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Effect of drilling and bone substitute on revascularization of an avascular femoral head

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Abstract
Introduction: Avascular Necrosis (AVN) is pathology in which femoral head undergoes degenerative changes due to reduced blood supply. Osteotomy is surgical procedure that involves cutting bone to reshape or realign your bones. It acts by multiple mechanisms. Newer mechanisms include increased blood flow, Osteoinduction due to new fracture (Osteotomy), Change of shear force into compression force. Novel concept for AVN treatment is blocking of femoral canal near lesser trochanter area by Osteotomy/Drilling and insertion of synthetic absorbable Bone substitute (hydroxyapatite cement). Thereby blocking the trabecular canal system at junction so Blood supply get diverted towards femoral head.
Methods and Materials: Study was carried out in New Civil Hospital, Surat in September 2021. The prospective study comprised of 62 year old male having C/o Pain, limp while walking and restriction of Adduction and Internal rotation of Left Hip. Xray, MRI of both hip showed Left Avascular Necrosis Femoral Head (Ficat Arlet Grade 2B). Via Lateral incision of Hip, Drilling and Scooping done at level of Lesser Trochanter. Drilled site was inserted with 10-12 gm of synthetic absorbable Bone substitute (hydroxyapatite cement). Full weight bearing started after 1 week. All patients were followed up immediately, 3rd month, 6th month, 1 year. Follow up X-ray were taken to assess radiological outcome and Harris Hip score for functional outcome.
Results: Xray at 3rd, 6th month, 1 year showed No further progression of Grade 2B AVN Femoral head. Improvement in Harris Hip Score with values 38, 67, 81, 89 at Immediate, 3rd, 6th month, 1 year postop respectively. Improvement in Left Hip range of motion.
Conclusion: Drilling creates disturbance in trabecular canal system (Creating haematoma callus) so that proximal shaft femoral blood supply is cut off (partially) and that blood supply which was destined for the upper shaft is now directed more proximally Towards femoral head.

Keywords: AVN, drilling, hydroxyapatite, ficat-arlet grade, harris hip score

Introduction

Avascular Necrosis or Aseptic necrosis or Osteonecrosis of the hip is a painful condition that occurs when the blood supply to the head of the femur (thighbone) is disrupted. Because bone cells need a steady supply of blood to stay healthy, osteonecrosis can ultimately lead to destruction of the hip joint and severe arthritis.

Osteonecrosis can affect anyone, but is more common in people between the ages of 40 and 65. Men develop osteonecrosis of the hip more often than women.

There are a number of risk factors that are more likely to develop osteonecrosis like: Injury (Hip dislocations, hip fractures), Excessive alcohol use, Corticosteroid medicines and Medical conditions like Caisson disease (diver's disease, or "the bends"), sickle cell disease, myeloproliferative disorders, Gaucher's disease, systemic lupus erythematosus, Crohn's disease, arterial embolism, thrombosis, and vasculitis.

The Modified Ficat and Arlet classification uses a combination of plain radiographs, MRI, and clinical features to stage avascular necrosis of the femoral head

Stage 0: Silent hip (pre-clinical and pre-radiographic)
Stage I: Suggestive clinically (pre-radiographic)
Stage IIA: Sclerosis or Subchondral cysts (Pre-collapse)
Stage IIB: Subchondral fracture/crescent sign (Transition)
Stage III: Segmental flattening and Sphericity loss/out of round appearance (Collapse)
Stage IV: Space loss, Secondary osteoarthritis-may involve acetabulum (Advanced arthritis).

Osteotomy is a surgical procedure that involves cutting bone to reshape or realign your bones. For e.g. Mcmurry's osteotomy, Dickson's osteotomy, Putti's osteotomy, schanz osteotomy, Pauwel's varus osteotomy, Pauwel's valgus osteotomy etc.

It acts by earlier explained mechanisms like Increase in contact area/ congruency, Improves coverage of head, Moves normal articular cartilage into weight bearing zone, Restoring biomechanical advantage. Its newer mechanisms include increased blood flow many times, Osteoinduction due to new fracture (Osteotomy), Change of shear force into compression force.

The circulation is in the form of blood flowing through the canaliculi around which there is a array of osteocytes and osteoblasts all along the length connected to each other and the blood flow this is known as trabecular system. And making a hole in the bone does not produce a canal of blood supply. The blood on these canaliculi get thromboses after injury and on the either side of fracture this area is known as terminal bone death. The length of the dead area depends on the severity of the injury since these dead end can't get a biological healing unless alive again, that's the reason we see callus and jumping callus.

The novel concept for Avascular Necrosis Hip treatment is blocking of Femoral canal near Lesser trochanter area by Synthetic absorbable Bone substitute - hydroxyapatite bone cement, and there by disturbing/blocking the trabecular canal system at the junction. So the Blood supply gets diverted towards femoral head.

These procedure is done while doing core decompression or newer stem cell procedures etc.

Methods and Materials

Study was carried out in New Civil Hospital, Surat starting from September 2021 upto September 2022. The prospective study comprised of 62 year old male having C/o Pain, limp while walking and restriction of Adduction and Internal rotation of Left Hip. The patient was evaluated on haematological & radiological basis pre-operatively. For radiological investigations, Xray and MRI of both hip were done which showed Left Avascular Necrosis Femoral Head involving **S**ubchondral fractures/crescent sign (Ficat Artlet Grade 2B). Functional outcome measured by Harris Hip Score was 41 preoperatively. Informed consent was taken.

Operative Procedure

Patient was operated under Spinal Anaesthesia. Patient was placed supine on a traction table to facilitate proper exposure in Hip joint. Via Lateral approach to Hip and proximal femoral shaft (DHS incision), 5-6 cm of skin incision was made. Subcutaneous tissue cut, Tensor fascia lata cut and Vastus Lateralis separated by blunt dissection. Flare of Greater trochanter and proximal femoral shaft exposed. Then drilling done and Scooping done at level of Lesser Trochanter with help of sequential Hollow mill drill bit. Then synthetic absorbable Bone substitute (Hydroxyapatite cement: IHA 10) prepared by mixing for 6-8 minutes. Osteotomy site was inserted with 10-12 gm of synthetic absorbable Bone substitute (Hydroxyapatite cement: IHA 10). Filling of osteotomy site checked under Fluoroscopic guidance. Partial weight bearing done immediately after operative procedure. Full weight bearing started after 1 week of Partial weight bearing. Post operatively intravenous antibiotics given for 5 days. On the 3rd post operative day dressing was done. Suture removal done on 12th post operative day.

All patients were followed up immediately, 3rd month, 6th month, 1 year. Follow up X-ray were taken to assess radiological outcome and Harris Hip score for functional outcome. Also surgical scar was examined, Neurology was checked and appropriate rehabilitation was advised.

Results

Xray at 3rd, 6th month, 1 year showed No further progression of Grade 2B AVN Femoral head. Improvement in Harris Hip Score with values 38, 67, 81, 89 at Immediate, 3rd, 6th month, 1 year postop respectively. There was significant Improvement in Left Hip range of motion.

Average blood loss for Drilling and Bone substitute surgery was 150 ml. Average duration for Drilling and Bone substitute surgery was around 75 mins.

Discussion

By Drilling and scooping, one is creating disturbance in trabecular canal system [creating haematoma callus] so that the proximal shaft femoral blood supply is getting cut off (partially) and that blood supply which was destined for the upper shaft is now directed more proximally towards femoral head.

This effect is temporarily for >4 months till the original trabecular canal systems reorganizes.

Limitation of Core decompression is that this procedure is two sided sword because of liner disturbances in bone matrix and damage to surrounding bone due to heating by drilling. Hence Drilling and Bone substitute surgery is a better option over Core Decompression.

Fig 1: Nutrient foramen in proximal femur

Fig 2: Preop MRI

Fig 3: Instrumentation

Fig 4: Drilling with Hollow mill

Fig 5: Drilling

Fig 6: HA cement prepared

Fig 7: Final cement placement

Fig 8: Final Intraop image

Fig 9: 6 month postop

Fig 10: 1 year postop

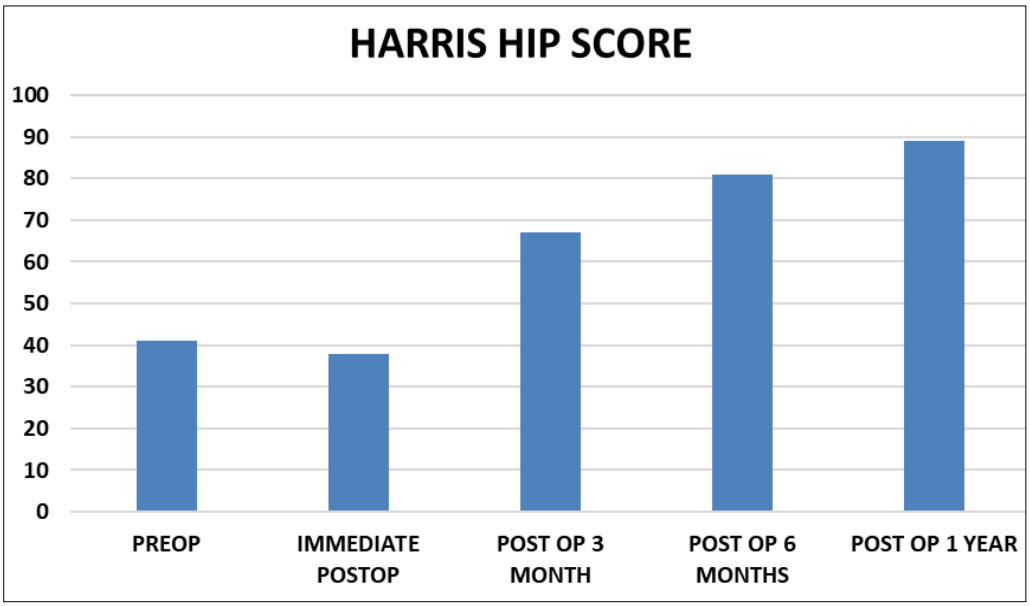

Fig 11: Harris Hip Score

Conclusion

Drilling and Bone substitute surgery is a Blood Supply Diverting procedure and hence this surgery is a type of AVN hip preserving surgeries, so that we can measure effectiveness of this on a larger scale for betterment of society. And Drilling and Bone substitute surgery can be preferred over Core Decompression surgery.

Conflict of Interest

Not available

Financial Support

Not available

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