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Effect of low speed drilling on osseointegration using simplified drilling procedures

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Abstract

Our aim was to find out whether simplified drilling protocols would provide biological responses comparable to those of conventional drilling protocols at the low rotational speed of 400 rpm. Seventy-eight root form endosseous implants with diameters of 3.75, 4.2, and 5 mm were placed into canine tibias and allowed to heal for 3 and 5 weeks. After the dogs had been killed, the samples of implanted bone were retrieved and processed for non-decalcified histological sectioning. Bone-to-implant contact (BIC) and bone area fraction occupancy (BAFO) analyses were made on the histological sections. Implants treated by the simplified protocol resulted in BIC and BAFO values comparable to those obtained with the conventional drilling protocol, and there were no significant differences in the technique or diameter of the drilling. The results suggest that the simplified procedure gives biological outcomes comparable to those of the conventional procedure.

Keywords: Drilling protocol; Simplification; Low-speed; Osseointegration; Histomorphometry

Introduction

Various factors such as surface of the implant, material, shape, length, diameter, mechanical and loading conditions, and surgical technique can influence the improvement in, or inhibition of, osseointegration.[1–3] Although much research has been published about the biocompatibility, design, surface, and loading conditions of implants, the inadequacy of investigations into surgical technique has led clinicians to follow instructions directly from the manufacturers, which at times are not based on scientific evidence.

The favourable outcome is to obtain good primary stability of the implant, which is a prerequisite for osseointegration.[4,5] The precise definition of primary stability has been widely discussed,[6] but minimisation of micromotion is known to be of great importance during the initial stages of osseointegration.[7] Previous studies have shown that micromotion above 150 μm leads to encapsulation by fibrous tissue, resorption of bone, and inhibition of the growth of osteoblasts that may hinder wound healing.[8,9] Initial good primary stability of the implant after insertion provides a basis for osteoconduction and subsequent bone modelling and remodelling, which can be described as biological, or secondary, stability.[10] It is therefore of great interest to

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investigate the optimal bone-implant interactions in the initial phases of bony healing, which may be influenced by factors other than the topography of the surface of the implant.

Previous investigations have reported that simplification of the traditional gradual expansion drilling protocols results in apposition of bone to the implant that is comparable with that of the traditional protocols.[1,11] The simplification of drilling not only provides stable osseointegration, but also significantly shortens the total operating time from incision to closure, and shorter operating time leads to fewer postoperative complications.[12]

Another important aspect of surgical technique is the effect of drilling speed during osteotomy, as it has been thought to affect the biological condition of the surrounding bone and the accuracy of the osteotomy. In some studies it has been suggested that low drilling speeds generate more heat than high drilling speeds, as there is a tendency for the surgeon to increase the vertical compression while drilling.[13–15] It has also been suggested that a low drilling speed may have the potential to increase the wobble, and possibly result in overpreparation of the osteotomy site.[16,17] On the other hand, an excessive drilling speed may also generate heat that could

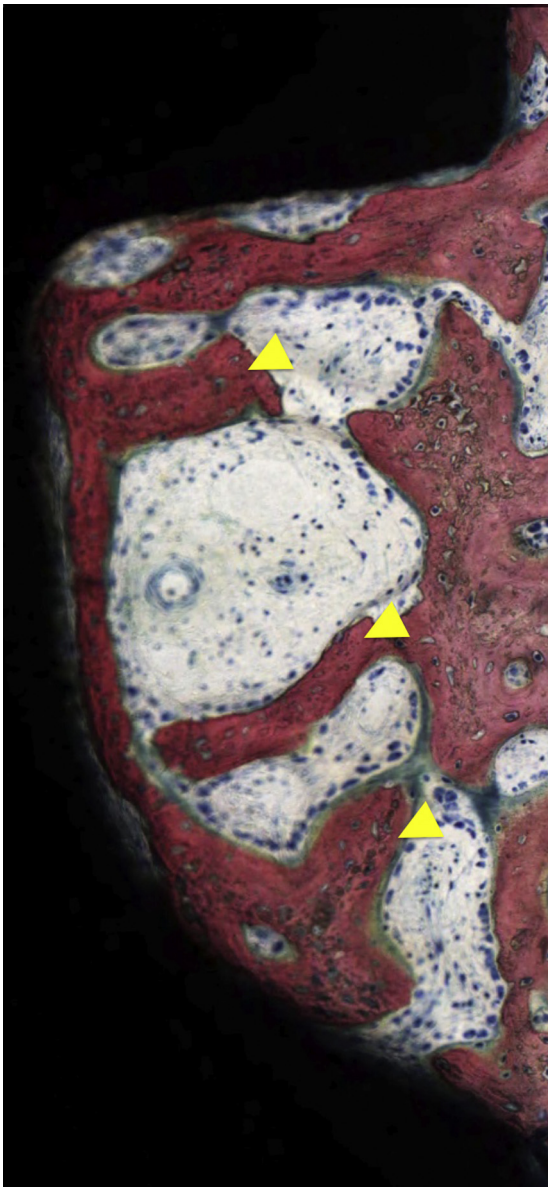

Fig. 1. Descriptive histological micrographs at 3 weeks. Ongoing formation of woven bone in the regions between threads and in contact with implant surface was apparent for both groups. All osteotomy procedures were done with 400 rpm drilling speed under abundant water irrigation. Arrowheads indicate where woven bone has formed (Stevenel's blue and Van Geison stain, original magnification 100×).

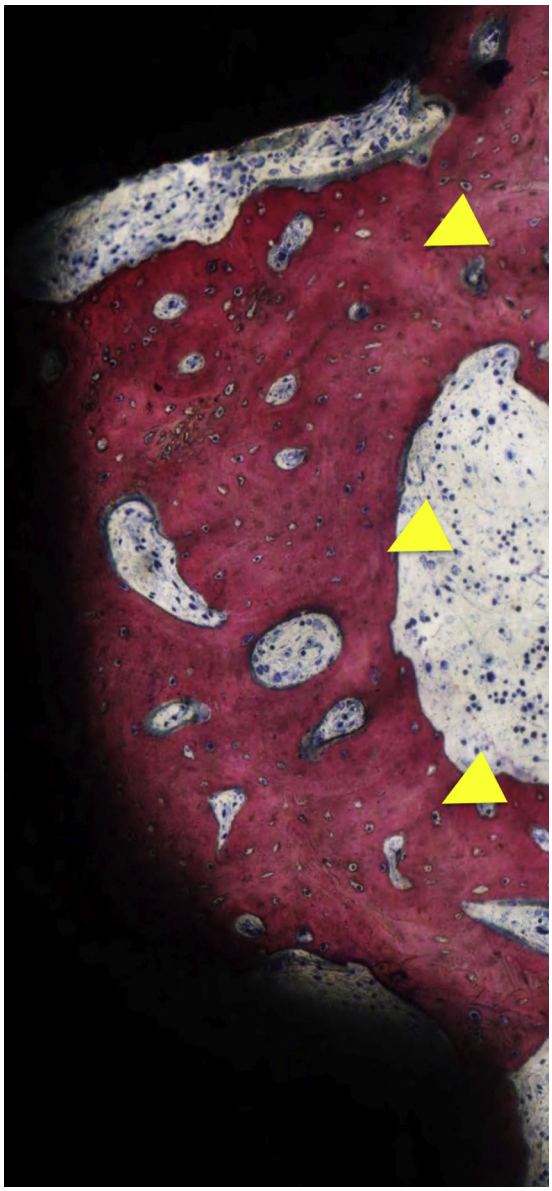

Fig. 2. Descriptive histological micrographs at 5 weeks. The initiation of replacement of the woven bone with lamellar bone was seen in all groups evaluated. All osteotomy procedures were done with 400 rpm drilling speed under abundant water irrigation. Arrow heads indicate where lamellar bone has formed (Stevenel's blue and Van Geison stain, original magnification 100×).