Bone tissue regeneration in Russia

In Russia, the work focused on creating contemporary materials for bone regeneration began in the late 1990s. At the time, most developed countries had been using calcium phosphate materials (such as hydroxyapatite and tricalciumphosphate of natural or synthetic origin) and products with a biopolymer collagen of animal origin for approximately 20 years.

I nitial products (already in the RF) were registered at the RF Ministry of Health in 1994, followed by rapid development of medical materials of this type.

Today, there are seven companies in the RF producing over 50 various products intended for medical purposes and used for bone tissue regeneration. It was for this particular reason that the year 2011 witnessed the Symposium “Tissue and cell engineering in dentistry and maxillofacial surgery” as part of the 26th All-Russian conference, the event confirmed the emergence of a new area in the medical industry, namely, the development and manufacture of materials for bone tissue regeneration, consequently, the widespread use of these materials in medicine.

Given the above and the demand in the practical medicine for such products, a number of medical-technical and methodological recommendations in the hope that it will be used widely by practicing doctors, graduate and undergraduate students.

The POLYSTOM company was the first company in Russia who engaged in the development and production of products for bone tissue regeneration. For this reason, these products were registered as a basis to do research and produce Hydroxyapatyl (pure HA in powder, granules) and compound collagen-HA; these Medical products were registered at the RF Ministry of Health in 1994-95. Later, the corporate author POLYSTOM was awarded the RF State Prize in science and technology.

The development of osteoplastic materials containing signal molecules that can provide an osteoinductive effect of implantation, which became possible due to studies performed by K.S. Desyatnichenko. Studying some types of non-collagen proteins of extracellular tissue (NPB, the minor fraction of an extracellular bone matrix) he found that nearly all NPBs demonstrate a biologic effect of local growth factors (LGFs), they produce a dose-dependent effect on proliferative activity of osteoprogenitor cells, hematopoietic progenitor cells and immunocompetent lymphoid cells; their differentiation and expression of tissue-specific proteins by differentiated cells. Infusion of several NPBs with LGF properties has greater influence on reparative osteogenesis due to their co-operative effect. Single LGFs and their compositions are currently used to potentiate reparative osteogenesis, their osteoinductive properties were revealed.

Also, NPB affinity differences were found with different physiological effects related to three basic ingredients of bone tissue: HA, TCP and collagen. Biological and physicochemical properties of these NPB compounds with various physiological functions make it possible to create more bone tissue engineering systems, i.e. to construct products and materials with a planned biological effect. POLYSTOM used this principle to develop the IN-DOST series osteoplastic materials. To date NPO POLYSTOM has worked to improve osteoplastic materials focusing on the following objectives:

1. To improve osteoinductive properties to use them during operations on patients with compromised regenerating potential (for cases of osteopathy and osteoporosis of involutive, iatrogenic and alimentary nature).
2. To optimize surrounding tissues’ reaction to implantation of an osteoplastic material into a bone defect – to decrease an aseptic inflammation activity and an oxidative stress.
3. To remove osteoplastic materials cytotoxicity to create cell- and tissue-engineering structures – the most promising direction of regenerative medicine.
4. To create gel- and paste-type osteoplastic materials to decrease the surgical aggression level when repairing bone defects.

Below we introduce some practical examples of POLYSTOM materials’ use.

1. USING THE IN-DOST GEL IN THE SINUS LIFTING SURGERY

Surgery and post-surgical period. Dissect the frontolateral area of the upper jaw alveolar process near the absent tooth. Separate a mucoperiosteal flap. Cut a bone window without injuring the Schneiderian membrane. Place the osteoplastic material INDOST gel into the cavity, then cover the defect with a resorbable PARODONOK membrane. Placed the flap back and fix it with noose sutures.

In the post-surgical period, cold should be applied to the cheek for 15 minutes every hour on the day of the surgery. A week-long anti-inflammatory treatment should be prescribed: flunisolide in solution 500 mg 3 times a day (7 days), clarin 1 time a day (7 days), cetanov tablet in case of severe pain; local mouth baths using a 0.05% chlorhexidine solution 3 times a day (10 days).

2. JAW BONES DEFECT REPAIR AFTER A CYSTECTOMY

Jaw cysts are the most widespread diseases of jaw bones. The true cyst is a cavity with a wall that consists of a fibrous tissue with epithelium-lined internal surface. There is transparent (sometimes slightly opalescent) liquid inside the cyst cavity. The most common type is a radicular (root) cyst, which forms as a result of chronic inflammation of periodontium and formation of an apical granuloma. Dystrophic changes in the granuloma lead to formation of small internal cavities followed by formation of a single cystic cavity. Radicular cysts account for 60% among all types of jaw cysts. Usually, a cyst diameter is 0.5 to 2.0 cm, but sometimes cysts may be up to 2.0 cm or more in diameter.

Cystectomy is a radical operation involving total removal of a cyst capsule and contents of the surgical cavity. (Indications: 1) a cyst as a defect of the odontogenic epithelium development; 2) a Symptomatic cyst located in a tooth-bearing segment, limited to 1 or 2 intact teeth; 3) a large cyst on the lower jaw characterized by presence of teeth in the cyst zone and of a preserved bone wall in the nasal cavity bottom. The bone defect after cystectomy is necessary to products, materials, where teeth are located in the projection of the cyst or, if the teeth are absent, for prosthetic reasons.

3. TREATMENT OF ODONTOGENIC CYSTS USING KOLAPOL KP-3

Surgical procedure. Under a local (infiltrative and conductive) anesthesia the buccal/marginal dissection should be made, then a full-thickness can be excised. The palatal/marginal incision is performed, reflecting the buccal mucosa. The Schneiderian membrane is opened. The osteoplastic material KOLAPOL KP-3 is used to cover the defect. The flap is sutured. The patient is prescribed according to indications. In the post-surgical period, the osteoplastic material is removed in 7 to 10 days.

Where a cyst grows into a maxillary sinus the surgery should be performed as described above. The bone defect connected to the maxillary sinus should be filled with KOLAPOL KP-3 up to the lower edge of the sinus. The material should be left uncovered. In future, it will be replaced by fibrous connective tissue.

Fig. 1. A clinical example of the lower jaw defect treatment (after a cystectomy) using KOLAPOL KP-3.

We stated only some examples of our products use. The product line of POLYSTOM can be used almost in all fields of dentistry, such as dental surgery, therapeutic dentistry, parodontics and dental implantology. Irrespectively of this all the materials are biocompatible, biodegradable, nontoxic, osteoinductive. Collectively the listed properties facilitate their use for bone defects restoration not only in dentistry but also in maxillofacial surgery, ENT surgery, traumatology, and orthopedics. By the year 2017 more than 3 million operations were conducted using the materials of POLYSTOM. Clinicians depending on their own preferences and encountered challenges may choose any material second to no similar foreign products in its biological properties. All these materials are designed to be used in clinics supported by the widest range of budgets and are affordable for various strata of population.

Before the surgery

b) 6 months after the surgery

a) CT reveals a deficiency of the alveolar process bone of the upper jaw near the absent 25 tooth (n=6.5mm).

b) The local radiography 2 months after the sinus lifting surgery. The bone tissue is restored partially, predominantly in the lower portion.

a) before the surgery

Fig. 2. A clinical example of the lower jaw defect treatment (after a cystectomy) using KOLAPOL KP-3.