By Providing A Painless, Stable, Mobile Hip Joint.

## REFERENCES

1. O Sunkwo I. An Update On The Recent Literature On Sickle Cell Bone Disease. *Curr Opin Endocrinol Diabetes Obes* 2013;20:539–546.
2. Kenanidis E, Kakoulidis P, Lepetsos P, Potoupnis M, Tsiridis E. Sickle Cell Disease. In: Tsiridis E, Ed. *The Adult Hip: Master Case Series And Techniques*. Springer, Cham, 2018:339–350.
3. Vanderhave KI, Perkins Ca, Scannell B, Brighton Bk. Orthopaedic Manifestations Of Sickle Cell Disease. *J Am Acad Orthop Surg* 2018;26:94–101.
4. T Tomas R, Dulman R, Lewis A, Notarangelo B, Yang E. Prospective Longitudinal Follow-Up Of Children With Sickle Cell Disease Treated With Hydroxyurea Since Infancy. *Pediatr Blood Cancer* 2019;66:E27816
5. Kenanidis E, Kakoulidis P, Leonidou A, Tsiridis E. Osteonecrosis. In: Tsiridis