Locked screws. Aspects of application and performance

Alberto Fernández, Pietro Regazzoni, Stephan M. Perren

Some aspects of self-drilling and self-tapping screws (Figure 1) may need clarification. Especially the function of the mono-cortical screw is often open to discussion.

The different types of self-drilling and self-tapping screws are:

- **Mono-cortical screws.** They offer advantages and some shortcomings (Figure 2)
    - The self-drilling (seldrill) and self-tapping characteristic allows simple and quick application with precisely fitting bone thread.
    - Todays design self-drilling and self-tapping does not result in biological loosening an argument that early on banned using these types of application.
    - The resistance to pull-out is usually larger than expected and mostly no problem
    - The choice of length of mono-cortical screws is not critical.
    - The resistance to tilting under torque or bending applied to the bone fragment is a weak point of mono-cortical screws.
- **Bi-cortical mono-thread contact screws.** (Figure 3) The seldrill tip of these screws is fixed within the far cortex without double thread contact. In respect to pull-out they resist like mono-cortical screws in respect to tilting under torque or bending applied to the bone fragment they offer the same good resistance as bi-cortically threaded screws.
    - The fact that the drilling in the far cortex advances slower than the advancement imposed by the pitch of the thread in the near cortex is a problem that requires special attention.
    - The application of the correct screw length is critical. This disadvantage is offset when predrilling with a small diadrill-bit. This procedure solves the problem of drill-bit advancement as mentioned before.
- **The self-drilling blue screw with bi-cortical double-thread contact screws** (Figure 4) perform well in respect to pull-out and tilting resistance but by necessity the drilling tip protrudes into the soft tissues a procedure, which is not recommended.
    - The same precautions as mentioned before apply.
- **The self-tapping green screw** in Figure 1 avoids the disadvantage of protrusion but requires predrilling.

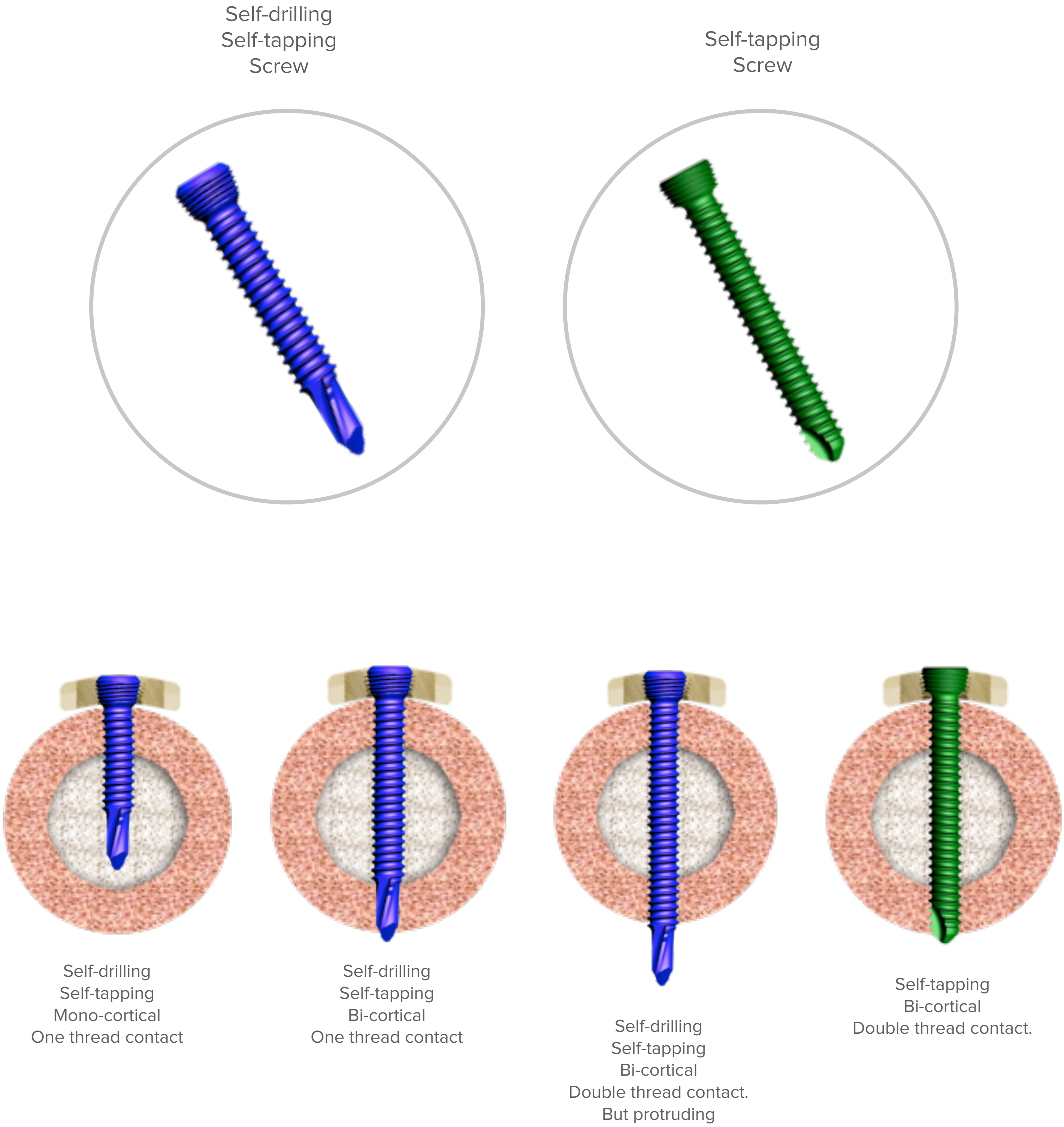

Figure 1 *The different types of screws discussed in respect of length, thread contact and performance.*

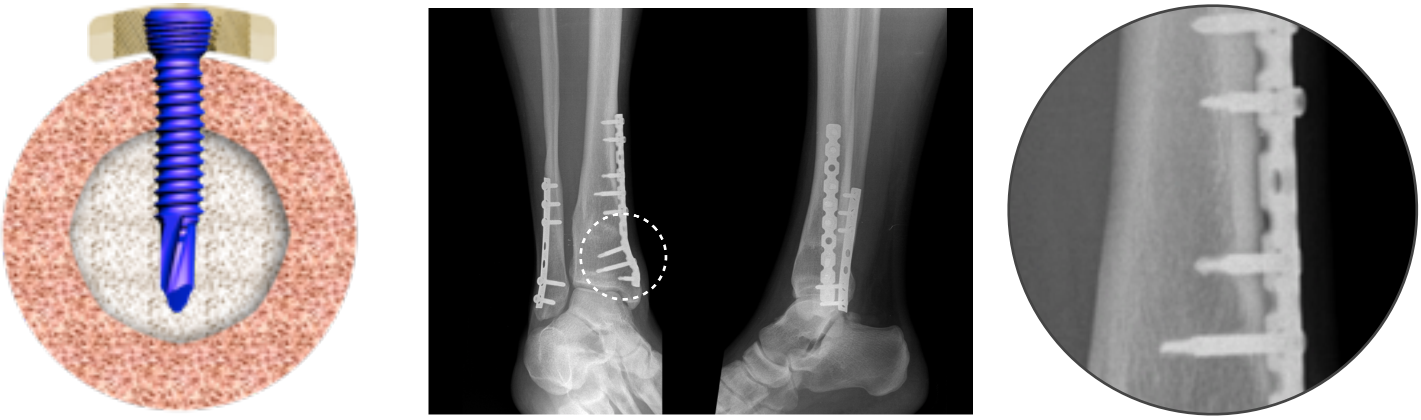

Figure 2 *Mono-cortical seldrill screw. Poor resistance to tilting under bending or torque applied to the bone/plate construct*

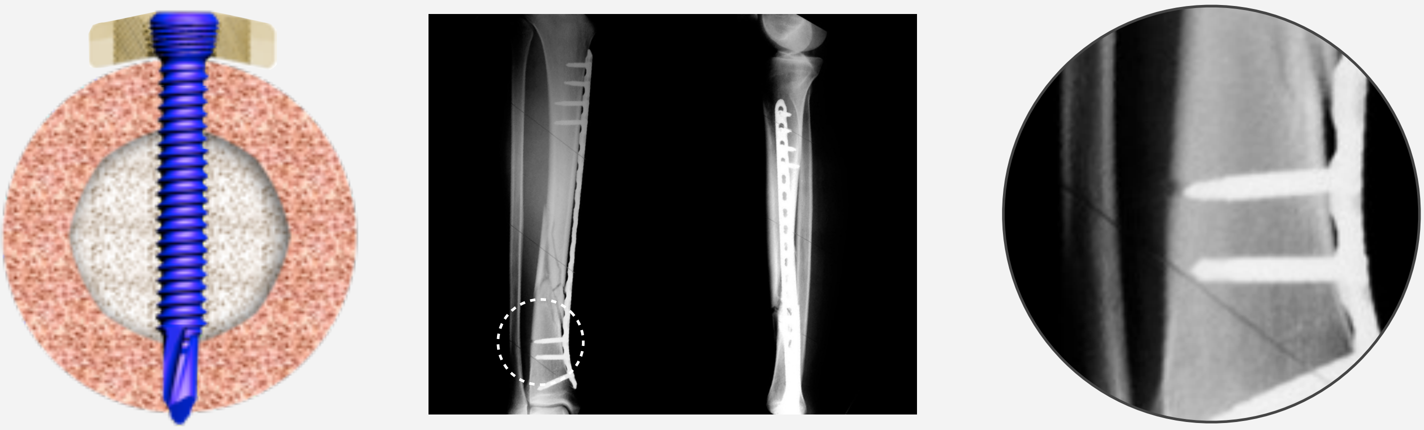

Figure 3 *Bi-cortical mono thread screw behaves on pull-out like a mono cortical and in respect to tilting like a bi-cortical screw.*

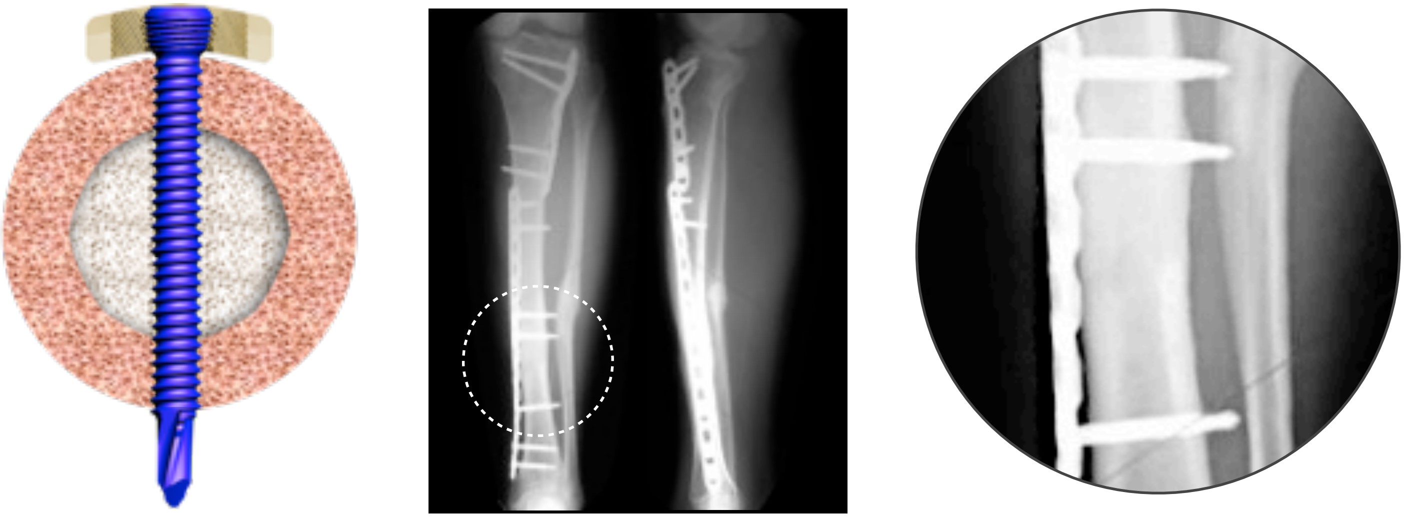

Figure 4 *Bi-cortical double-thread contact screw behaves in respect to pull-out and tilting like a bi-cortical screw but by necessity protrudes (not recommended)*

Self-drilling bi-cortical screws, problems and solutions

The problem of self-drilling bi-cortical screws consists in the fact that the pitch of the thread in the near cortex imposes a large advancement speed (Figure 5) that exceeds the speed at which the seldrill tip can advance (Figure 6). The consecutive large resistance to axial forward movement may strip the thread in the near cortex as shown in Figure 6. A further disadvantage of self-drilling screws is that the precise screw length cannot be determined by conventional technology.

The mentioned disadvantages can be avoided by predrilling with a drill bit of a diameter, which is somewhat smaller than the core diameter of the screw (Figure 7). This then allows to measure in the conventional way (Figure 8). Furthermore, the predrilling allows the drill bit of the screw to advance without producing too large a resistance (Figure 9) thus avoiding stripping of the near thread.

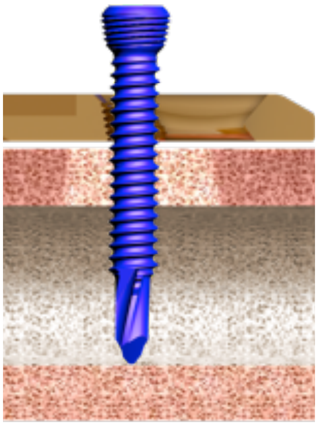

Figure 5 *Self-drilling screw hitting the far cortex.*

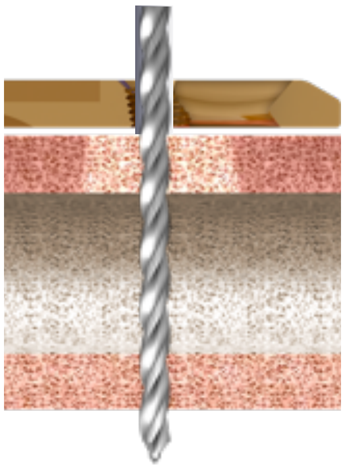

Figure 7 *Predrilling with a small diameter drill bit.*

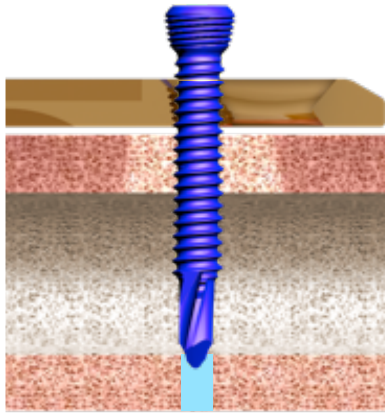

Figure 9 *The small pilot hole in the far cortex allows advancement of the screw at a speed imposed by the pitch of the screw thread without stripping the near thread.*

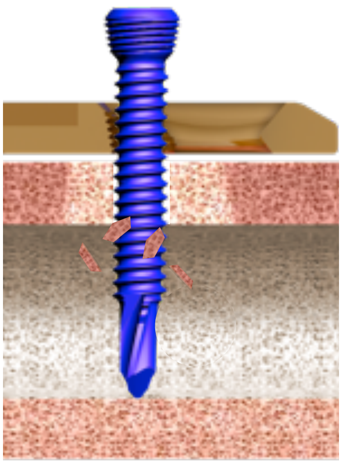

Figure 6 *Further advancement results in large axial resistance that results in stripping of the near thread.*

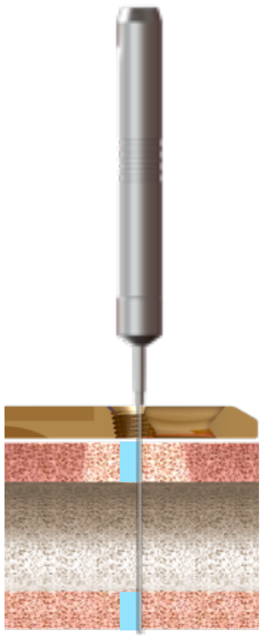

Figure 8 *Pre-drilling allows conventional measuring of screw length*

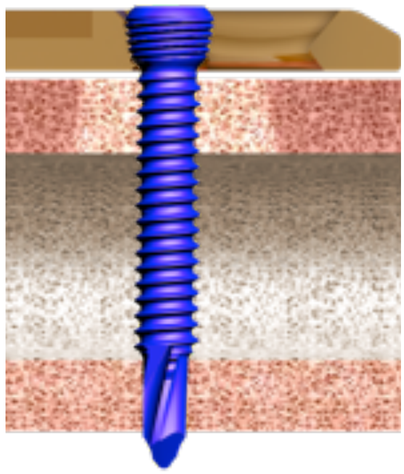

Figure 10 *Final situation.*

Mono-and Bi-cortical screws under torque and bending applied to the plate/bone construct.

It is obvious that mono-and bi-cortical screws differ in respect to pull-out strength. The difference is usually less than 50% for reasons explained later in a newsletter. The resistance to loads that result in tilting around the long axis of the plate (torque and bending) is very different in the two types of screw application. The lever arm of a mono-cortical screw in the respect mentioned corresponds to only the thickness of the cortex. The lever arm of a screw in contact with both cortices corresponds to the outer diameter of the bone cross section. The difference varies depending on the diameter of the bone and the thickness of the cortex. Usually the bi-cortical anchorage provides a multiple resistance when compared to the mono-cortical application. It is important to understand that the resistance to tilting of a bi-cortical screw is the same whether or not the contact in the far cortex is threaded.

Torque or bending applied to plate to bone contact

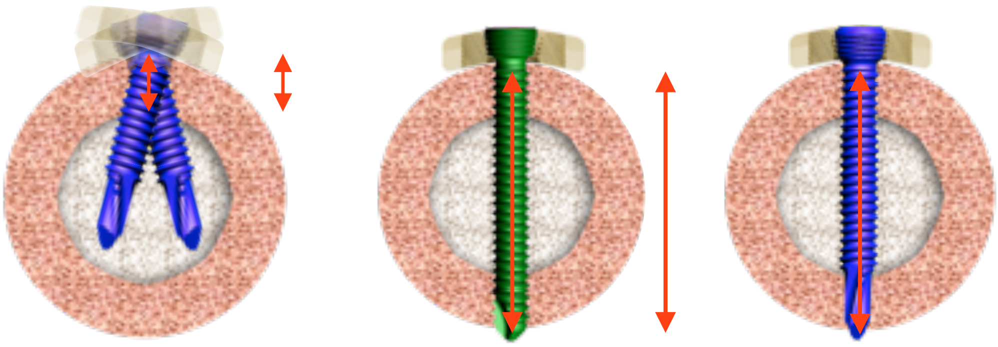

Figure 11 *The resistance of a mono-cortical screw to tilting is small. The resistance to tilting of bi-cortical screws whether with one or with two threads is excellent*

Torque or bending applied to plate to bone contact

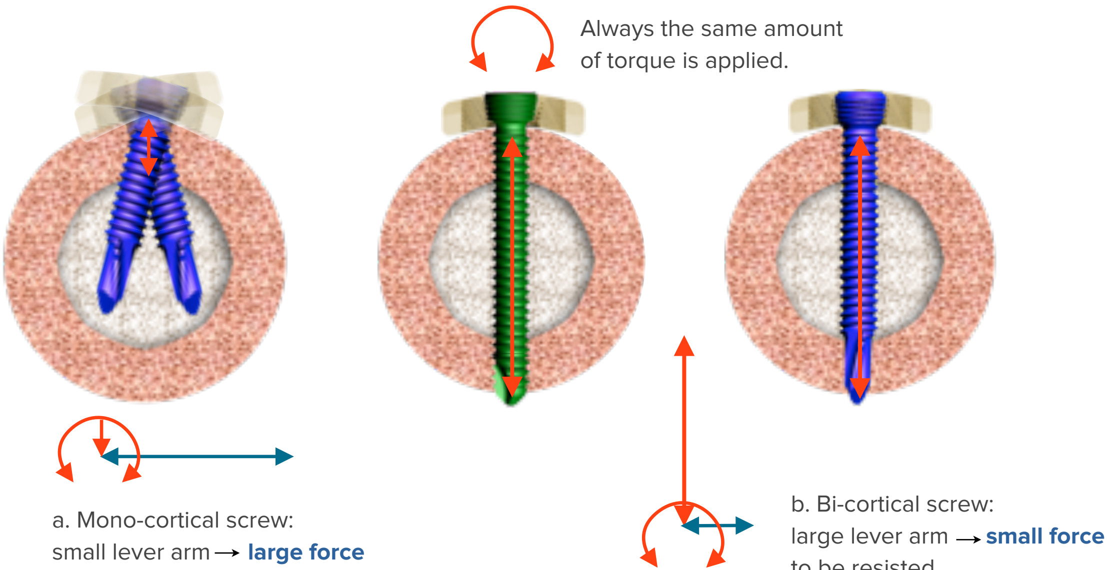

Figure 12 *Mono-cortical screw with small lever arm and high lateral force vs. bi-cortical screw with large lever arm and small lateral force.*