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COMPARATIVE CHARACTERISTICS OF OSTEOPLASTIC MATERIALS IN DENTAL IMPLANTATION

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Abstract
This article presents an analysis of current domestic and international publications on the use of bone grafting materials, which can restore lost bone volume, create conditions for stable osseointegration of implants, and increase the durability of orthopedic structures. The article discusses the use of synthetic and allogenic osteoplastic materials that allow avoiding the donor stage of surgery, have high biocompatibility and demonstrate comparable clinical results in dental implantation.

Keywords: Synthetic osteoplastic materials; allogenic osteoplastic materials; dental implantation; comparative analysis of osteoplastic materials; jaw bone.

Relevance of the topic

Restoration of lost teeth using dental implantation is currently one of the most effective and physiologically sound methods of dental rehabilitation.
High rates of implant survival, improved quality of life for patients, and predictability of long-term results have led to the widespread introduction of implant technologies

into clinical practice. However, the success of dental implantation largely depends on the condition of the jaw bone tissue, in particular its volume, density and anatomical features.

C.E. Misch identified the following factors as the main components of a successful outcome of osteoplastic surgery: absence of infection, sealing of soft tissues, size and topography of the defect, presence of bone autograft, providing space for new bone formation, healing time, immobilization of the graft, blood supply, growth factors, regional acceleration phenomenon (RAP), collagen, calcium phosphate.

In addition, E.E. Keller et al. noted that attention should also be paid to the correct execution of the incision and the adequate shape of the flap, gentle peeling of the periosteum, maintaining the temperature regime to avoid overheating of both the receiving bed and the autograft, etc.

Biological events occurring at the biomaterial/bone interface should also be considered, including:

1) blood clot formation, release of cytokines and growth factors;
2) aseptic inflammation, migration and proliferation of stromal cells, formation of a fibrous capsule around the biomaterial;
3) superficial resorption of the biomaterial and defect edges by osteoclasts and macrophages;
4) angiogenesis and neovascularization, the growth of vessels into the biomaterial;
5) endesmal and/or endochondral ossification on the surface and inside the biomaterial with gradual restructuring towards the creation of a full-fledged bone tissue structure [1; 2; 4; 7].

The periosteum plays an important role, participating in angiogenesis and mediated osteogenic action during augmentation. When the periosteum is preserved, the area replaced by osteoplastic material is better vascularized [6;8]. It can be assumed that in this way its restructuring will be accelerated due to the attraction of inducible osteoprogenitor cells of the periosteum.

These cells appear along the periphery of the bone damage zone, spread into the area of growing capillary endings on the 3rd-5th day after the injury and, entering the zone of active osteogenesis, can also subsequently differentiate into osteoblasts

The integrity of the periosteum plays a crucial role in resisting fibrous invasion and encapsulating the bone deposit within a fibrous capsule. When augmenting small defects (single tooth), the periosteum can act as a membrane and maintain its osteogenic and vascular potential [3,5].

Istvan A. Urban and Alberto Monje identified four principles for successful guided bone regeneration:

1) primary tension-free wound closure – with tension-free wound closure, the risk of membrane exposure is relatively low;
2)angiogenesis, providing nutrition and oxygen access;
3) creating space to prevent tension;
4) blood clot stability.

The aim of the study was to conduct a comparative evaluation of synthetic and allogenic osteoplastic materials used in dental implantation of the upper and lower jaws and to determine optimal approaches to their clinical use.

Research Materials and Methods

This study was conducted as a comparative clinical and analytical study aimed at assessing the effectiveness of synthetic and allogenic osteoplastic materials in dental implantation of the upper and lower jaws.

The work is based on:

- analysis of data from modern scientific literature;
- systematization of clinical results presented in open sources;
- comparison of clinical, radiographic, and functional indicators of the use of osteoplastic materials;
- analysis of clinical cases of patients who underwent bone augmentation surgery followed by implantation.

Synthetic osteoplastic materials are represented by artificially created biocompatible compounds that imitate the mineral component of bone tissue. The following main types are considered in this paper: calcium hydroxyapatite; beta-tricalcium phosphate; biphasic calcium phosphates; and bioactive glass-ceramic materials.

Synthetic materials are characterized by:

- high biocompatibility;
- absence of immunological reaction;
- predictable resorption rate;
- ability to combine with biologically active components.

Results of using allogeneic materials in the upper jaw

Analysis of clinical data showed that allogeneic osteoplastic materials, when used in the upper jaw, provide:

- active formation of new bone tissue;

pronounced integration with surrounding structures;

- satisfactory increase in the height and width of the alveolar ridge.

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The use of allogeneic materials has proven to be most effective in:

- closed and open sinus lifts;
- horizontal augmentation in the anterior regions;
- socket preservation after tooth extraction.

The average increase in bone height after sinus lift using allogeneic materials was 8–10 mm. After 4–6 months, signs of partial graft resorption were observed, accompanied by the formation of mature bone tissue. Clinical complications (membrane exposure, inflammatory reactions) were rarely recorded and, as a rule, were associated with a violation of the surgical technique or insufficient tightness of the soft tissues.

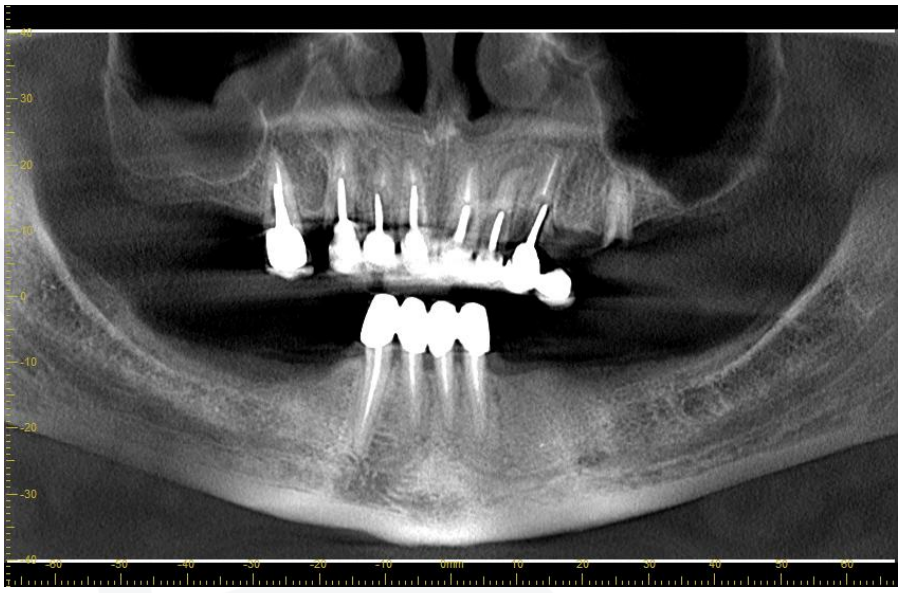

Fig. 1 Orthopantomogram before implantation treatment.

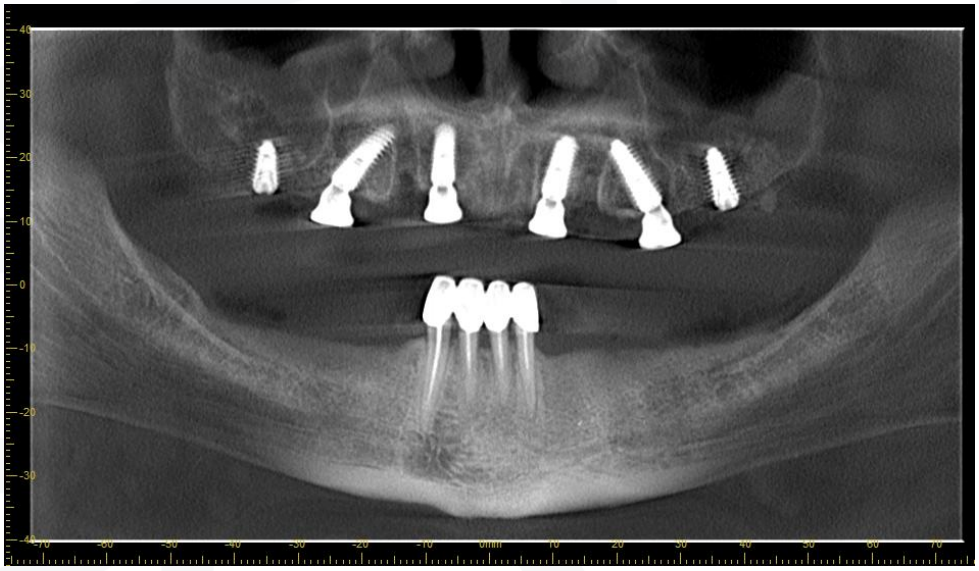

Fig. 2 Orthopantomogram after installation of implants and gum formers

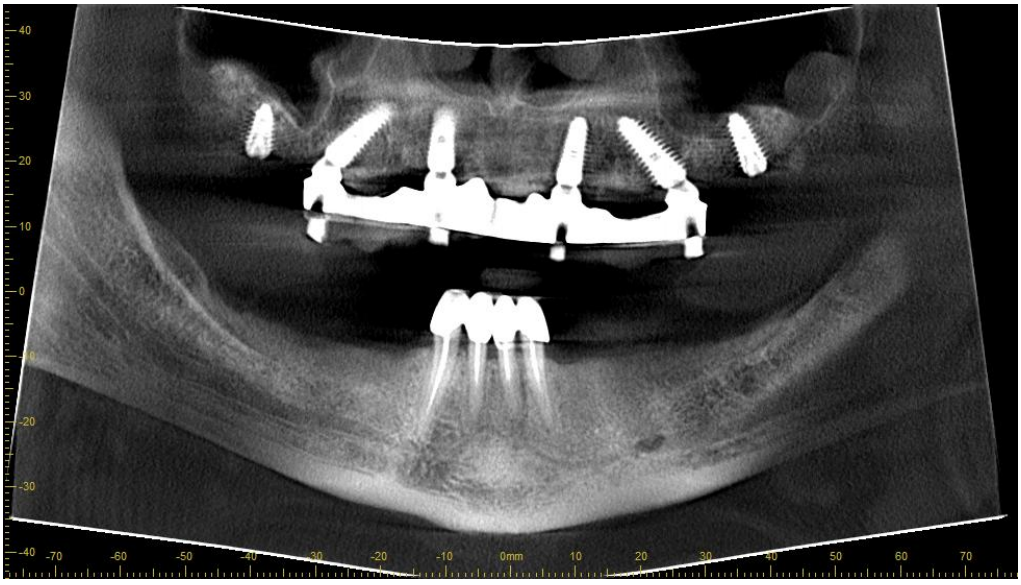

Fig. 3. Orthopantomogram after delivery of the orthopedic structure on artificial supports.

Results of using synthetic materials in the upper jaw

Synthetic osteoplastic materials based on calcium phosphates have demonstrated high effectiveness in restoring bone volume in the upper jaw.

Clinical and radiographic data indicate:

- stable maintenance of regenerate volume;
- slow and controlled resorption of the material;
- formation of bone tissue of sufficient density for subsequent implantation.

The average bone height gain using synthetic materials was 7–9 mm. Unlike allogenic materials, synthetic osteomaterials retained their structure for a longer period of time, which is especially important for sinus lifts and large defects. However, the maturation time of the regenerate when using synthetic materials was somewhat longer and amounted to an average of 6–8 months.

Table 2 Comparative analysis (upper jaw)

Indicator	Allogeneic materials	Synthetic materials
Average height increase	8–10 mm	7–9 mm
Remodeling rate	Fast	Moderate
Volume stability	Average	High
Implantation period	4–6 months	6–8 months
Complication rate	Low	Low

Thus, in the upper jaw, synthetic materials demonstrate an advantage in maintaining volume, while allogenic materials promote faster bone formation.

Results of using osteoplastic materials on the mandible

Clinical features of the mandible

The mandible is characterized by higher bone density, a predominance of cortical bone, and a slower rate of atrophy. However, the proximity of the mandibular canal is a limiting factor, which requires high precision when performing bone augmentation.

Results of using allogeneic materials in the mandible

Allogeneic osteoplastic materials have demonstrated high efficacy in:

- horizontal alveolar ridge augmentation;
- reconstruction of moderate vertical defects;
- treatment of peri-implant bone defects.

Four to five months after surgery, dense regenerated tissue was observed, suitable for the placement of standard-sized implants. The average increase in ridge width was 3–5 mm.

In some cases, partial resorption of the graft was observed; however, it did not have a negative impact on the stability of the implants when the optimal implantation time was observed.

Results of using synthetic materials in the lower jaw

The use of synthetic osteoplastic materials in the lower jaw was characterized by:

high mechanical stability;

- good integration into dense bone tissue;
- minimal incidence of inflammatory complications.

However, when using exclusively synthetic materials in areas with limited blood supply, longer periods of regenerate remodeling (up to 7–9 months) were observed. The most favorable results were achieved with the combined use of synthetic materials with autologous blood or fibrin matrices.

Table 2 Comparative analysis (lower jaw)

Indicator	Allogeneic materials	Synthetic materials
Width increase	3–5 mm	3–4 mm
The quality of the regenerate	High	High
Remodeling speed	Fast	Slow
Implant stability	High	High
Complication rate	Low	Very low

Analysis of Complications and Risk Factors

The overall complication rate with osteoplastic materials was low, not exceeding 5–8%. The most common complications were:

partial membrane exposure;

- delayed soft tissue healing;
- local inflammatory reactions.

Risk factors for complications included:

- smoking;
- Failure to follow recommendations in the postoperative period;
- Insufficient stabilization of the osteoplastic material;
- Premature functional loading

Conclusions

1. Synthetic and allogenic osteoplastic materials provide highly effective bone augmentation.
2. In the upper jaw, preference should be given to materials with high volume stability.
3. In the lower jaw, the speed of remodeling and the quality of the regenerated material are more important.
4. A combined approach improves the predictability of clinical outcomes.

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