Cervical Disc Prosthesis versus Arthrodesis Using One-level, Hybrid and Two-level Constructs. An in vitro Investigation
C. Y. Barrey, S. Campana, S. Persohn, G. Perrin, W. Skalli
Hospices Civils de Lyon, Neurosurgery and Spine Surgery, Lyon, France, Claude Bernard University Lyon, Neurosurgery, Lyon, France, Arts et Metiers Paristech, Laboratory of Biomechanics, Paris, France

Study design: Biomechanical In Vitro evaluation using human cadaveric cervical spines.
Objectives: To analyse cervical spine kinematics after 1-level and 2-level total disc replacement (TDR) and compare them with those after anterior cervical arthrodesis (ACA) and hybrid construct. Kinematics and intradiscal pressures were also investigated at adjacent levels.

Methods: Twelve human cadaveric spines from C2 to T2 were divided in two groups. In group A, six specimens were evaluated intact, after TDR (Discocerv™, Scient'x/Alphatec Spine Inc., Carlsbad, CA) at C5-C6, after TDR at C5-C6 and C4-C5, and after ACA at C4-C5 and C5-C6. In group B, the six specimens were evaluated intact, after ACA at C5-C6 and after additional TDR at C4-C5 (hybrid construct). All tests were performed under load control by applying pure moments loading of 2 N.m in FE, AR and LB. Three-dimensional ranges of motion (ROM) were measured from C3 to C7 using optoelectronic system and intradiscal pressure (IDP) was measured at upper adjacent level for 2-level constructs.

Results: Group A. Implantation of TDR at C5-C6 decreased ROM in FE, AR and LB (only significant in LB). Additional TDR at C4-C5 resulted in decrease of ROM at the two instrumented levels in FE, AR and LB; however reduction of mobility was only significant at C5-C6 in AR and at C4-C5 in LB. A second TDR did not affect kinematics of the previously implanted TDR. Two-level arthrodesis caused significant decrease of ROM at the two instrumented levels (p< 0.05). Group B. One-level arthrodesis at C5-C6 was associated with significant reduction of ROM. Implantation of additional TDR at C4-C5 (hybrid construct) did not affect ROM at C5-C6 but decreased ROM at C4-C5 in FE (not significant), AR (p=0.046) and LB (p=0.028). One- and two-level arthrodesis increased adjacent levels contribution to global ROM during FE. Significant changes in contribution were noted for 2-level TDR at lower level and for 1-level TDR at upper level. Concerning IDP during FE, we found no significant differences between intact spines and those instrumented with 2-level TDR whereas IDP increased by a factor of 6.7 (p< 0.05) and 2.3 (p< 0.05) for 2-level arthrodesis and hybrid constructs, respectively.

Conclusions: Implantation of TDR at 1 or 2 levels restored only partially native kinematics of the cervical spine. However, compared to ACA, 1- and 2-level TDR generated better biomechanical conditions at adjacent levels limiting contribution of these segments to global ROM and also reducing the amount of internal stresses at these segments. Finally, hybrid construct and 2-level TDR could be considered as alternative options to treat multilevel degenerative disc disease in the cervical spine.
[Fig Protocol]
TWO-LEVEL CONSTRUCTS

CONTRIBUTION of lower and upper adjacent levels

% ROM
(C3-C7=100 %)

Intact (Gp A)  Intact (Gp B)  2-level TDR  Hybrid  2-level arthrodesis

C3-C4  C6-C7

ONE-LEVEL CONSTRUCTS

CONTRIBUTION of lower and upper adjacent levels

% ROM
(C3-C7=100 %)

Intact (Gp A)  Intact (Gp B)  1-level TDR  1-level arthrodesis

C4-C5  C6-C7

[Fig ROM at adjacent levels]