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ORIGINAL ARTICLE

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Maintenance of graft compression in the adult cervical spine

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Abstract It is generally advised that the graft inserted in adult cervical spine should be pre-loaded with a compressive force or that the screws are inserted in a divergent orientation, in order to maximise compression and the chance of graft incorporation (Truumees et al. in Spine 28:1097–1102, 2003). However, there is little evidence that a compressive force is maintained once the force applicator has been removed, or that the divergent screws enhance compression. This study compared the maintenance of applied pre-load force, across cervical spine graft, between standard anterior plating technique with pre-load and divergent screws and a novel plate technique, which allows its application prior to removal of the force applicator. Six intact adult cadaveric human cervical spines were exposed by standard surgical technique. A Casper type distracter was inserted across the disc space of interest, the disc was removed. In 14 experiments, following the disc removal, an autologous iliac crest bone graft was inserted under distraction, together with a strain gauge pressure transducer. A resting output from the transducer was recorded. The voltage output has a linear relationship with compressive force. A standardised compressive force was applied across the graft through the "Casper type" distracter/compressor (7.5 kg, torque). The pre-load compressive force was measured using a torque drill. Then two different procedures were used in order to compare the final applied strain on the bone graft. In eight experiments (procedure 1), the "Casper type" distracter/compressor was removed and a standard anterior cervical plate with four divergent screws was inserted. In six experiments (procedure 2), a novel plate design was inserted prior to removal of the distracter/compressor, which is not possible with the standard plate design. A final compressive force across the graft was measured. For the standard plate construct (procedure 1), the applied compression force is significantly greater than resting (SO/SC)—$P=0.01$, but the compression force is not maintained once the compressor is removed (SO/SR)—$P=0.27$. Final bone graft compression after plate insertion is not significantly different to the resting state (SO/SF)—$P=0.16$ (Wilcoxon's sign test for paired observation). Application of the plate tended to offload the graft; the final compressive force is $170\pm100\%$ less than the resting force. None of the applied force was maintained (mean $9.5\pm8.8\%$). For the new plate (procedure 2), the end compressive force (SF) measured across the graft was greater than the resting force (SO) ($P<0.001$). Further, the novel plate application increased the compressive force on the graft by $712\pm484\%$. The final bone graft compression using a novel plate, which allows its application prior to removal of the force applicator, is significant (SO/SF)—$P=0.01$. Here, $77\pm10\%$ of the applied pre-load was maintained. The difference between the plates is significant ($P<0.001$). Conclusions are as follows: (1) Applied pre-load is not maintained across a graft once the force applicator is removed. (2) Divergent screws with a plate do not compress graft and rather tend to offload it. (3) Compressive force may be maintained if the plate is applied prior to the force applicator removal.

Keywords Cervical spine · Bone graft · Graft compression · Standard cervical plate system · Novel plate