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Case Report

Computer-Assisted Planning and Three-Dimensional-Printed Patient-Specific Instrumental Guide for Corrective Osteotomy in Post-Traumatic Femur Deformity: A Case Report and Literature Review

電腦輔助術前規劃和三維打印患者患者特定器械指南在創傷後股骨畸形矯正截骨術的應用:病例報告和文獻綜述

Lau Chi-Kay*, Chui King-him, Lee Kin-bong, Li Wilson

Department of Orthopaedics and Traumatology, Queen Elizabeth Hospital, Hong Kong

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ABSTRACT

Post-traumatic limb deformity is often multiplanar and thus is a difficult pathology to deal with surgically. Precise preoperative planning and accurate intraoperative execution are two main important steps that lead to satisfactory outcome. Computer-assisted planning and three-dimensional-printed patient-specific instrumental guides provide excellent aid to the two steps, respectively. We report a case of post-traumatic lower limb deformity in a patient who underwent closing wedge corrective osteotomy with the aid of the aforementioned new technologies.

中 文 摘 要

創傷後肢體畸形通常是多平面的，因此是手術治療的困難病理。 準確的術前規劃和準確的術中執行是導致滿意結果的兩個主要重要步驟。電腦輔助術前規劃和三維打印患者特定器械指南分別為兩個步驟提供了極好的幫助。 我們報告了在創傷後下肢畸形，借助上述新技術來進行閉合楔形矯正截骨術的病例。

Introduction

Lower limb corrective osteotomy is known to be a technically demanding procedure in which accuracy is of utmost importance. Post-traumatic cases are especially challenging due to the often encountered multiplanar deformities.

Traditionally, two-dimensional (2D) radiographs were used for preoperative planning. Its accuracy was limited by the quality of the images and complexity of the deformity. Furthermore, intraoperative execution was often technically demanding as any suboptimal cut would end up with persistent deformity or even potential new malalignment.

In recent years, computer-assisted planning has been providing an alternative for complex orthopaedic cases to improve surgical accuracy. Moreover, with the new advances in application of three-dimensional (3D) printing to orthopaedic surgery, intraoperative execution has been improved by patient-specific instrumental (PSI) guides.[1,2] The feasibility of introducing the use of PSI into corrective osteotomy was proven in previous studies.[3]

Case report

We report a case of post-traumatic malunion of the femur requiring corrective osteotomy, in which computer-assisted planning and 3D-printed PSI guides were used.

Our patient was a 57-year-old victim in a road traffic accident who suffered from polytrauma with bilateral lower limb injuries in 2007 (Figure 1). The left limb injuries included open left distal femur intercondylar and patella fracture with Gustilo Classification Type IIIB injury and Mangled Extremity Severity Score of 8.

The left limb was initially stabilized with external fixation after wound debridement. Partial patellectomy was conducted as the

* Corresponding author. *E-mail:* laukay@gmail.com.

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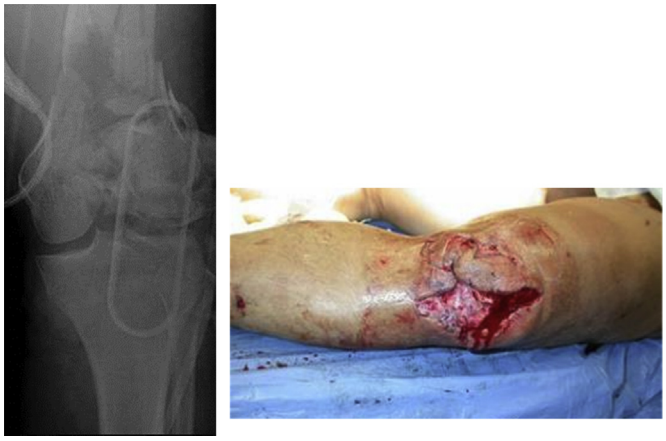

Figure 1. Clinical photo and radiograph of the injured left lower limb in 2007.

patella was shattered by the injury and was beyond repair. The extensor mechanism was impaired by the loss of quadriceps and patella tendon after repeated debridement. The situation was further complicated by the comminuted distal femur fracture with bone defect and by methicillin-resistant *Staphylococcus aureus* wound infection. The distal femur fracture was eventually fixed with intercondylar screws and external fixation with limb shortening. The soft-tissue defect was dealt with using gastrocnemius flap and partial thickness skin graft after the infection was under control.

The fracture healed up in 1 year, with varus, procurvatum, external rotation deformity, and shortening (Figure 2).

The contralateral limb was also severely injured in the same accident, with right femur, tibial, and fibular fractures, which all eventually healed up after multiple operative interventions (Figure 3).

Figure 2. Malunion of the left distal femur.

Figure 3. Standing radiograph prior to corrective osteotomy.

Functionally, the patient was able to walk without assistance and he resumed his prior work as a taxi driver. However, the patient suffered from symptoms due to post-traumatic arthritis and leg length discrepancy.

Initially, he coped with the symptoms well, but as time went by the symptoms deteriorated. In early 2015, when he reached the age of 65, he presented with further increase in left knee pain. The pain was over the medial side, while the range of movement of the left knee was very limited, ranging from 10° to 20° of flexion. Surgical intervention was requested at this juncture for pain control and correction of lower limb alignment.

Options including corrective osteotomy, total knee replacement (TKR) with or without osteotomy, and knee arthrodesis were thoroughly considered and discussed.

Arthrodesis was not preferred by the patient as he would like to preserve the remaining range of movement, which was very important to board or alight his taxi.

TKR with or without osteotomy was expected to be technically demanding due to previous infection, known multiplanar deformity, and existing implants in the distal femur. Furthermore, the improvement in range of movement, if any, was expected to be insignificant due to the loss of extensor mechanism from previous surgeries and soft-tissue scarring from previous infection.

In the end, closing wedge corrective osteotomy was chosen. The authors believed that it could best improve the overall lower limb alignment, relieve pain, and preserve the remaining range of movement. Unnecessary complications of TKR could also be avoided.