Traslational dynamism allows higher transfer load even after graft shortening, with less plate stress avoiding failure: a combined biomechanical study with FEM and essays in an ACCF model

Background

Cervical plates stabilizes vertebrae after anterior decompressive procedures; nevertheless, its stabilizing property may negatively affect load transfer if stiffness is too much. On the other hand, there is concern about load transfer after graft shortening, as the contact between vertebral plate and graft may be suboptimal.

Research question

Do traslational dynamic plates transfer more load than static ones independently of implant material or design?

Design

Biomechanical study comparing load transfer and plate stress with a same plate design working either with static or dynamic mechanism.

Methods

This biomechanical study consists of both a Finite Elemente Model (FEM) as well as biomechanical essays.

A FEM is a computer-generated design; in this case, ANSYS 10 software was used combining both geometrical and mechanical properties of human cervical vertebrae. After developing and validating the cervical FEM, a C6 corpectomy model with plate reconstruction was developed and tested.

For the biomechanical study, a simulation of one Functional Vertebral Unit (FVU: two adjacent vertebrae together with the intervertebral disc between them) was simulated with polyethylene blocks for the vertebrae and with plastic materials similar to disc`s rigidity. With an INSTROM tensile testing machine, flexo-compression force was applied at 0.42mm/s under controlled displacement (following ISO12189: 2008 guidelines), and rigidity and displacement between plate and polyethylene were recorded.

Results

As can be seen with the Von Misses equivalent tensions, when the plate is working under static configuration most of the load goes through the plate, overloading it, while only a small proportion of the load goes through the graft. On the other hand, when the plate is in dynamic configuration the load is distributed not only on the plate but also and mainly through the graft.

After simulated shortening of the graft, in static situation the load transmitted from C5 to C7 hardly any at all goes through the graft, overloading the plate. Whilst when the plate is dynamic, there is maintenance of contact between the vertebral plates and the bone graft, allowing load transmission.

Discussion

Traslational dynamic plates enable more load transmission through the graft both in inmediate postoperative scenario and after graft shortening, contrarily to the same plate working in static configuration, which is overloaded specially after graft shortening. Dynamic plates should be used to foster bony fusion and to avoid plate overloading, which could lead to construct failure and/or plate breakage due to excessive tensions.