

Pin loosening and infection are the major post-operative complications in external fixation. Progressive mechanical deterioration of the bone-pin interface is an inevitable result of fixation with standard pins, regardless of type. This deterioration can lead to pin loosening, thereby contributing to infection of the pin tract. Thus, external fixation is a continual juxtaposition between the growing stability provided by callus maturation and the destabilizing effect of pin loosening.^{1,2}

Measurement Of Pin Loosening

The most precise method to quantify pin loosening is to measure the extraction torque of a pin and compare this measurement with the corresponding insertion torque.^{3,4} A pin extraction torque lower than the corresponding insertion torque is indicative of pin loosening.^{4,5}

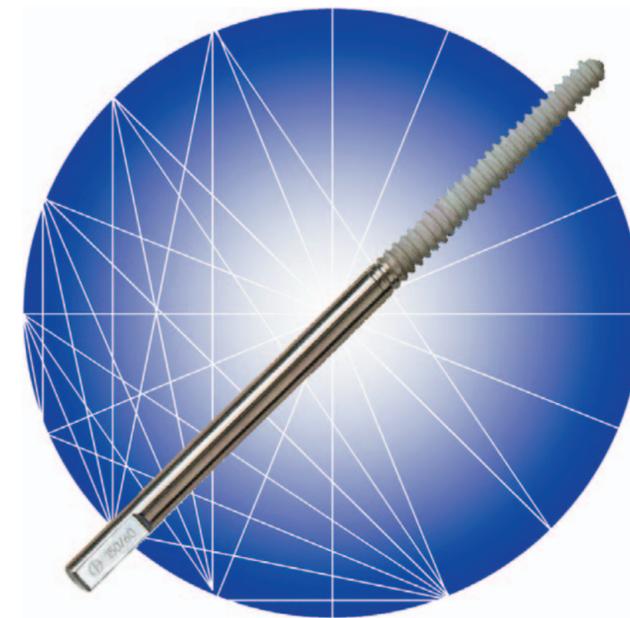
In an animal study, the extraction torque of standard tapered pins decreased by 80% at twelve weeks when compared to the corresponding insertion torque.⁵ In a clinical study on tibial fractures, the extraction torque of Apex and Superfixation pins decreased by 83% and 93% respectively at twenty-three weeks, compared to the corresponding insertion torque.³

Causes Of Pin Loosening And Infection

Bone-pin fixation is dependent on the integrity of the bone-pin interface. The primary causes of pin loosening and infection are thermal and mechanical damage to the bone during pin insertion and the subsequent fibrous tissue interposition at the bone-pin interface.⁶

Solution

To improve bone-pin osteointegration and bone-pin fixation, OsteoTite[®] tapered pins coated with hydroxyapatite have been developed.^{6,7,8,9}



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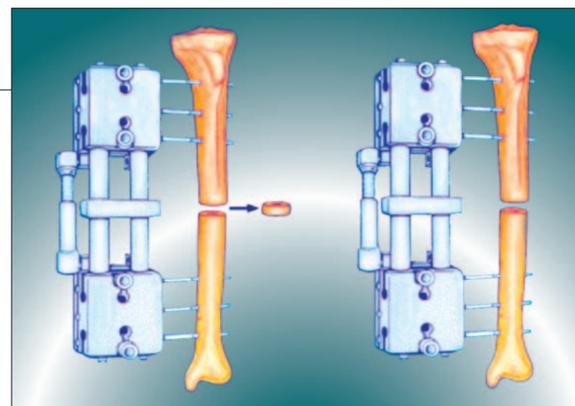
Pin Loosening and Infection are No Longer a Challenge

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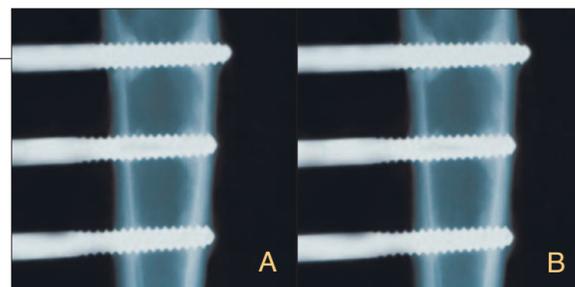
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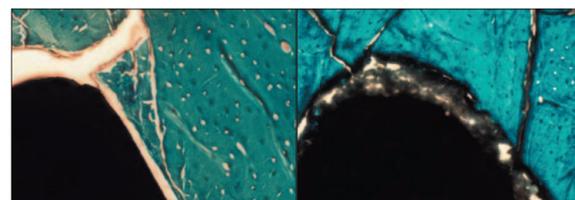
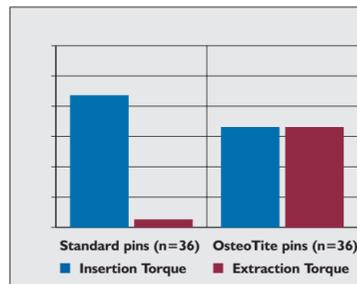
Thirty-six standard pins and thirty-six OsteoTite pins were implanted in the tibiae of two paired groups of sheep and a unilateral external fixator was mounted on the pins.⁶ Each sheep received either OsteoTite or standard pins. To ensure high load at the bone-pin interface, a five-millimeter resection osteotomy was performed in the tibial mid-diaphysis.



At six weeks, x-rays showed significant pin loosening in the standard pins (A), while the OsteoTite pins appeared well osteointegrated (B).



Pin extraction torque was thirteen times higher in the OsteoTite pins ($p=0.002$). In the standard pins, a significant deterioration of the bone-pin interface strength was observed, as demonstrated by an extraction torque seventeen times lower than the corresponding insertion torque ($p<0.001$). No deterioration was observed in the OsteoTite pins. The duration of fixation was found within the period studied.

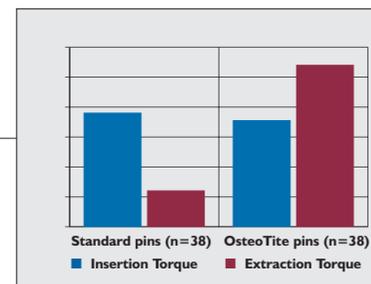


Histology revealed bone resorption and wide gap at the bone-pin interface with the standard pins (A). With the OsteoTite pins, extensive and direct bone-pin contact without fibrous tissue interposition was observed (B).

R A N D O M I Z E D S T U D Y

Knee Hemicallotasis

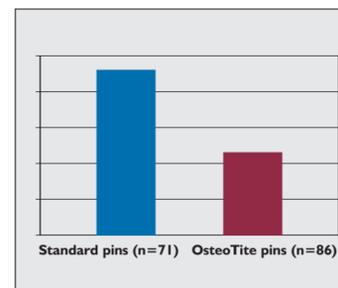
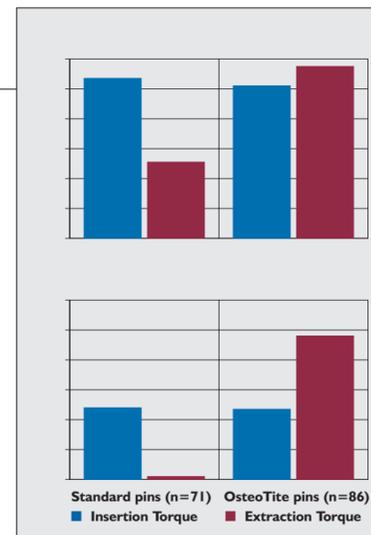
Thirty-eight standard and thirty-eight OsteoTite pins were implanted in two paired groups of patients treated by hemicallotasis for osteoarthritis of the knee.⁷ Each patient received either standard or OsteoTite pins. All pins were removed without hospitalization, sedation, or anesthesia. Extraction torque of the OsteoTite pins was four times higher than that of the standard pins ($p<0.001$). With OsteoTite pins, no correlation between extraction torque and the duration of fixation was found.



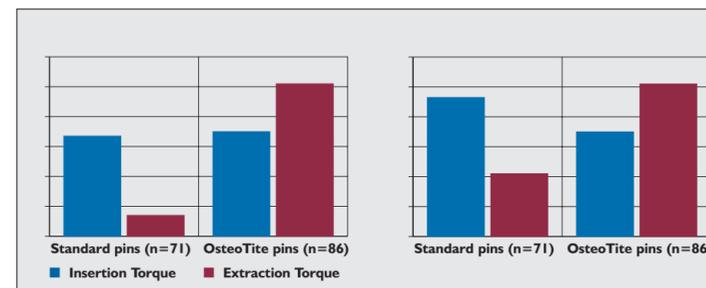
Femoral and Tibial External Fixation

Standard and OsteoTite pins were implanted in patients treated with femoral or tibial external fixation.⁸ Eighteen patients received seventy-one standard pins and twenty patients received eighty-six OsteoTite pins.

In both cortical and cancellous bone, extraction torque of the OsteoTite pins was higher than the standard pins ($p<0.001$). Furthermore, a deterioration of the bone-pin interface strength was observed with the standard pins ($p<0.001$), whereas an improvement of the bone-pin interface strength was observed with the OsteoTite pins ($p<0.04$). These findings were more evident in cancellous than in cortical bone.



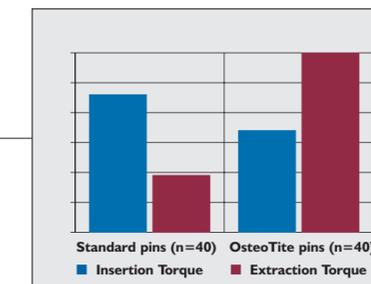
Pin tract infection rate, measured according to the Checketts and Otterburn classification¹⁰, was significantly lower with OsteoTite pins than with standard pins.



When standard pins were removed from infected pin tracts, a lower extraction torque than those removed from uninfected pin tracts was observed ($p<0.0001$). However, with the OsteoTite pins, there was no difference in extraction torque between the pins extracted from the infected or uninfected pin tracts. These results demonstrate that even in the presence of pin tract infection, the anchorage of OsteoTite pins is not compromised.

Osteoporotic Wrist Fractures

Forty standard pins and forty OsteoTite pins were implanted in two paired groups of female osteoporotic wrist fracture patients treated with external fixation.⁹ Extraction torque of the OsteoTite pins was three times higher than the standard pins ($p<0.0001$). Significant deterioration of the bone-pin interface strength was observed with the standard pins, as demonstrated by a lower extraction than insertion torque ($p=0.001$). An increase in fixation strength was observed with the OsteoTite pins, as confirmed by a higher extraction than insertion torque ($p=0.001$). Pain during pin removal was assessed, and no difference between the two groups was observed.



Conclusions

Regardless of study design, pin loosening was avoided and pin tract infection minimized with OsteoTite pins. The osteoconductive properties of hydroxyapatite promote bone remodelling, resulting in optimal pin osteointegration without fibrous tissue interposition. Additionally, strength and stability of the bone-pin interface are increased and pin tract infection rates reduced. With OsteoTite pins, pin anchorage was maintained even in long duration treatment, in cancellous bone, in osteoporotic bone, and in the presence of infection of the bone-pin tract. OsteoTite pins represent a tremendous advance in the reliability of external fixation.

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