**Manuscript Title:** Development and experimental study of a novel cervical implant with enhanced cushioning function and reduced bone-implant interface micromotion

Short Title: Experimental study of a novel cervical implant


## Abstract

**Objective:** Here, we aimed to design and develop a novel cervical implant that combines the advantages of IFD and ACD.

**Methods:** First, the bone-implant interface microenvironment was observed using finite element analysis (FEA). Second, optimum elastic polymer material and implant morphological characteristics were screened, and a new cervical implant with cushioning capabilities was developed. Subsequently, the effectiveness and design plausibility of the implant were assessed by functional and biomechanical tests.

**Results:** PU possessed the minimum interface micromotion and effectively reduced the stress concentrations. Simultaneously, PU had a better elastic deformation ability than other polymer materials and cushioning and shock absorption performance was improved by synthesising an aromatic polycarbonate polyurethane elastomers (APPUE). The stress in the cylindrical APPUE cage was lower than that in the other shapes of the APPUE cages and was more evenly distributed. This novel cervical implant was stable and fulfilled the mechanical property requirements of the cervical prosthesis. Furthermore, the kinematic features were intermediate between ACD and IFD. The facet joint stress was significantly lower than that in the IFD and was comparable to that in the ACD.

**Conclusion:** The prepared APPUE effectively decreased the interface micromotion through cushioning and shock absorption performance and elastic deformation ability. The structural design and mechanical properties of the novel cervical implant were reasonable. The results of the present study are promising, and this novel cervical implant is expected to be implemented in the clinic in the near future after further improvement.

**Table 1** Maximum interface micromotions of the various materials (μm)

| | | PEEK | HMP | PU | SR |
|---|---|---|---|---|---|
| | | X-axis direction | | | |
| FE | Prosthesis-C5 lower | 5.51 | 7.28 | 8.84 | 11.46 |
| | Prosthesis-C6 upper | 587.17 | 11.07 | 10.14 | 6.69 |
| LB | Prosthesis-C5 lower | 3.58 | 5.94 | 8.61 | 9.48 |
| | Prosthesis-C6 upper | 96.63 | 61.28 | 12.75 | 47.87 |
| AR | Prosthesis-C5 lower | 3.12 | 3.58 | 10.54 | 10.78 |
| | Prosthesis-C6 upper | 4.67 | 4.16 | 8.59 | 3.911 |
| | | Y-axis direction | | | |
| FE | Prosthesis-C5 lower | 2.50 | 9.46 | 2.80 | 5.28 |
| | Prosthesis-C6 upper | 474.51 | 282.29 | 23.36 | 162.90 |
| LB | Prosthesis-C5 lower | 4.41 | 4.17 | 11.17 | 15.77 |
| | Prosthesis-C6 upper | 962.75 | 739.15 | 104.95 | 205.41 |
| AR | Prosthesis-C5 lower | 1.73 | 2.13 | 8.41 | 9.57 |
| | Prosthesis-C6 upper | 106.80 | 87.38 | 8.59 | 8.81 |

PEEK, poly-ether-ether-ketone; HMP, high molecular polyethylene; PU, polyurethane; SR, silicone rubber; FE, flexion-extension; LB, lateral bending; AR, axial rotation.

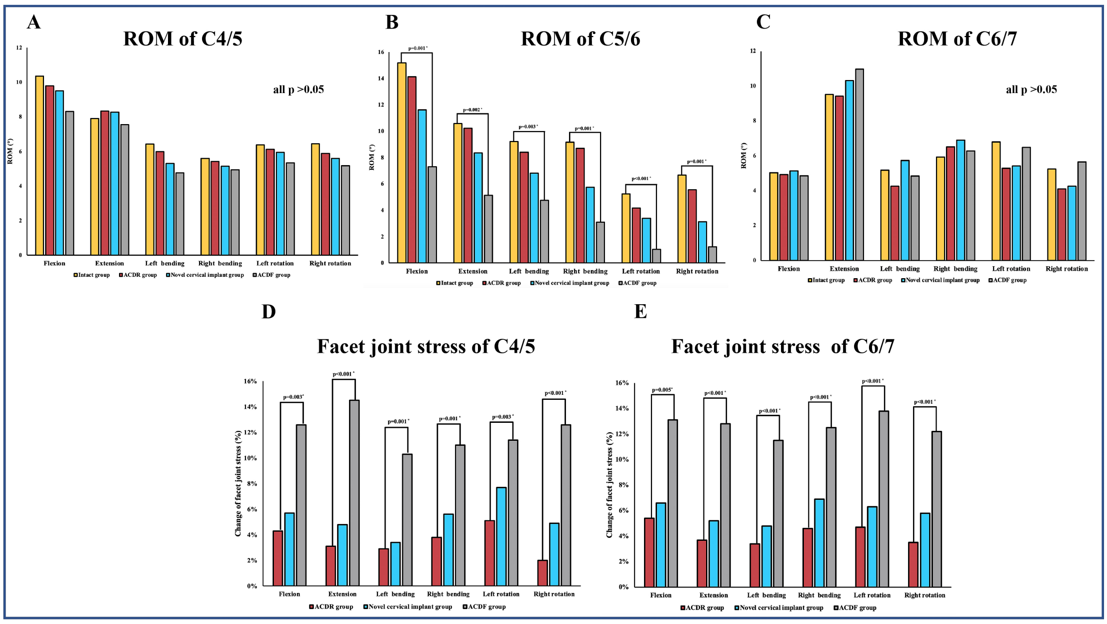


**Fig.1** Comparison of the ROM and facet joint stress between different cervical implants. The results indicated that there were no significant differences in the ROMs of C4/5 and C6/7 between the groups. The ROM of the C5/6 segment in the novel cervical implant group was between that in the ACDR group and that in the ACDF group, and the ROM of the C5/6 segment in the ACDF group was lower than that in the other groups in all directions. In addition, the maximum facet joint stress at the C4/5 and C6/7 segments in the ACDF group was significantly higher than that in the other groups, and there were no differences in the other groups.