Oral surgery lecture #16

6/2/2017

**Maxillofacial Reconstructive Surgery**

When we talk about reconstruction we will talk about **restoring** the form and function (animation, speech, swallowing and chewing) so we are not talking about static structures that we need only to reconstruct. We **replace** any possible tissues to be lost such as skin, bone, soft tissue, muscle, teeth, and nerve function.

In this lecture we will try to concentrate about bone replacement..

What are the applications that we generally need bone reconstruction for it?

* Minor/ septic cases

Dental implants, simple loss of bone,..

* Major surgery

Tumors, traumas, TMJ, ..

They are different from each other's; in major surgeries we really rely on natural (autogenous) bone graft most of the time, while in dental implants reconstruction (minor surgeries) we tend to try to utilize synthetic material.

**Methods of bone reconstruction:**

* Local manipulation

which means that we try to borrow bone from an adjacent areas in the jaws to try to replace missing part or to use the neighboring areas by simple surgical methods to replace the bone .

* Extensive grafting

It's about trying to deal with big deformities, by taking large blocks of bone from distant areas

* Distraction osteogenesis

using a distractor to elongate bone, this device can be activated daily. It can be applied in maxillofacial area when you want to put implant or for jaw elongation or correction of asymmetries.

* Tissue engineering

**Generally bone grafts are classified into**:

* **Autogenous bone graft**
* From the same body of the patient
* autogenous bone graft is the main option, it’s the golden standard for treatment because it gives the best results
* Advantages:
1. the best bone graft to be used

It has osteoconductive, osteoinductive and osteogenic properties osteoinductive: bone graft can produce bone morphogenic proteins or cytokines or bone cell mediators that will stimulate the meshnchymal cells to form osteoblast and therefore will stimulate bone process for bone formation (stimulate bone formation by cell mediators)

Osteoconductive: it means that it will form anatomy in which a new bone will form

Osteogenic: it means that they have osteoblast that will form bone

…. these three features are available in autogenous bone grafts only, when we talk about another types we will talk about osteoconductive feature only, that’s why we use autogenous bone graft that it will give a good bone formation, higher success and better results.

1. Good genetic match because it's come from the same individual
2. Affordable (you don’t have to buy it or pay for it)
3. You can get cortical or cancellous bone according to the donor site
* Disadvantages: usually need another surgery, that makes the operating time longer and usually patients prefer another options if available.
* **Allograft**
* Same species but different individual so they are genetically different
* They are treated by freezing, drying or lyophilized.
* Can be either mineralized or demineralized
* osteoinductive
* Advantages: No donor site morbidity, shorter operating time (because it comes as a ready blocks).
* Disadvantages: don't have a live cell so no osteoprogenitor cells, many patients refuse to have cadaveric grafts.

(These grafts usually get screened for AIDs, hepatitis and many other diseases)

* **Xenograft**
* Different species (such as cows, bovine and porcine)
* Inorganic (mineralized) content
* Osteoconductive
* usually they may have more connective tissue inside the bone graft (can block new bone formation inside the bone graft) and delayed vascularization and bone resorption

(generally when we use bone grafts we rely on the fact that bone graft will be replaced by bone after a while, so usually we need the bone graft to resorb and to have minimal connective tissue growth inside the bone graft.. so in xenograft this procedure is slower that's why they are less successful than autogenous bone graft and allograft)

* **Alloplastic materials**
* Synthetic bone graft
* Mainly they are minerals
* Most commonly used material is hydroxyapatite, calcium sulfate and bioactive glass.
* Indications: around dental implants, in guided bone regeneration procedures
* However its success can be sometimes high and sometimes limited, so we tend to mix them with autogenous bone graft whenever possible to make the success higher.

**Cortical vs. cancellous bone graft:**

|  |  |  |
| --- | --- | --- |
|  | **Cortical bone** | **Cancellous bone** |
| **Sources** | Symphysis, chin, ramus (usually available as allograft blocks) | Maxillary tuberosity, chin (make a hollow inside the chin by trephine (round bur) so you can get cortical and underlying cancellous bone) and iliac crest |
| **Advantages** | 1. Stronger in the first period (they maintain the structural shape, as in ridge reconstruction we need to maintain the shape of the block.. so here cortical bone is better)2. high concentration of Bone morphogenetic proteins (BMPs), which has the potential of osteoinductive feature to stimulate bone cell formation3. can be fixed easily by screws | 1. have a high osteocompetent cells.2. high vascularity3. good osteogensis |
| **Disadvantages** | 1. vascularity is lower2. if exposure occurs, this might lead to failure sometimes (revascularity is slower) | 1. can be compressed easily, so we lose the shape of desired ridge for example.2. you can't fix it.. we use membranes and meshes to maintain support for grafts |

\*Indication for cancellous bone graft in the jaw that taken from the iliac crest: cleft palate.. the bone graft covered by soft tissue flap, it heals quickly and will allow canine eruption for the patient.

\* Mainly in bone grafts we use autogenous bone grafts that can be vascularized or non-vascularized bone grafts

all what we mentioned before was non vascularized bone grafts(we take the bone and put it in site without blood supply, just free transfer to the recipient site), however in some conditions we need to have a big piece of bone together with its muscle and skin or composite flap; ex.: to replace a mandible that had a squamous cell carcinoma which was associated with lose of overlying mucosal tissue, so here you will need a composite flap to reconstruct the area and the patient might have a radiation after it, so autogenous bone graft might not be resistant to radiation and this will lead to osteoradionecrosis… in this condition you can go for vascularized bone graft

for example you can take the radial forearm free flap … radius, muscle, skin, blood supply and venous supply together and then connected to the facial artery and the vein in the neck …so will become like healing; heal of the new bone to the original bone, and therefore the bone will be very resistance to those radiation or other procedure that will happen later on.

**Non-vascularized bone graft**

* Non-vital bone grafts harvested without a blood supply, gain this from the recipient bed
* Donor sites: intraoral donor sites (symphysis, ramus, retromolar area, coronoid, … actually anywhere intraoral even if we have torus mandibularis we can take from it), iliac crest, rib, outer table of calvarium.
* Biology:

bone cells survive for 5 days then the cells die → central parts of large grafts become necrotic → become revascularised within weeks to months →form of new bone cells by osteoinduction procedure →these cells start forming new bone →then it will be fully replaced by bone after few weeks to months

Sources of newly formed cells:

1. Osteoprogenitor cells
2. Undifferentiated mesenchymal cells

(differentiate into bone producing cells (inductive period)).

… so actually the autogenous bone graft will be totally replaced.

* Criteria for success
1. Firm fixation (mobilization of bone graft can lead to resorption and then failure will occur)

you can fix the graft by small screws or plates

1. Intimate contact to recipient site (direct touch between recipient bone and bone graft)
2. Minimal contamination

**Vascularized bone graft**

* We can take it from:

actually we have many sites in the human body, but commonly taken form:

1. Radial forearm
2. Iliac crest (DCIA)
3. Scapular
4. Fibula
* Indications of vascularized bone graft:
1. huge defect more than 10 cm (non-vascularized autogenous bone graft will resorb
2. In case of complex deficiencies (not only bone, but also muscle, skin ,…) so here you need composite graft/flap
3. Oncology cases ( because of fear of osteioradionecrosis)

In mandible reconstruction:

When we need to have mandibular reconstruction.. ridge (implant cases), body, ramus or condyle problems

* In oncology problems for example: ameloblastoma, malignant tumor in the jaw where you need to resect big part of the mandible less or more than 10 cm .. we are talking about loss of continuity of mandibular bone so we need to think about bone graft we will have autogenous bone graft from the iliac crest if we don’t have radiation afterwards or you can go for vascularized bone graft.
* Joint replacement… if we have a patient with TMJ ankylosis and you need to replace or reconstruct the joint after resection of the ankylosis, classically we are talking about costocondral graft (take the rib and overlying cartilage (5 or 6 or 7 rib)).

Example for a condition affecting the mandible:

The dr. showed a panoramic radiograph for a patient complaining of pain and swelling, there was a well-defined radiolucent lesion affecting the body of the mandible and extended superiorly to the ramus…it was an Ameloblastoma.

3D- imaging for the ameloblastoma… there is perforation in the lingual plate… so here we should sacrifice the continuity of the mandible, so we have to remove a block of the mandible then reconstruct the mandible.

How we reconstruct this mandible after resection?

(Definitely here we need cortical bone and we need a thick reconstruction plate which is very strong to hold the mandible together)

we put the reconstruction plate firstly ( when we make osteotomy we will lose the shape of the mandible so we put the plate to maintain the original shape of the mandible)→ then screw it →then remove it again (so that when we put it back it will maintain the original sites/holes of the screws)→ resection of the mandible→ postpone the procedure of bone graft unless we get good cover of soft tissues and we get a good reply from the pathologist that the margins of the lesion are negative→ after 3 weeks we get a bone graft from the iliac crest (cortical strong bone) placed at the site→ utilize the original holes for the screws.

A postoprative panoramic radiograph showing a reconstruction plate with the bone after 6 months.

When to remove reconstruction plate? you can't remove it unless you are 100% sure that the union between autogenous bone graft and the original graft is done.

In maxillary reconstruction:

You can utilize different type of autogenous (vascularized and non-vascularized) bone graft according to the condition; you can take a block of cortical bone from the iliac crest or cancellous bone or vascularized graft; according to the size and site of the defect.

Slide #14: the process of autogenous bone graft from the iliac crest is relatively easy. This is the iliac crest of the patient where we put a mark and make osteotomy to take bone from anterior superior iliac crest; we either take cortical or cancellous bone according to the case. In this case we take 4 cm only however in some cases we can take a bone for whole mandible from iliac crest.

Slide # 16: transfer bone graft to the ramus because we want to make elongation of the ramus of the mandible→ fixed by plates and screws.

Another example: here we make augmentation of the chin.

… so we use iliac crest very commonly in our practice, because its safe procedure and have very low side effects (might make parasthisea in the lateral side or the walking ability of the patient might be disturb for the first 2-4 days but it's not common especially if the surgery was made in a safe way).

**Alloplastic materials**

1. Hydroxylapatite crystals
2. Bioactive glasses
3. Calcium sulfate
4. Beta tricalcium phosphate
5. Biphasic calcium phosphate

**Platelet rich plasma (PRP):** this concept is commonly used now in the surgical practice. We get concentrate of the platelets which is rich of cell mediators or cytokines so that you promote the desired site of surgery to allow for better bone formation … it’s the same concept as bone morphogenic protein (BMPs), however the concentrate is really rich in all type of mediators and it has a special technique to apply.

**Distraction osteognisis:** it's a way to gain natural high quality vascular bone by using the distractor.. it’s a good option in our surgeries.

**Osteinductive agents:** as BMPs especially type 2 and 7, now a days there are some commercially available applications of those proteins; however they are very expensive.

How BMPs work? it's an intracellular messenger (small protein) inside the cell, it stimulates receptors of the meschymal cell to transform to a differentiated cells as osteoblast.

…so if you increase the concentration of that cytokine theoretically you will have better formation of bone in that area …. This is the principle of **tissue engineering** or **osteoinductine agents** used in surgery.

**Computer-assisted planning and modeling for surgical reconstruction:**

used to have better outcomefor the autogenous bone graft

Case #1:

the patient had a history of an ameloblastoma, after autogenous bone graft, he had an asymmetry (mandible on the left side is shorter than it should be), because of loss of bone graft and there wasn't complete repositioning of the bone graft and the mandible to the original position ..so the patient come after a year's complaining of asymmetry… so here they use the software planning to produce a mirror imaging of the normal site and apply it to the abnormal site so you will have a better 3D outcome of the mandible

take a CT scan or cone beam for the patient → mirror image → custom made titanium → use the prosthesis and autogenous bone graft on the patient to reconstruct the defect

Limitations: custom made titanium prosthesis is not easy to be produced (need special machines), and there is a problem in the quality of the metal that available.

However it's the best technique that produces the best outcome, however the skills of the surgeon was it will give a good 3D outcome.

Case #2:

This patient was treated 12 years ago from ameloblastoma in the mandible, at that time we didn’t have the option of computer surgical planning, so they resected the bone, and then placed a reconstruction plate and bone graft from the iliac crest, and after that he had the same problem of facial asymmetry with healed bone. He came back and we did for him the same procedure of computer assisted surgery (CT scan, 3D reconstruction, custom made prosthesis,..)

Case #4:

This patient had a history of rhabdomyosarcoma during childhood on the left masseter muscle, so he had chemotherapy that arrest the growth on the left side ( the zygoma in the left side is under developed) …he has asymmetry, it’s a much difficult case because he has asymmetry because of atrophy of muscles as well as bones, here we have many options for the zygoma we can do reconstruction or use synthetic material such as; medpore or silicone, in this case we used the same technique by computer assisted planning, we made mirror image of the normal side and make the zygoma prosthesis , and then placed silicone on temporalis defect.

Limitations:

1. soft tissue
2. Mirroring technique, sometimes it's not 100% accurate because the faces already have symmetries even in normal patients.
3. Infections

\*Aims of this lecture:

1. To understand the concept of different types of bone grafting
2. Applications of autogenous bone grafts in the facial area and how to make it more successful
3. How to select different types of bone graft

\*We can't guarantee how long the reconstruction plate should stay, it may stay forever, however it should be removed in case of fracture due to trauma … or in case of infection.

\*Titanium is biocompatible but as any material it's a foreign body.

\*Ameloblastoma is not a malignant lesion, its locally invasive tumor, and we don’t have loss of soft tissue more than 10%, so no need for radiation, we only need to resect the tumor completely with a safety margins ….so it's enough to have an iliac crest graft (not a vascularized graft).

\*Remember: whenever you deal with bone graft especially in implant cases the local manipulation is really very useful so don't jump for graft with those fancy materials because all have limitations. whenever you can, try to use bone from buccal or labial bone of the maxilla or mandible such as small piece of bone on trephine or use a basket on the suction when you make extraction or drilling in the bone this basket will collect pieces of bone … the collected materials are autogenous bone graft, so always try to use these materials even as a mixture.

\*using a mixture (natural bone with synthetic bone graft) is much better than using alloplastic materials alone.