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TECHNICAL NOTE

# Technical difficulties in hardware removal in titanium compression plates with locking screws

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**Summary** With the advent of locking screws fixation devices, came new problems when removing internal fixation hardware. The objective of this study was to evaluate these problems and their possible solutions. The first problem was screws jamming on the plate, secondary to either initial poor screwing technique (with inadequate placement of the targeting device) or use of excessive force (when screwing in the screws without using the torque-controlling screwdriver). Treatment consists of destroying the screw heads using tungsten drills. The screw bodies can then be extracted using a trephine drill. The second problem involves destruction of the recess of the screw head. It can be secondary to overly forceful screw insertion or risky screw extraction. This can be treated using a specific conical left-turn screwdriver, assuming that the screw/plate thread is still intact. Finally, the screw recess can be filled. The plate itself may be a source of problems when being extracted because the screw holes left free also have been filled. Lever arm maneuvers to raise the fibrous bridges and substantial traction along the axis can be useful. These problems are more frequent with minimally invasive surgery. The consequences of this fixation type's hardware removal surgery are multiple: lengthened operative time, risk of secondary maximally invasive surgery, presence of metallic shavings residues in cases of screw head destruction, and the risk of iterative fracture secondary to trephine drill use. Prevention is thus essential. It is based on rigorous technique in placing the targeting device, drilling, and inserting screws, the systematic use of the torque-controlling screwdriver, and the verification of proper screw position. The locking compression plate (LCP) material is highly effective but its removal should not become challenging.
*Level of evidence:* Level V.


## Introduction

The locking compression plate system [LCP, Synthes®] is increasingly used in traumatology. The locking characteristic of the plate can result in specific problems compared to the classical screw fixation with a spherical head.

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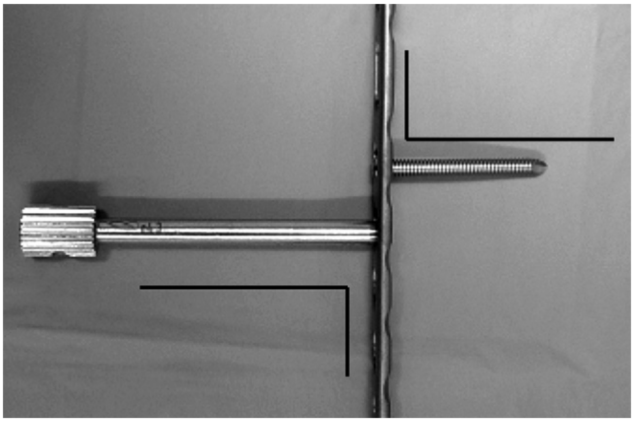

**Figure 1** Targeting device. Example of a large-fragment plate: targeting device, drilling and screwing in the axis, perpendicular to the plate.

This report aims to inventory the problems encountered in removing this material and the possible solutions. To our knowledge, two studies have reported clinical cases [1,2] but with no discussion of the problems encountered.

After reviewing the osteosynthesis material and the surgical technique, this report will describe each problem encountered, delineating the cause, its treatment, and preventive measures.

## Material

We have used the titanium LCP (Synthes®) material. The choice of this material was dictated by several considerations: it has a Young modulus closer to that of bone, postoperative CT follow-up was less perturbed, MRI was possible, and most particularly titanium has a certain elasticity that favored osteogenesis. The screws were mixed, standard, or locking and came in variable sizes (2.7, 3.5, 4.5, 5 mm). The plates often had an anatomical design. They frequently present with dual-purpose holes so that they could be used as a compression system (standard screw), as internal fixation (locking screw), or as a mixed system. Locking uniaxial screws to the plate requires using a targeting device, so that drilling and screw placement follow the same axis, most often perpendicular to the plate (Fig. 1). Precision in placing the targeting device is imperative [3]. The screws are placed in the drilling axis using the mandatory torque-controlled screwdriver. This surgery can be done via a minimally invasive approach [4], which makes the operative technique more delicate and increases the risk of occurrence of the problems described below.

## The problems encountered: explanation, treatment, prevention, consequences

The most frequent and the most challenging problem encountered is specific to this system locking the screw to the plate: jamming the screw in the plate. There are multiple causes. Jamming can be secondary to poor drilling orientation, itself secondary to poorly positioning the targeting device or not using a targeting device. The quality of screw placement depends on how accurately the targeting device is placed. When it is improperly introduced, drilling and screw insertion are imperfect and the screw appears to be locked but actually is not. This situation is encountered mainly for small-diameter targeting devices and screws. The most frequent cause of screw jamming is screwing the screw in too forcefully without using the torque-controlling screwdriver. Excessive force while inserting the screw leads to threading lesions on the screw head and the plate hole, independently of target device placement and drilling quality. The operative technique recommends systematic use of the torque-controlling screwdriver. In our experience, it was used insufficiently for small-diameter screws, which are more fragile, for the most part because the ancillary instrumentation was insufficiently familiar. Correcting this problem requires using a nonspecific material: a tungsten drill. The objective is to totally destroy the screw head and enlarge the plate's hole. A trephine drill can be used to extract the remaining screw body. This problem can be prevented by rigorous technique and respect of the ancillary instrumentation. The major risks are lengthening the operative time, the presence of titanium particles after destruction of the screw head, and a ''maximally invasive'' surgery. On small bones (fibula, ulna, radius), use of the trephine drill exposes the patient to the risk of postoperative iterative fractures as well as intraoperative fractures. Evaluating the risk—benefit ratio of removing the osteosynthesis material is essential.

The second problem encountered, nonspecific this time, stems from the destruction of the recess of the screw head. There are various causes: difficult screw placement, risky screw removal with problems identifying the screw, use of a worn screwdriver whose worn end damages the recess, a difference in the mechanical resistance between the screwdriver material and the titanium screw, and not using the torque-controlling screwdriver when inserting the screws. In addition, the substantial osteointegration of the titanium screws makes extraction extremely difficult, requiring greater stresses to be applied to the screw head. For locking screws, treatment requires either a specific conical left-turn screwdriver or tungsten drills. The standard screw can be removed using a tungsten drill. The conical left-turn extraction screwdriver (Fig. 2) introduced in the damaged screw head removes the screw using a reversed thread, which is possible because the external thread of the screw head, and consequently the screw-plate locking, is intact. Georgiadis et al. [2] proposed an original solution for situations in which the conical left-turn extraction screwdriver is not effective: cutting the plate around the screw. Our experience has centered on more malleable titanium material, with the screw head recess subject more easily damaged. This raises the question of the titanium screw/classical screwdriver given the difference in rigidity of the two materials. The recess lesion is amplified with use of a screwdriver whose tip is worn, preventing proper purchase. To our knowledge, no problems have been encountered in removing screws with StarDrive-type recesses. This problem can be prevented by using the stainless steel LCP system and systematic use of StarDrive recesses. The consequences in case of recess lesions are similar to those with jammed screws: lengthening operative time and the risk of maximally invasive surgery.

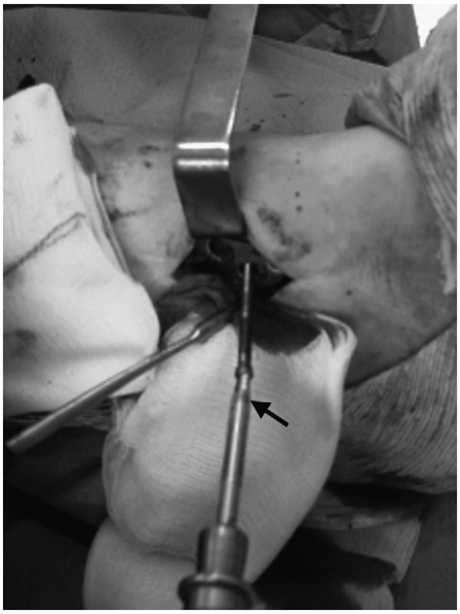

**Figure 2** Use of a conical left-turn extraction screwdriver (arrow), to remove a screw with a destroyed screw head but with intact screw and plate threading.

Screw head recess filling (with bone or fibrous tissue) is encountered for all types of screw and is not specific. Cleaning is indicated, but caution should be exercised so as not to damage the screw head. If it is damaged, it can be treated either with a tungsten drill or a conical left-turn extraction screwdriver, depending on the condition of the screw/plate thread. Finally, at times the operator may find the screw head recess filled with the broken tip of the screwdriver. We have observed two such cases (StarDrive screwdriver for 2.7-mm screws on distal radius plates).

Finally, plaque removal itself can be a source of problems. This is not specific to the material but rather to how the locking compression plates, placed with a minimally invasive approach, are used, notably in the lower limb. Postoperative rehabilitation requires precise mechanical load specifications for the limb to bear weight: use of a long locking compression plate with well-spaced screws to allow absorption and distribution of the stresses [5]. The problem of removing these plates is secondary to free hole filling (Fig. 3). Lever arm maneuvers must be done via the screw approaches to raise fibrous bridges and to exert strong traction in the axis through the main approach after having rasped the deep side of the plate (Fig. 4). The essential risk is increasing the size of the approach openings.

## Discussion

Prevention is certainly the most effective treatment. The surgical technique should be rigorous and the material placement rules respected. The targeting device should be used systematically with no resistance, most often placed perpendicular to the plate. The self-tapping screws should follow this axis and be properly placed. They are most often perpendicular and flush with the plate. Intraoperative radioscopic guidance can be used should there be any doubt, notably during minimally invasive surgery.

**Figure 3** Filling of the free holes on a small-fragment locking compression plate (LCP).

Screws should be placed using a torque-limiting screwdriver, limiting tightening stresses and the risk of damaging the screw head recess and the screw/plate thread. This is all the more true when titanium components are used. The torque that should not be exceeded depends on the screw diameter: for a 5-mm screw, the torque should not

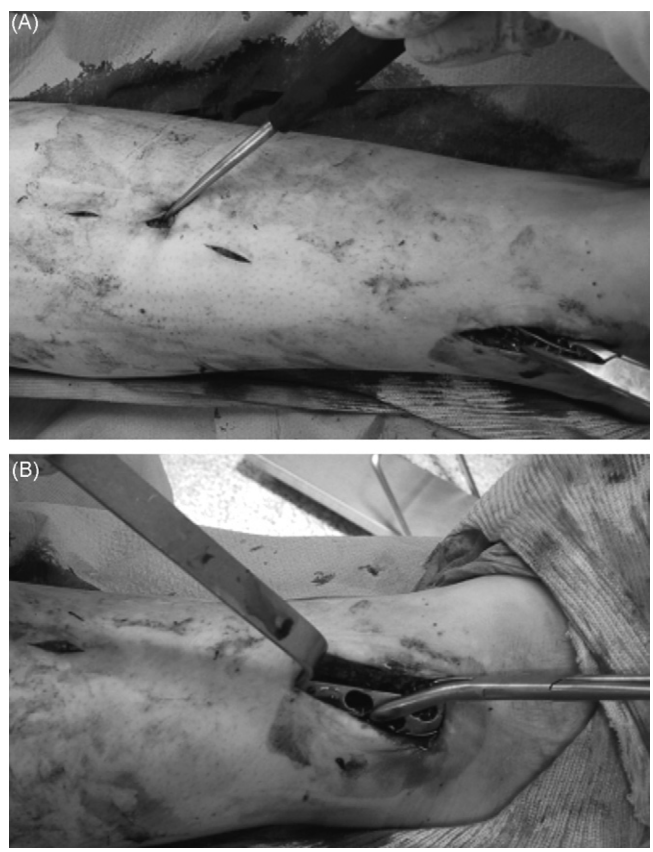


**Figure 4** Removal of a locking compression plate (LCP) placed through a medial minimally invasive approach at the distal tibia. A. A lever arm maneuver to remove the free hole with fibrous bridges. B. Strong traction in the plate axis, with all adherences released.

exceed 8 N m. For 3.5-mm screws, torque between 4 and 6 N m is the cause of approximately 10% of the damaged screws (in laboratory conditions) after iterative tightening/loosening. Torque-controlled screwdrivers are therefore set to lower values: for 5-mm screws, they are set to 4 N m, for 3.5-mm screws they are set to 1.5 N m, and for 2.7-mm screws, 0.8 N m. In addition, surgical technique recommends using a screwdriver that is in good condition when the screws are removed. According to laboratory tests, tightening—loosening—tightening does not increase the risk of jamming if a good-quality torque-controlled screwdriver is used and proper technique is respected.

The metal also has a certain responsibility in the problems here. Does use of stainless steel screws and plate eliminate the problems encountered in removing this osteosynthesis material?

For the direct destruction of the screw head recess, this is certainly true. With a more malleable material such as titanium, using a worn screwdriver potentiates the risk of lesion. In addition, the microstructure of the screw surface in titanium was designed to obtain bone attachment over the entire surface of the implant. The hold is optimal and the force required for extraction is greater. The risk of damaging the screw head recess is increased.

For screws jamming to the plate, the response is more difficult. Imperfect surgical technique is often the cause. The majority of jammed screws are 3.5-mm screws that are rarely screwed in using a torque-controlled screwdriver. We have already said this and repeat it here: use of torque-controlled screwdrivers is essential. Noncompliance with this recommendation risks damaging the threads with excessive tightening. Laboratory tests have not demonstrated screw jamming with the torque values indicated in the operative technique and with new instruments. In addition, cold fusion, an argument that has been raised, does not exist in the metallurgic sense of the term in the context of screws locked into the plate. Titanium alone does not seem to explain the problems encountered. It is the accumulation of technical errors that should be implicated.

## Conclusion

The LCP system is an effective material, but removal can be laborious and challenging. Prevention with thorough knowledge of the surgical technique and of the material is the best treatment. Removing osteosynthesis material is a delicate and difficult intervention and the indications should be carefully considered. Finally, the adapted and specific material for removal of jammed screws should be thoroughly familiar to the surgeon and available for use.

## Conflict of interests

None.

## References

[1] Hamilton P, Doig S, Williamson O. Technical difficulty of metal removal after LISS plating. Injury 2004;35:626—8.
[2] Georgiadis GM, Gove NK, Smith AD, Rodway IP. Removal of the less invasive stabilization system. J Orthop Trauma 2004;18:562—4.
[3] Stoffel K, Dieter U, Stachowiak G, Gachter A, Kuster MS. How can stability in locked internal fixators be controlled? Injury 2003;34:11—9.
[4] Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P, Tscherne H. Minimally invasive plate osteosynthesis: does percutaneous plating disrupt femoral blood supply less than the traditional technique? J Orthop Trauma 1999;13:401—6.
[5] Ehlinger M, Cognet JM, Simon P. Traitement des fractures fémorales sur matériel par voie mini invasive et remise en charge immédiate : apport des plaques à vis bloquées (LCP). Série préliminaire. Rev Chir Orthop 2008;94:26—36.