Case Report

Re-flighting in the Fighter Cockpit after Total Hip Replacement: A Case Report

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Introduction

In flying apart from the anthropometric limits for aircrew pertaining to the critical parameters, thestatic and dynamic loading of the spine and joints arealso important, especially with respect to combat flying. Flying is a closed loop, continuous task, best performed with goodman-machine dynamics. The dynamics can be compromised whenever an aircrew suffers from musculoskeletal disabilities.

Indian Air Force has laid down policies, which define awarding anappropriate medical categories with the aim of determining the aircrew fitness for flying a particular aircraft following recovery from the musculoskeletal disabilities. Ranging from the simple contusion or low back pain to a major Total Hip Replacement (THR), sometimes there are no guidelines for reflighting novel cases, such that reflighting solely depends on the recovery, ability to withstand aviation stressors risk of sudden incapacitation. In IAF, till date no case of THR has been reflighted to the fighter cockpit [1].

Case Summary

A 27 year old fighter pilot of Indian Air Force with a total flying experience of 600 hours with currency of 200 hours on Su-30 MKI, met with a road traffic accident. He sustained fracture dislocation left hip joint along with femoral head fracture (Pipkin'sType). He was managed with wound debridement and open reduction and internal fixation (ORIF) with metal (RECON®) plate for the acetabular fracture.He also underwent K wire fixation for the fracture of femoral head. Subsequently, he was given upper tibial skeletal traction for 06 weeks.After discharge from the hospital he was observed in low medical category A4G4 for a period of (08+24) weeks. Thereafter, he was referred to an Air Force boarding centre for evaluation. At the time of presentation at the centre, he was symptomatic and was able to walk with support. Wasting of quadriceps, hamstring and calf muscles on the affected side were noticed. Goniometry revealed that his hip was fixed in 21° abduction, 20° external rotation with neutral flexion. In addition, a 2.5 cm apparent lengthening of limb was observed. Owing to his functional limitations he was recommended to continue in non-flying medical category for another 24 weeks. He continued to be symptomatic and developed delayed post-operative infection and septic arthritis of left hip, for which he was managed with an uncemented Total Hip Replacement with Ceramic-on-Ceramic Prosthesis at a Military Medical Research & Referral Centre. After 24 weeks of this surgery, the aircrew became asymptomatic and ambulatory and could move without any support. He was referred back to the same boarding centre. His clinical and radiological findings were suggestive of a well seated hip prosthesis with good implant alignment, but functional evaluation for determining his suitability in afighter cockpit, revealed restricted movements of the left hip joint. These restrictions had implications for the aircrew in carryingout external checks on the aircraft, entry and egress especially in emergency conditions. Therefore, he was recommended to continue in non-flying medical category for another 12 weeks.

His subsequent review at the centre did not reveal any limitations and the simulated stressors (Vibration and G stress) were well tolerated by the aircrew. Keeping in view, his functional status, motivation and confidence to continue in

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fighter stream and also to conserve trained fighter aircrew in the same aircraft stream he was recommended to be upgraded to a 'restricted flying medical category' in A3G2 (T-12), fit for ejection seat aircraft, subject to approval by competent medical authorities. In response, the competent authority advised him to undergo assessment on 'Force Platform' at Defence Institute of Physiology and Allied Sciences (DIPAS), New Delhi before reflighting. His gait analysis was carried out at DIPAS Ergonomic Lab for evaluating temporal spatial parameters, kinematics, and kinetic changes during walking at different speeds. The study indicated that there were no anomalous gait pattern in any joint angular displacement, force and power responses. Accordingly, during his next review, he was recommended a restricted medical category [A3G2 (T-12)], fit to fly with a qualified pilot on type, under waiver from DGMS (Air). The aircrew was advised by the boarding centre to furnish an 'Executive Report' on flying with details commenting on his ability to comfortably ingress and egress from the aircraft during emergency, donning and doffing of flying clothing and on flying a long duration sortie (approx. 04 hours).

The aircrew reported with a complimentary 'Executive Report' on flying for his next review. During this period,the aircrew logged a total of 09 hoin the cockpit involving 03 sorties. During this review, the Aviation Medicine specialist at the Dept of Human Engineering, after thorough evaluation recommended him to be upgraded to A2G2 (P), fit ejection seat aircraft, which was in consonance with the opinion of Orthopaedic Surgeon.

Discussion

Total Hip Replacement (THR) or Total Hip Arthroplasty is a surgical procedure whereby the diseased cartilage and bone of the hip joint is surgically replaced with artificial material. The normal hip joint is a ball and socket joint. The socket is a 'cup-shaped' component of the pelvis called the acetabulum. The ball is the head of the Femur. Total hip joint replacement involves surgical removal of the diseased ball and socket and replacing them with a metal (or ceramic) ball and stem inserted into the femur bone and an artificialplastic (or ceramic) cup socket. The metallic artificial ball and stem are referred to as the 'femoral prosthesis' and the plastic cup socket as the 'acetabular prosthesis'. Upon inserting the prosthesis into the central core of the femur, it is fixed with a bony cement called methylmethacrylate. Alternatively, a 'cementless' prosthesis is used that has microscopic pores which allow bony ingrowth from the normal femur into the prosthesis stem. This 'cementless' hip is felt to have a longer duration and is considered especially for younger patients [2].

Total hip replacements are performed most commonly for progressively worsening severe arthritis of the hip joint in elderly. The most common type of arthritis leading to total hip replacement is degenerative arthritis (osteoarthritis) of the hip joint. Other conditions which require total hip replacement include bony fractures of the hip joint, rheumatoid arthritis, septic arthritis or avascular necrosis of the hip joint. The replaced hip joints can fail with time, that is why, to perform total hip replacement is not an easy decision to make, especially in a young patient. A total hip replacement is usually an elective procedure and it is a decision that is made with an understanding of the potential risks and benefits. The risks and complications following hip replacement are similar to those associated with all other joint replacement surgeries. They include dislocation, loosening, impingement, infection, osteolysis, metal sensitivity, metal toxicity, nerve palsy, pain and death. As indicated, most hip replacements will be uncomplicated and provide excellent results; a few patients will experience undesirable outcomes too [2, 3].

In the present case, a ceramic on ceramic, non-cemented implant was chosen, probably to avoid possibility of systemic cobaltism which is known to occur in metal on metal implants. Furthermore, a non-cemented, ceramic on ceramic prosthesis is preferred for a young patient, which is textured or has a porous surface coating around much of the implant that allows

new bone to grow into the surface of the implant for better fixation and stability. However, non-cemented prosthesis takes much longer time to be stabilised. The aeromedically significant implications of a 'prosthetic joint' are joint instability, implant failure and aseptic loosening. The issue of returning aircrew with THR to ejection seat aircraft primarily depends upon the ability to perform routine flying activities. But the major concerns are the risks of prosthetic hip dislocation and periprosthetic fracture due to the kinetics of ejection, windblast flail injury and the impact of parachute landing.

This young pilot, if reflighted to an ASF aircraft, would be exposed to the aviation stressorssuch as G stress, restricted space, Long duration flying and ejection forces in case of an ejection.The probability of G stress leading to any dislocation in a case of THR is remote. Most traumatic hip dislocations are posterior dislocations, usually due to an axial force on the flexed hip during a sudden -Gx deceleration in a subject not appropriately harnessed.This mechanism of injury is not likely to affect an aircrewwho would typically be well harnessed. [4].

Confinement in the limited space of a fighter cockpit for a prolonged period might result in pain, discomfort in the muscles and thereby distraction from the primary task of flying.This has not been documented in any of the available literature but can be assessed by flying a long duration sortie which was achieved in this particular case. Furthermore, he has regained full range of movements and was able to perform the lower limb functional assessment tests satisfactorily, and so there is no problem envisaged during ingress/egress from cockpit which has been documented in the 'Executive Report' on flying.

Flailing injury post ejection is a possibility if correct posture during ejection are not adopted. The review of six Su-30 ejection cases evaluated at Institute of Aerospace Medicine between the period from 2008 to 2014, none of the ejections resulted in dislocation of the hip joint. The chances of hip injury on landing are possible in individuals with THR [5]. An engineering study by DePuy, Inc., Warsaw, an implant manufacturer, specifically evaluated the loading effect of a 16-G ejection on an implanted total hip design with the help of a mathematical model. It was observed that the loading forces were unable to dislocate a well- fixed prosthetic hip in a seated subject because of the compressive nature of force on the implant. The study concluded that the implant material is strong enough to withstand the forces of an ejection [6]. However, there is no other evidence in the literature to rule out the possibility of such injury in these cases. The possibility of such risk had been explained to the aircrew in this case.

In IAF, policies are silent regarding the aeromedical disposal of such cases. A review of current US Army and US Air Force waiver policies after total joint replacement reveals that waivers may be granted for non-ejection seat aircraft. However, US Navy has reflighted 03 aircrew (with cement-less THR) in F/A-18 (fighter), TA-4s (twin cockpit jet trainer) and P-3C (four-engine, turboprop) aircraft. Since return to flight status, the airman on F/A-18 hadflown approximately 900 hours and reported no difficulty with ingress/egress from the cockpit, prolonged sitting or difficulty sustaining G forces in air combat manoeuvres [6].

In view of the normal clinical & human engineering evaluation and high level of motivation and adequate period of observation, the aircrew was recommended for a waiver from the competent authority to retain him in the fighter stream. In agreement with the recommendations of IAM, a waiver was accorded by the competent authority and a trained fighter aircrew was conserved in the samestream [5].

Conclusion

This is the first instance in Indian Air Force to reflight an aircrew back to fighter flying following a Total Hip Replacement surgery. This decision was taken based on scientific evidence, thorough radiological, clinical and Human Engineering evaluations. After adequate observation on ground, the pilot demonstrated no limitations in his range of movements and functional capa-

bility. In cockpit also, he had shown unhindered capability to actuate and activate all controls and was finally retained in fighter flying.This case is considered as a 'bench mark' for future aero-medical decision making towards an effort to preserve trained pilots.

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Disclaimer

The opinions expressed in this article are those of the author & do not reflect the official views of the Indian Air Force or the Indian Society of Aerospace Medicine

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ANSWERS TO AEROSPACE MEDICINE QUIZ

1(a), 2(b), 3(a), 4(d), 5(b), 6(b), 7(b), 8(c), 9(c), 10(c), 11(d), 12(d), 13(c), 14(c), 15(b),16(b), 17(b), 18(a), 19(a), 20(b)