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ORIGINAL PAPER

# Less is more: lag screw only fixation of lateral malleolar fractures

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**Abstract** Displaced fractures of the lateral malleolus are typically treated with plate osteosynthesis with or without the use of lag screws, and immobilisation in a plaster cast for up to 6 weeks. Fixation through a smaller incision with less metal, such as lag screw only fixation, would theoretically lead to decreased infection rates and less irritation caused by hardware. The purpose of this study was to evaluate the benefits and success of lag screw only fixation of the lateral malleolus in non-comminuted oblique fractures of the lateral malleolus. A total of 25 patients who had non-comminuted unstable oblique fractures of their lateral malleolus that had been surgically fixed with lag screws only were retrospectively evaluated. All patients were younger than 60 years of age. Evaluation of the success of fixation, complications, resultant mobility and patient satisfaction was based on information gathered from chart reviews, X-ray findings and a standardised questionnaire based on the AOFAS Foot and Ankle Outcomes Questionnaire. These results were compared to an age-matched group of 25 consecutive patients treated with plate osteosynthesis. Of the 25 patients fixed with lag screws, nine had an unstable fracture of the lateral malleolus only, ten were bimalleolar fractures and six were trimalleolar. Eighteen patients were treated with two lag screws, and seven were treated with three lag screws. The bi- and trimalleolar fractures were treated with standard partially threaded cancellous screws. None of the lag screw-only group lost reduction. There were no documented wound infections in the lag screw group as compared to three deep infections in the plate group. Lag screw-only patients reported no palpable hardware as compared to 50% of the plate group. AOFAS scores at a mean of 12 months post-operative were similar in both groups. Lag screw only fixation of the lateral malleolus is a safe and effective method that has a number of advantages over plate osteosynthesis, in particular less soft tissue dissection, less prominent, symptomatic and palpable hardware and a reduced requirement for secondary surgical removal.

**Résumé** La fixation des fractures déplacées de la malléole externe est habituellement traitée par une plaque d'ostéo-synthèse avec ou sans vis malléolaires et immobilisation par un plâtre, pendant six semaines. La fixation par une petite incision avec un matériel moins invasif et une fixation avec vis malléolaires isolées peut théoriquement diminuer le taux d'infection et diminuer la gène au niveau du matériel. Le propos de cette étude est d'évaluer les bénéfices et le succès des vis malléolaires isolées dans les fractures obliques de la malléole externe. 25 patients avec une fracture oblique instable de la malléole externe ont été traités chirurgicalement par des vis malléolaires avec une évaluation rétrospective. Tous les patients étaient âgées de moins de 60 ans et, évalués, sur le plan clinique radiographique et par un questionnaire standardisé de l'AOFAS du pied et de la cheville. Enfin, le questionnaire devait évaluer le succès de la fixation, les complications, la morbidité et la satisfaction des patients. Ces résultats ont été comparés à un groupe de 25 patients consécutifs traités par plaques. Résultats : sur les 25 patients traités par vis malléolaire, 9 avaient une fracture instable de la malléole externe, 10 une facture bi-malléolaire et 6 une tri-malléolaire. 18 ont été traités avec deux vis malléolaires et 7 avec trois vis malléolaires. Les fractures bi et tri-malléolaires ont été traitées de façon standard par des vis spongieuses. Aucune des vis malléolaires n'a entraîné de pertes de réduction. Il n'y a pas eu d'infection dans le

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groupe vis malléolaires alors qu'il y a eu trois infections profondes avec le groupe traité par ostéosynthèse par plaques. Les vis malléolaires isolées n'ont pas entraîné de gêne alors que 50% des patients traités par plaques présentent une gêne à ce niveau là. Le score de l'AOFAS à 12 mois a été similaire dans les deux groupes. En conclusion, l'utilisation de vis malléolaires isolées est un procédé sûr de fixation de la malléole externe et présente des avantages par rapport à l'ostéosynthèse par plaque notamment en ce qui concerne un abord mini invasif, l'absence de gêne au niveau du matériel et une ablation de matériel facilitée.

## Introduction

In spite of a general perception that the functional recovery after operative treatment of ankle fractures is predictably good, there is mounting evidence to suggest that post-injury disability is measurable and significant, persisting for at least the medium term [4, 9]. Health outcome and quality of life research has demonstrated reduced physical function and general health scores in patients following internal fixation of ankle fractures compared to matched population norms for at least 2 years. Although multi-factorial in aetiology, with social and occupational factors having a significant impact, between 17 and 24% of patients may have a less-than-satisfactory long-term outcome with residual physical effect [2].

The surgical priority in the management of unstable ankle fractures is to re-establish joint congruency. This is achieved through restoration of the anatomical ankle mortise with reduction of lateral talar shift and correction of fibular length and rotation. Failure to address these issues has been shown to correlate with poor outcome and to pressage the development of post-traumatic osteoarthritis [21, 22].

The philosophy of open anatomical reduction and rigid internal fixation using lateral plate osteosynthesis with or without lag screws to achieve inter-fragmentary compression has been the conventional and gold standard treatment of such injuries. However, the bulk of a fibular plate and the minimum amount of soft tissue over the lateral malleolus may contribute to a situation where infection, dehiscence or wound edge necrosis can occur. Prominent laterally applied hardware is frequently symptomatic and postero-lateral plate osteosynthesis has been associated with troublesome peroneal tendonitis [16, 19, 25].

It is unclear if the particular technique adopted to operatively fix an ankle fracture can influence the results of the treatment. A study examining the influence of peri-operative soft tissue complications after open reduction and internal fixation of closed ankle fractures demonstrated that major soft tissue complications have a negative effect on the long-term functional outcome [13]. If a particular approach were to be associated with less soft tissue complications, it could confer a superior functional result for patients treated by that method.

In tandem with the move towards less invasive surgical approaches in other areas of orthopaedic surgery, there have been a number of studies in the literature examining the results of operatively treated fibular fractures using alternative techniques, such as cerclage wiring supplemented with lag screws, intra-medullary and bio-absorbable fixation [2, 3, 7]. The rationale for adopting these more conservative approaches has been to respect the integrity of an often already compromised soft tissue envelope and hence to minimise the "second hit" of surgery. The potential advantages include the need for less extensive dissection, smaller amounts of foreign material in situ and, possibly, shorter operating time [17].

While many of these less rigid fixation modalities do not permit early mobilisation, there is limited evidence regarding it's benefit, both in relation to the lack of effect on long-term outcome and the possibility of increased local wound complications [10, 19, 24]. In our own unit, patient factors, in particular concerns regarding poor compliance with non-weight bearing and other post-operative restrictions, has led us to adopt a less aggressive approach towards mobilisation following internal fixation of ankle fractures. Regardless of the mode of fixation, we prefer to treat most patients in a cast for at least 4–6 weeks following surgery.

It has been the perception of the senior author (TB) that the potential for greater local complications arising as a result of plate osteosynthesis of unstable lateral malleolar fractures, namely a greater risk of soft tissue- and hardware-related problems, outweigh the benefits of rigid internal fixation. To further test this hypothesis, we conducted a retrospective study to compare the results of plate osteosynthesis with lag screw only fixation of such fractures.

## Materials and methods

This is a retrospective comparative study of operative-treated, closed Lauge-Hansen supination-external rotation (SER) IV ankle fractures. Twenty-five consecutive patients who had undergone lag screw only fixation of lateral malleolar fractures were matched by age and sex to 25 patients with fractures of similar morphology who had undergone open reduction and internal fixation using lag screw inter-fragmentary compression and laterally applied neutralising plate osteosynthesis. The study included all fractures occurring from December 2003 until June 2005 with a mean follow-up following surgery of 13 months and

a minimum follow-up of 6 months. All cases with lag screw–only fixation were operated on by, or under the direct supervision of the senior author. The patients who had been treated with plate osteosynthesis were operated on either by other orthopaedic consultants in the unit or junior doctors under the direct supervision of those consultants.

In order to be selected as suitable for lag screw only fixation, the fibular fracture morphology needs to be of a simple oblique or spiral pattern with no bony comminution at the fracture site. In addition, the fracture itself must to be of sufficient length to accept at least two screws placed 1 cm apart and orthogonal to the fracture line. The surgical technique adopted by the unit for lag screw fixation was that recommended by the AO/ASIF group: lateral incisions are placed over the anterior edge of the fibula at the fracture site, and soft tissue dissection is kept to a minimum. The fracture is reduced anatomically, and two or three stainless steel lag screws, typically either partially threaded cancellous screws or 3.5-mm cortical screws in lag mode, are inserted in the anterior-posterior direction.

Regional osteoporosis is a relative contra-indication to this method of fracture treatment, consequently we have not treated any patient over 55 years of age with lag screw only fixation. Ankles with an associated medial malleolar fracture were treated in a standard fashion with screw fixation. In all cases, any deltoid ligament damage was treated closed, assuming the mortise was reduced as demonstrated by a medial clear space of less than 4 mm.

Post-operative immobilisation in both groups consisted of a below-knee cast worn for a total period of 6 weeks. Partial weight-bearing was permitted after 4 weeks with progression to full weight-bearing at 8 weeks.

The patients' clinical notes were reviewed with particular reference to any complications encountered, ongoing symptoms and the need for secondary treatment or surgery. A radiological review was carried out examining the quality of the initial reduction and final fracture healing. Finally, patients were administered the Foot and Ankle Outcomes Questionnaire which is a standardised questionnaire developed in conjunction with the American Academy of Orthopaedic Surgeons, based on version 2.0 of the Foot and Ankle Outcomes Instrument [14]. It consists of 25 questions relating to patients' stiffness, pain, stability, ability to wear shoes and ability to exercise. Both a Foot and Ankle Core Scale Score and a Shoe Comfort Score are generated. All statistical analyses were performed using SPSS ver. 11.0 statistical software (SPSS, Chicago, Ill.).

## Results

The patient and fracture characteristics were similar in the two groups (Table 1). All lateral malleolar fractures united with an anatomically reduced ankle mortise. Complications occurred more frequently in the group treated with plate osteosynthesis: four patients (16%) developed wound infections that required treatment with antibiotics as compared to none in the lag screw-only group; five patients in the plate osteosynthesis group required additional surgery (three for removal of metal, one for wound debridement and removal of metal, one for debridement and skin grafting) (Table 2).

The response rate to the patient administered questionnaire was 68%. Eight patients in the plate group reported palpable metal as compared to only one in the lag screw group (chi-square test $p$-value 0.015). Although patients in the lag screw-only group reported similar levels of lateral ankle pain after treatment, the duration of pain was significantly less in the lag screw group: less than 3 months once mobilisation commenced as compared to 6 months in the plate group (Fig. 1).

**Table 1** Patient and fracture characteristics

| | Lag screw only | Plate osteosynthesis |
|---|---|---|
| Age (years) | 16–55 (mean: 37.9) | 14–59 (mean: 37.3) |
| Male:female | 20:5 | 17:8 |
| Mean follow-up (months) | 12 (range: 7–26) | 13 (range: 6–26) |
| Type of fracture: | | |
| Lateral Malleolus Only | 9 | 12 |
| Bi-malleolar | 10 | 5 |
| Tri-malleolar | 6 | 8 |
| Questionnaire – respondents | 18/25 (72%) | 16/25 (64%) |

**Table 2** Results of questionnaire

| | Lag-Screw Only | Plate Osteosynthesis | $p$-value |
|---|---|---|---|
| Palpable metal | 1/18 (5%) | 8/16 (50%) | 0.015 (chi-Square) |
| Complications | | | |
| Additional surgery | 0 | 5/25 (20%) | 0.023 (chi-Square) |
| Infection | 0 | 4/25 (16%) | <0.001 (Fisher's exact test) |
| Foot and Ankle Questionnaire Scores | | | |
| Core Standardized Mean Score | 86 | 76 | =0.02 (Students Independent $t$-test) |
| Shoe Comfort Standardized Score | 74 | 60 | =0.211 (Students Independent $t$- test) |

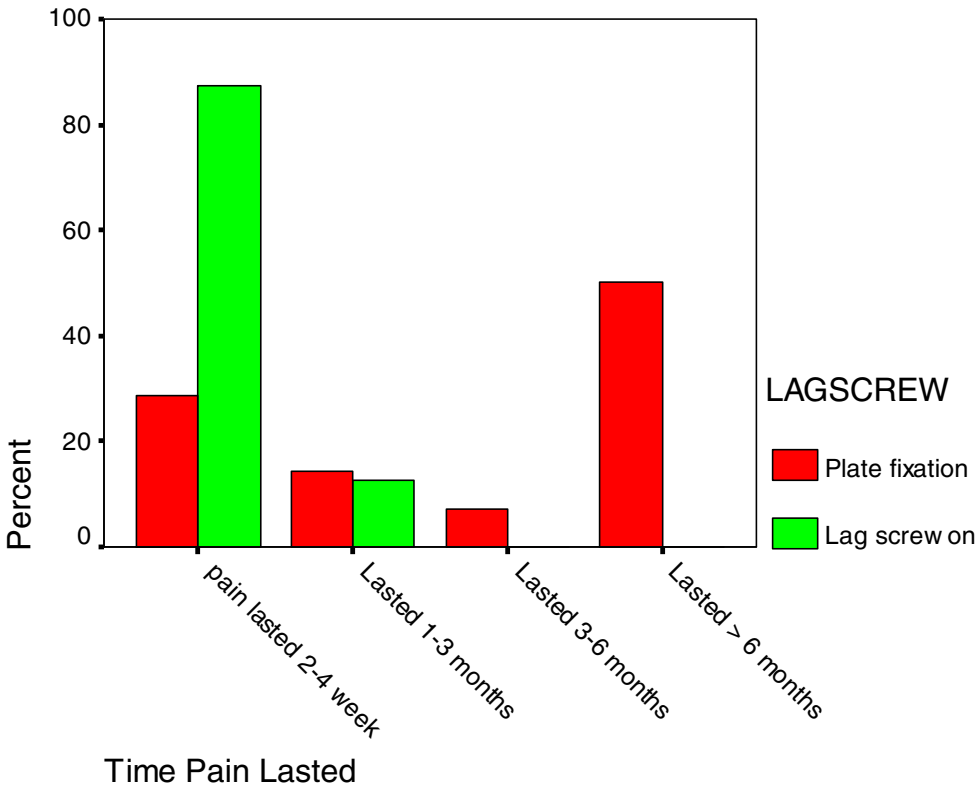


**Fig. 1** Bar chart comparing the duration of lateral ankle pain in patients in the two groups. (Pearson chi-Squared $p$=0.004)

A proven algorithm for the Foot and Ankle Outcomes Questionnaire generated Standardised scores such that a "0" represents a poor outcome/worse health while "100" is the best possible outcome/best health [14]. Standardised scores from the Foot and Ankle Outcomes Instrument demonstrated a significant difference between the two groups. Lag screw-only treated patients had an average score of 86 as compared to 76 for the plate osteosynthesis group ($p$-value <0.05) (Fig. 2). Shoe Comfort Scores between the two groups also showed differences (standardised score of 52 in the lag screw-only group as compared to 45 in the plate osteosynthesis group), but these were not significant.

## Discussion

This study has shown that in selective cases lag screw only fixation of fibular fractures is an attractive alternative to plate osteosynthesis. Performing an open reduction allows the surgeon to achieve the anatomical reduction shown to be integral to a good outcome [22]. It also permits direct visualisation of the fracture personality, avoiding the inappropriate application of the technique of limited internal fixation and the attendant complications which have been described [20]. We feel this represents a direct advantage over other less invasive forms of fixation that have been described, such as percutaneous intramedullary fixation either using a screw or Knowles pin [17].

While limited fixation is biomechanically weaker than lateral or postero-lateral plate osteosynthesis [3, 25], the absence of any loss of fracture reduction in the present series suggests that while not absolutely rigid, fracture fixation is clearly stable. We have found no evidence to suggest that this less rigid fixation compromises fracture healing or clinical outcome.

A potential disadvantage of less rigid fixation is the necessity for cast immobilisation following surgery. However, although a number of studies have demonstrated better short-term functional outcome and a quicker return to a normal symmetrical pattern of gait following early mobilisation, no study has proven that an improved final outcome is positively correlated with an accelerated rehabilitation regime [10, 12]. The trade-off for early mobilisation may in fact be a higher incidence of local wound complications and a slight increase in fracture instability and equinus contracture [1, 9, 18].

In all cases, standard small fragment AO stainless steel screws were used to achieve compression. While bio-absorbable screws could have been employed, the anticipation of a low need for metal removal and the additional implant-related costs which would be incurred discouraged us from doing so. In addition, there is still a lingering concern regarding the occurrence of foreign body reactions as a result of using bio-absorbable implants. The incidence

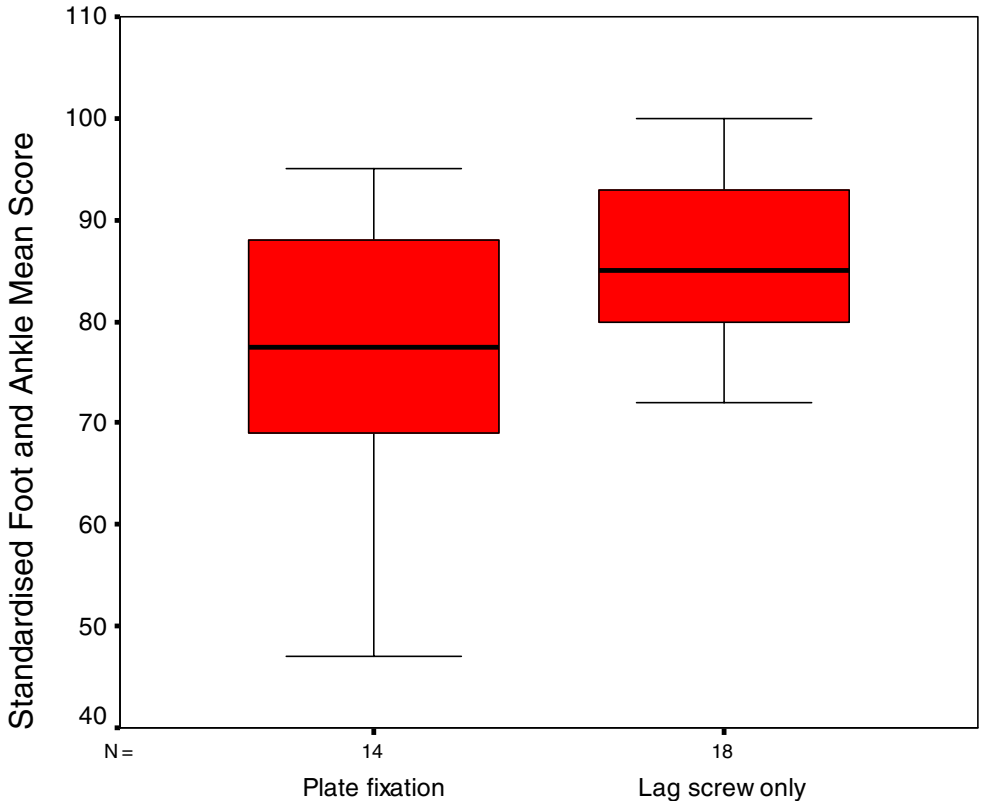


**Fig. 2** Boxplot of Standardized Foot and Ankle Mean Score between the two groups. There was a significant difference between lag screw only fixation group and the plate osteosynthesis group, as demonstrated by independent Student's *t*-test ($p$=0.02)

rates of such reactions has been reported to be 6.1% following the fixation of ankle fractures [5, 11], with the reactions ranging from the development of mild local inflammation to cases of extensive osteolytic lesions with moderate to severe osteoarthritic changes supervening as a result in 0.8% of patients.

There have been two previous studies published in peer-reviewed journals which have analysed the outcome of lag screw only fixation of ankle fractures. Kim et al. prospectively followed 72 consecutive patients with Danis-Weber type B fractures treated with open reduction and internal fixation using two cortical lag screws. Although there was no comparison group, the clinical outcome was found to be satisfactory in 93% of the cases. These authors cited the benefits of avoiding plate osteosynthesis as including less potential for cartilage damage caused by penetration of the ankle joint, reduced periosteal dissection and a lower likelihood of requiring hardware removal. [15]. In a study similar to the one presented here, Tornetta et al. reported good results following lag screw only fixation with no soft tissue complications in the study group when compared to a historical group of controls. The patients also reported less lateral pain and less palpable hardware, and no patient had required lag screw removal at a mean follow-up of 1.6 years [23]. The reduced demand for secondary surgery has obvious cost implications.

With regard to the issue of hardware removal, Brown et al. found that only 50% of patients with symptomatic prominent lateral hardware benefitted from removal. Although there was a significant reduction in visual analogue pain score following removal of the hardware, there was no difference in general health and disease-specific scores between those who had and had not undergone metal removal. Patients with lateral pain due to hardware had lower post-operative scores than those without, irrespective of whether or not the metalwork had been removed [6].

A particular concern that came to light in the present series was the unexpectedly high rate of infection that occurred in the plate osteosynthesis group, with a superficial infection occurring in one and a deep infection occurring in three of the 25 patients. While this incidence may be anomalous – i.e. a product of the relatively small sample size – the fact that infection only occurred in the plating group lends credence to our hypothesis that the increased metal burden and greater soft tissue dissection necessary during plate osteosynthesis will lead to higher rates of infection. A potential cofactor is the fact that approximately 50% of ankle fractures treated in our unit have occurred in patients initially treated in and referred from other institutions. Carragee et al. have previously highlighted the potential adverse effect on outcome of the inter-hospital transfer of patients with ankle fractures [8]. Delayed surgical treatment and acceptance of residual subluxation in cases of fracture-dislocations treated initially by those with limited orthopaedic expertise may lead to

further compromise of the traumatised soft tissue envelope and hence more frequent wound complications.

We acknowledge the methodological flaws with the present study. Retrospectively, it was not possible to examine the decision-making processes that led to specific fractures being treated with either form of fixation. Also, in the majority of cases, the clinical histories did not contain definite comments on the bone quality at the time of fixation and, hence, the appropriateness of the fixation used.

## Conclusion

Our study has shown that when a patient has suffered a simple oblique or spiral fracture of the lateral malleolus and has good bone quality, lag screw only fixation is preferable to plate osteosynthesis. The lag screw method has several advantageous characteristics over that of plate osteosynthesis including, in particular, less soft tissue dissection, less prominent, symptomatic and palpable hardware and a reduced requirement for secondary surgical removal.

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