COMPARATIVE ANALYSIS OF THE STRUCTURAL CHARACTERISTICS OF VERTEBRAL BODY REPLACEMENT IMPLANTS FOR ANTERIOR FUSION*

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Currently, practicing traumatologists and orthopedists have at their disposal a large number of various implant systems to successfully perform anterior decompression and stabilization spinal surgery. However, analysis of available literature shows that most investigations focus on the results of clinical application of vertebral body replacement implants, while not enough attention is paid to the comparative evaluation of the structural and functional characteristics of the existing structures. This paper presents a literature review on the structural characteristics of various telescopic vertebral body replacement implants aimed at assessing their functionality and improving the effectiveness of their use in the anterior fusion.
Key Words: anterior fusion, telescopic cage, vertebral body replacement implant, structural features.

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Decompression and stabilization surgery of the anterior and middle supporting spinal columns is quite effective and widely used method to treat various traumatic and destructive diseases [3, 10, 13].

Various vertebral body replacement implants are currently used to increase the effectiveness of the anterior fusion and reduce patients' incapacity period [2, 9].

The design features of solid and hollow telescopic systems determine the level of their functionality in the implementation of the tasks set by the developer while designing these systems, as well as the methods and approaches to solve these problems [14, 15].

In the extendable systems, telescopic effect is achieved in different ways:

1) using a special tool; in this case, the implant is an integral, removable part of the mechanism acting as a distractor (Fig. 1e) [21, 22]; availability of this tool simplifies the structure and results in larger cavity inside the device, thus increasing the amount of filler;

2) telescopic mechanism; the structure is a mechanism capable of changing its vertical size (Fig. 1d, e) due to threaded joints, gears, hydraulic devices (hydraulic cylinder) [8, 23]. In this case, the volume of the cage cavity is lower than in the former case by the volume occupied by the telescopic mechanism.

We discussed some characteristics of the implants in order to provide an evidentiary assessment of the advantages and disadvantages of different cages as the cavities for filling:

– Cage volume (V_C);

– Cage cavity volume suitable for filling with autologous bone or its substitutes (V_{CAV});

– location of telescopic mechanism;

– Contact area between the cage and endplates of the vertebral bodies (S_C);

– Contact area between cage filler and the vertebral body (S_{FILL}).

It is known that the internal volume of any hollow structure depends on its size and structural features. In telescopic systems, this characteristic is significantly affected by the location of telescopic mechanism, because it determines an internal volume of the structure with limited volume.

For the sake of convenience, this structural feature was analyzed by comparing all implants with the mesh structure, which has maximum V_C value. The results were classified as follows:

Group I – no telescopic mechanism (Fig. 1a) [11, 16];

Group II – cage body plays a role of telescopic mechanism (Fig. 1b, c) [19, 20];

Group III – telescopic mechanism is located on the outer surface of cage body: threaded system (Fig. 1d) and an additional tool, retractor (Fig. 1e);

Group IV – telescopic mechanism is located within the cage cavity (Fig. 1f).

When determining the reasonable combination of these characteristics, it is advisable to consider the following relationships:

– between V_{CAV} of the cage and telescopic mechanism location (Fig. 2);

– between S_{FILL} and S_C of the cage with a vertebral body (Fig. 3);

– between filling density and cage filling type (Fig. 4).

These data show that group II telescopic systems demonstrate the highest V_{CAV}. Telescopic mechanism located inside the cage cavity reduces V_{CAV} and limits the functionality of implants in terms of providing conditions for vertebral bone fusion.

Formation of an effective bone block is significantly affected by V_{CAV} for filler