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Benefits of hardware removal after plating

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ABSTRACT

Routine implant removal is frequently performed although evidence-based guidelines are lacking. But routinely planned implant removal has significant economic implications and shows considerable complication rates. In general, clinical outcome seems to improve but pain relief after operation is often unpredictable. Even in patients reporting implant-related pain, implant removal does not guarantee relief and may be associated with further complications. The intra- and postoperative complication rate remains very high. Implant removal demonstrates a significant learning curve and unsupervised junior surgeons tend to cause more complications. The need for implant removal may be questioned. Even with the implant in place, contact activities can be resumed. However, a new adequate trauma can create a new fracture independently if there is an implant in-situ or not. It is important to understand the complications and outcomes to be expected with hardware removal to carefully evaluate its indication.

Introduction

Routine implant removal in asymptomatic patients remains a very controversial issue [42]. With increasing number of operative fracture fixations, the frequency of indwelling metallic implants increases considerably. A clinical questionnaire among orthopaedic surgeons in the United Kingdom tried to identify current state of practice for implant removal in asymptomatic patients [20]; 87% of the questioned orthopaedic surgeons agreed that retaining metal hardware was safe. Only 11% believed that implants should be removed mainly because of concerns with regards to bone overgrowth and associated difficulty with later removal, and 21% stated that ion toxicity and metallosis was of concern and 16% possible carcinogenesis [20]. In a questionnaire addressing 655 trauma surgeons from 65 countries only 15% agreed that routine implant removal is necessary [15]; 58% did not agree that indwelling implants pose an excess risk for fractures or general adverse effects, and 48% felt that removal is riskier than leaving the implant in situ.

However, routine removal was commonly seen for internal fixation of the clavicle (27%) and in the lower limb for midshaft tibial fracture (11%) [20]. In a Finnish study, nearly all (81%) implants inserted for fracture fixation were eventually removed [11]. In total, implant removal contributed to almost 30% of all planned orthopaedic operations [11]. The reason for this perception and behaviour mismatch remains unclear particularly considering the associated high complication rate of 20% with up to 14% infection rate, 2% nerve injury and refracture in 0.5% [31]. From a health economic standpoint, patients after intramedullary nail removal took a mean of 11 days sick leave after a standard implant removal [7]. The purpose of this review article is to summarize and to discuss reason and benefits as well as limitations for implant removal.

Peri-implant fracture and refracture after implant removal

A commonly mentioned reason for implant removal is the fear of more complex peri-implant fractures. However, some surgeons fear refracture after bone healing and implant removal as well. Peri-implant fractures occur mainly through peripheral screw holes [22]. These types of fractures occur particularly at the forearm [19,22]. In contrast, peri-implant fractures of intramedullary nails are rare and only some case series are published [21,25]. McKee et al. published three cases of peri-implant humerus fractures after intramedullary nailing [25]. The fractures occurred at the tip of the distal interlocking screw after a rotational force at 8, 10 and 26 weeks postoperative, respectively. A reason for the higher incidence of peri-implant fractures in plate osteosynthesis might be a higher rate of vascular disruption in open plate osteosynthesis. Perren et al. analysed the occurrence of osteopenia in vicinity of fractures treated by plate osteosynthesis [29]. In their conclusion, bone loss in the vicinity of implants could not been explained as being induced by mechanical unloading of the bone and consecutive stress protection. In animal models, reduction of peri-implant blood circulation lead to bone necrosis and osteopenia. But this osteopenia was transient, produced even by flexible plastic plates, and occurred less often and

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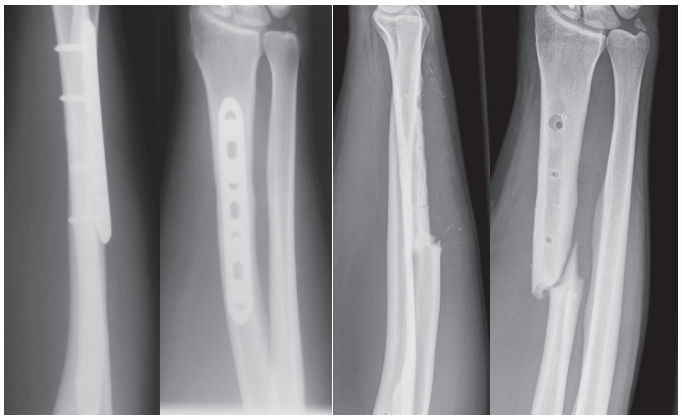

Fig. 1. Refracture of a healed radius shaft fracture 2 months after implant removal.

for a shorter time when the vascular supply to the bone was less disturbed. Several reports demonstrated lower rates of refracture when implants were retained longer; possibly further supporting the idea that osteoporosis is a self-limited, vascular phenomenon. Evans et al. assessed professional rugby players with indwelling implants returning to their competitive level of sport [13]. Almost 90% returned to their preinjury level of performance in the premier league for up to six years without symptoms or re-fractures.

On the other hand, there is the risk of re-fracture after implant removal (Fig. 1). A main concern is the stress riser at the cortical defect. In a study of drilled dog femurs, Brooks et al reported a mean 55% reduction in energy absorbing capacity in the presence of a single 2.8- or 3.6-mm drill hole [8]. But radiographic evidence of a screw hole might remain even after the hole begins to fill with new bone [10]. The stress concentration was eliminated after 4 weeks in a canine model after new woven bone filled the hole [10]. In young adults however, single photon absorption of screw holes showed incomplete filling of the hole until 18 weeks after plate removal [32]. The recommendation in adults is therefore to avoid contact activities for 4 months after screw removal.

So conclusively, the literature reports no benefits with removed or retained hardware to prevent peri-implant or post implant removal fracture. Even with the implant in place, contact activities can be resumed. The decision to remove or retain hardware cannot be clearly decided solely on the basis of refracture risk; therefore, other factors ought to be considered.

Clinical outcome after implant removal

A frequent reason for implant removal is pain, prominence of hardware or impaired function due to the osteosynthesis material (Fig. 2). In a survey, Reith et al. analysed the reasons for implant removal in different locations in 332 patients [30]. Functional impairment was the main cause in 31%. Two third of this subpopulation showed functional improvement after hardware removal. Miller et al. analysed the functional result after plate and syndesmotic screw removal [26]. They found a significant functional improvement in range of motion, as well as higher Olerud and Molander Ankle scores at the immediate postoperative visit. Acklin et al. published similar results after plate osteosynthesis for proximal humerus fractures [1]. Elective hardware removal even after good plate placement initially showed significant functional improvement. But they concluded, that it remained unclear, if the functional improvement justifies hardware removal in all patients.

In literature, improvement rates concerning pain are more heterogeneous. One study analysed pain reduction after plate removal in malleolar fractures [9]. Although pain was generally decreased after hardware removal, nearly half of the patients

Fig. 2. Pre- and postoperative situation after plate osteosynthesis for a clavicle fracture and disturbing hardware.

continued to have pain even after hardware removal. Functional outcome scores were poorer for patients with pain overlying lateral ankle hardware than in those with no pain at this location. Reith et al. reported similar results after removal for pain on different body regions [30]. Of all patients analyzed, only 52% stated an improvement. Pain relief following tibia intramedullary nail removal is similarly unpredictable. Anterior knee pain often occurs after tibia nailing. Boerger et al analyzed anterior knee pain after hardware removal [7]. Only 50% of patients who were operated for anterior knee pain had improvement of their symptoms. However, 8% of patients who were previously asymptomatic developed anterior knee pain after tibia nail removal.

In conclusion, impaired function seems to be a better indicator for hardware removal than pain. Clinical scores generally increase after hardware removal for functional deficit. But the extent of pain relief varies after hardware removal and the surgeon must be cautious with the operative indication.

Metal allergy

In patients with a suspected adverse reaction from a metal implant, an allergic reaction to one of the metal components of the alloy is frequently suspected. The currently used alloys mainly encompass chromium-nickel alloys, chromium-cobalt alloys [37,39], and titanium [5,43]. The latter is used as pure titanium mainly or as alloys such as titanium-aluminum-vanadium or titanium-aluminum-niobium [43].

It should be kept in mind that all alloys contain traces of other metals such as manganese, molybdenum, iron, niobium, palladium, zirconium and ruthenium etc. [6]. Their relevance, however, appears to be low, due to very low sensitization rates, their presence in small amounts and no detectable release from the alloy if firmly bound.

In patient populations tested with the European patch test standard series where the three metals nickel, cobalt and chromium are included, as well as in the general population a high prevalence of contact sensitization to these metals has been determined [41]. Contact sensitization to nickel was approximately 25% in females and approximately 7% in males. To cobalt it was about 7% in females and about 5% in males, to chromium about 4% in both genders. Since these three metals are also often used in osteosynthetic materials, exposure may result in contact sensitization or in a contact allergic reaction in previously sensitized individuals and may lead to osteosynthesis-related problems. Contact allergy to titanium and its alloy metals aluminum, vanadium and niobium [6] is considerably