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Case Report

Re-fracture as Impact of Rigid Implant and Bone Osteoporosis: A Case Report

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ABSTRACT

Background: The increasing life expectancy of the world population associated with osteopenia and osteoporosis leads to low-energy fractures, especially in the lower limb. The overture of locking plates has widened the area of close fracture fixation, and it is essential to justify and optimize their usage. This study aims to report the potential postoperative re-fracture after implant removal and as a consequence of bone osteoporosis.
Case report: We present a re-fracture of proximal femur case in 60 years old female after a trivial fall into her right femur. This patient underwent a removal implant surgery a week before in the same spot where she fell. The open surgery was made with the same incision, and we do the Open Reduction Internal Fixation for her.
Discussion: The major design of the fixation tool is to secure the fracture with less effect on native axial load stress from the whole bone. Stress shielding caused due to firm bone-implant results in its resorption. The bone degradation underneath gives rise to the plate's collapse, resulting in repeated bone breakage. Early discharge, continued weight-bearing training for proximal femur fractures were associated with speedy improvement in daily activities. The photodynamic polymer liquid was the latest technology for bone stabilization.
Conclusion: Rigid bone plates can cause stress shielding, and when the implants are removed, re-fracture easily happens. Therefore, discharge of patients quickly for weight-bearing training in proximal femur fractures was encouraged to promote better healing.

Keywords: Fracture; Osteoporosis; Bone plates; Life expectancy; Human and medicine

INTRODUCTION

In this recent decade, the life expectancy of humans has increased globally. It is concurrent with the active lifestyle of the elderly today and the reduction of musculoskeletal capability, resulting in osteopenia and osteoporosis.[1] Osteoporosis is a degenerative disease in which the bone is susceptible to fracture due to decreased bone mineral density (BMD). Eight million women and 2 million men in the United States are affected by this disease. Also, 34 million of them have low bone mass. Trivial fractures, like hip fractures, repeatedly happen because of them.[2] The disability and functional disturbances, even death, are mainly because of this fracture. Fractures of the proximal femur are common in the elderly, especially on the intracapsular (of the femoral neck) and extra-capsular (trans-trochanteric and subtrochanteric) types.[1] Data reported that osteoporotic fracture complications had made significant health and economic burdens.[2]

Proximal femoral fracture is one of the most common fractures because of which elderly patients get admitted to an orthopedic trauma ward. They account for 90% of all fractures occurring in the proximal femoral region.[3] Nearly half of these are divided into intertrochanteric or subtrochanteric fractures. If the patterns are unstable, its management needs serious effort to reduce and retain them. Usually, it happens together with complicating factors like poor bone quality and the inability to limit weight-bearing.[4] In general, the locking plates' debut has enlarged the area of fixing close fracture and plate fixation more specifically. Because of pitfalls and limits, its usage

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needs to be justified and optimized.[5] When the poor bone quality undergoes removal implant procedure, orthopedic should concern with the postoperative management. Because re-fracture could happen due to several factors following implant removal, such as bed rest duration after implant removal procedure, age, gender, and bone mineral density.[6] In this study, we report a case of an older woman with re-fracture after implant removal in her right proximal femur.

CASE REPORT

A 60-year-old female was admitted to ER with the chief complaint of excruciating pain on the right upper limb and the ipsilateral wrist joint after a trivial fall when she was walking in front of her house, and her right-hand acts as body support. She cannot move her hip joint and wrist joint. She mentioned that 10-days before, she was undergoing a removal implant surgery at the same spot where she fell again. In May 2019, she had the first right proximal femur fracture and right proximal humerus fracture surgery. Both of these fractures were treated using the proximal locking compression plate.

The primary survey is stable with no remarkable injury. After a brief physical examination, a stitched scar with a small bruise on the patient's right femur area, with mild LLD found without any rotation on her hip. She can barely not flex her hip passively. There is minimal swelling on the right wrist joint without any open wound, bruise, or visible deformities. Her wrist joint movement is very limited because of pain. The plain X-Ray of the thorax, hip, and wrist joint is done to evaluate her right femur and wrist joint condition.

It shows a closed fracture of the proximal third right femur and a closed fracture of the distal right radius (Figures 1A and 1B). The thorax X-Ray also confirms the previous right proximal humerus implant surgery. She also brings the previous X-Ray of the right femur when she had the first surgery and after undergoing the removal implant surgery (Figures 1C and 1D). From the last X-Ray, before she undergoes the removal implant surgery, it seems that her right femur bone has signs of osteoporotic bone even after two years after the first surgery (Figure 1D). Using the same incision with the previous surgery, we do the Open Reduction Internal Fixation for her (Figure 1E). Two weeks after this procedure, in the OPD, there were no significant complaints and complications in this patient. She went to scheduled rehabilitation faster after the surgery.

Figure 1. (A) Plain X-Ray of Hip after the patient fell, (B) Plain X-Ray of Wrist Joint, (C) Plain X-Ray of Femur after two years of the first surgery, (D) Plain X-Ray of Femur after Removal Surgery, (E) Postoperative X-Ray

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DISCUSSION

Bone is a miraculous tissue; it always repairs itself through a process back to normal function whenever there is damage. The skeletal system can tamper with some diseases, disorders, and trauma.[7] Discontinuity of the bone cortex, with a degree of injury to the surrounding soft tissues commonly referred to as fractures.[8] This skeletal system issue can elevate the mortality rate, which has a different value in every bone. An implant is needed for this issue, or it can also cause a fracture.[7] In severe cases, implants become mandatory–because they need realignment and fixation for proper healing–or somehow, it completely fails to regenerate, producing bone defects.[7,8]

After fractures happen, the bone will heal in two ways, direct (primary) or indirect (secondary) healing. Primary healing is the bone cortex restoration without callus formation. It resulted from rigid fixation because of a fragment of bony vascular surfaces in contact. Secondary healing is natural bone restoration through three phases. First is an inflammatory phase that starts directly after fractures. After the rupture of bone and periosteum, the hematoma was formed and brought all pro-inflammatory substances such as vascular endothelial growth factor (VEGF) to encourage the healing process. The second phase, the reparative phase, happens when primordial bone cells begin to take action to make a soft callus and continuously replace it with a hard callus. The last phase is the remodeling phase, where the bone begins to back to normal anatomical and physiological function.[7,8]

The fracture holds steady by the bone plate/bone implant (i.e., to make sure the fracture site is always under slight compression) while minimally affecting the natural stress state of the bone.[9] Bone healing process with an implant is similar to non-implant bone healing. As implant stabilization, the bone formation around it extremely relies on the surface chemistry and implant topography. Locking plates make bone healing vary depending on the fracture site. Intraarticular fragment needs to return to an anatomical position with contact with each other fragment if in the epiphyseal area. While in the diaphyseal area, it is not required to directly reduce the intermediate fragment when alignment (coronal, sagittal, and rotational) and bone length are restored.[5,7]

The inflammatory process started as soon as the implant was used, and hematoma formed underneath. This inflammatory process culminates in the recruitment of mesenchymal stem cells (MSCs) to the implant's surface. The cells became osteoblast, which later became the new bone along the edge. It is called contact osteogenesis. Because of contact osteogenesis, bone bonding is formed only if the implant surface has good topography. In distance osteogenesis, it grows from the old bone surface to the implant surface in an oppositional way. Both of them encourage the forming of immature woven bone, fill the gaps between the bone and implant. The remodeling phase of this sub-implant space begins from immature bone to the mature bone.[7,10–13]

While bone stabilization happens, bone union through the remodeling phase occurs if overly stiff conditions. It will not be healed. If not stiff enough, it would be compromised.[5,7,9] The natural stress state of bone changes accidentally because of the plate compared to the state before fracture. Some bone parts are shielded from either tensile or compressive stress or both. It is well known that the bone reacts to applied stress through remodeling. Stress shielding caused due to rigid bone-plates results in bone resorption. Implant failure and re-fracture after removal surgery could happen because of this sub-implant bone resorption.[7,9] To prevent the re-fracture, good rehabilitation programs should be initiated early after ambulation. It can be started with partial weight-bearing until carefully used in daily activities.

Reducing death rate, the short length of

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stay, and discharge of the patient was linked to immediate ambulation with weight-bearing training after proximal fracture surgery. It also helps to boost the psychological confidence and morale of the patient.[14] Most hip fracture patients should be allowed unrestricted weight-bearing and mobilization post-surgery. Restricted weight bearing or delayed mobilization may delay functional recovery, delay the return to independent living, and result in depression and anxiety. Allowing patients early mobilization after stabilizing these fractures also helps prevent bedsores, deep vein thrombosis, pulmonary complications, and muscle atrophy.[1,3] As a mechanical force given to the bone, it responds with its ability to rebuild and change architecture. The bone strain is in homeostatic conditions with balanced turnover for osteoblast and osteoclast in normal physiological conditions. Animal study shows that if a moderate axial loading is given to the osteotomy site, the callus forms thicker and union quicker than enormous early loading or even no loading. In vitro osteoblast activity (proliferation and synthesis) begins while there are moderate uniaxial strains between 0.3 and 2.8%. At first, granulation tissue and fibrous callus will form in the fracture site due to the high strain, when it becomes stiffer until the strain is low enough as the bone formation.[14]

Axial loading and weight-bearing will act as outside stimuli, improving bone ability to heal at the fracture site. The same healing process in osteoporotic bone happened for quite longer. Direct load-bearing supported with favorable blood supply at the fracture site, fortified by micro-movement and fracture steadiness, will improve bone healing. In situ mechanical elements influence cell differentiation and phenotype: osteoblastic differentiation is supported by small to moderate strain, while larger strains promote the fibroblastic cells and increase fibrous union possibility. After surgery, the weight-bearing training only focused on early mobilization and restoration of physiological function to encourage healing while evading displacement of fracture or implant failure.[14]

The biomechanical study from 2 groups of cadaveric bone shows that the PFN surpasses the PFLCP in axial rigidity, subsidence, and the number of specimens that failed to fix oblique proximal femur.[15] Nandakumar R et al. studied 60 patients with an intertrochanteric fracture treated surgically with Proximal Femoral Nail (PFN). This study concluded that early mobilization with full weight-bearing gives a good outcome and reduces morbidity and mortality. It also boosts the patient's confidence, which has a good effect on the well-being and morale and should be recommended following intertrochanteric fracture fixation with Proximal Femoral Nail (PFN).[3] Other studies about early weight-bearing after proximal femur or hip fracture also showed similar results. It is stated that femoral shaft fracture treated with PFN allowed for immediate mobilization with WBAT.[16,17]

There are many recommendations for preventing re-fracture caused by implant-induced osteoporotic make a significant challenge for surgeons. The latest technology was the minimally invasive Photodynamic Bone Stabilization System, said to be a novel technique for surgical repair of osteoporotic fractures in long bones that provides enhanced stability and excellent clinical results.[18]

CONCLUSION

In this study, we present a case of a female elderly who got re-fractured after she fell. Ten days earlier, she had her implant removed from her proximal femur. This case reminds us that small things could happen anytime, even if we are already prepared to prevent them, because stiff bone plates can cause stress shielding, which results in bone resorption and can result in re-fracture of the bone when the fixation device is removed.

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