# Locking Screw Implants in Internal Fixation

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**INTRODUCTION:** By late seventies and early eighties *in vivo* studies conducted at the AO Research Institute, Davos, under direction of Stephan Perren produced convincing evidence that early temporary porosis, commonly observed under the conventional bone plates was the result of the insult to the periosteal blood circulation caused by the implant-bone contact. Deprived of blood perfusion the bone turned necrotic, then sclerotic before undergoing remodelling through neovascularization, resulting in early, frequently persistent porosis. While in the majority of cases the end result was still a bony union, many of the major complications of internal fixation could be rationally linked to the vascular damage caused by the surgical intervention and the implants used. Infection tops the list. Could one improve by implant design?

**METHODS:** Two engineering proposals from the Straumann Institute, Waldenburg, provided the leads: (i) Brunner had proposed to increase DCP deformation tolerance in fatigue by transverse undercuts between the screw holes, evening out longitudinal variation in plate stiffness; (ii) Sutter had developed a mandibular reconstruction locking plate system. *In vivo* testing of the Brunner plate has provided some of the most convincing evidence linking bone remodelling to perfusion damage. Sutter's *in vitro* testing of the locked vs. conventional plates has demonstrated mechanical advantages of locked screws.

Combining those two proposals with a novel technique of locking the screw by means of friction between a conical head and a conical hole in the plate has initiated the development of a new plating system, PC-Fix, or Point Contact Fixator. The name was chosen to distance the system from conventional plating, which has, at the time, come under considerable pressure from the expanding indications for interlocked nailing.

**RESULTS:** Approximately eight years of testing on animals demonstrated some anticipated and some surprising advantages of PC-Fix when compared to conventional plating:

1. Significantly increased resistance to infection;
2. Faster, more consistent, healing;
3. Reduced impact on bone remodelling.

PC-Fix was then taken into clinical setting in both veterinary and human applications. A large, multi-centre clinical trial on forearm fractures largely met the expectations, but the system was not commercialized.

**DISCUSSION & CONCLUSIONS:** Elucidation of the role that vascular damage plays in plating for internal fixation has provided a fertile ground for innovation in what has appeared to be a near perfection in the art of implant and surgical instrument design, production and application. Commercial interests have also stimulated new developments – the patent on DCP, the single most defining product feature, a trademark of a sort of the AO and its commercial partners, was about to expire. A spur of activity in research, development and marketing in the eighties has resulted in the release of the LC-DCP system, featuring a modification in design and establishing titanium as the metal of choice, but the surgical principles of application remained the same. Unlike PC-Fix, *in vivo* testing of LC-DCP did not demonstrate any major advantage over DCP.

PC-Fix has been put aside, but the locking screw principle has caught the attention of both the industry and the surgical community and within a very short period of time it has become a standard feature on just about every internal fixation system. Technical solutions have also proliferated, but the main message of the research that has started it all seems to be still looking for the audience.

Kyon, a Zurich-based, veterinary surgical products company has entered the field as well, by releasing its Advanced Locking Plate System – ALPS – in 2007. The plate of the ALPS is a combination of Shermann (1907) and Brunner plates, with its holes providing for use of either conventional or locking screws. The shape of the plate allows for bending in both planes – FE analysis suggests superior mechanical properties in comparison with the similarly sized DCP. The material is exclusively commercially pure. Titanium (cpTi). The screws are either cpTi or titanium alloy. Three sizes suitable for small animals are currently available. The first clinical reports from a limited number of veterinary surgeons who have used ALPS for now a year are expected in the fall of this year.