Embryology

During the fourth week of life, the tongue appears as a mesenchyme swelling on the floor of the primitive pharynx that is called the tuberculum impar. The anterior two thirds of the tongue form from the first pharyngeal arches, which are lateral to the tuberculum impar. This forms the sulcus of the tongue. The posterior 1/3 of the tongue is from the hypobrachial eminence of the copula. This forms the third and fourth pouch.

Tongue defined

The tongue is used for speech, taste, swallowing, manipulation of food, and cleaning of the oral cavity. It is lined with stratified squamous epithelium. The tongue develops keratinization when it is repeated pressure placed on it. There are five taste senses, bitter, sweet, salty, umami, and sour. However, they are not located in a tongue taste map as widely believed.

The sulcus terminalis divides the tongue into anterior and posterior regions. The tongue ends at the termination of the base, which is at the vallecula. The foremen cecum is the area in which the thyroid descends.

Muscles of the tongue

There are eight muscles of the tongue, with four extrinsic and four intrinsic. The four intrinsic muscles are:

- Narrows Superior longus - tongue at midline by going across the tongue - runs length of the tongue - moves tongue up and down
- Inferior longus - lines the side of the tongue - moves tip up and down
- Verticalis- Runs up and down along the middle of the tongue- flattens and depresses tongue
- Transversus- Divides and lengthens

The four extrinsic muscles are

- Genioglossus- from the mandible- Protrudes the tongue
- Hyoglossus- from the hyoid bone- depress the tongue
- Styloglossus- from the styloid process- elevates and retracts
- Palatoglossus- from the palatine aponeurosis- elevates and retracts
Artery and nerves

The main artery of the tongue is the lingual artery, which branches from the external carotid artery. Other contributors include ascending palatine and tonsillar branch of the facial artery. These cause an extensive submucosal plexus which creates the plush blood supply of the tongue. The lingual branch from V2 creates sensation of for the anterior 2/3 of the tongue. The chorda tympani from VII provides the taste for anterior 2/3. The lingual branch of CN IX does both taste and sensation of the posterior 1/3. The Superior laryngeal nerve from X, does the sensation of tongue root.

History

The history of tongue disease was first described by the Egyptians around 1550 BC. They tried various concoction to treat tongue lesions. In 600-300 BC, Sushrua from ancient India described macroglossia and a procedure for rupturing of a tongue cyst. During the dark ages, Albucasis, a healer, described different oral and tongue lesions, but the only surgical procedure he described was draining of a ranula. Other early surgical interventions included tongue bleeding and mauling of the tongue to cause contracture for macroglossia. Several case reports included excising the portion of tongue that protruded from the mouth, ligations of lingual and external carotid artery, and using an ecraceur, which is a chain like snare.

Glossectomy Procedure

A partial glossectomy is 1/3 or less of the tongue, while a hemiglossectomy is 1/3 to ½ of the tongue, a near total is ½ to ¾ of the tongue, while ¾ or greater is a total glossectomy. The treatment consists of planning. First, involvement of floor of mouth, mandible, or other surrounding landmarks, size, and presence of lymph node disease must be determined. Oral cancers can be treated with radiation, but due to potential side effects and ease of surgery, surgical options remain the primary option. With T1/T2 lesions, a transoral partial glossectomy remains a good option. As long as good articulation and swallowing function remain. However, as always, early stage cancers may be associated with nodal disease, and therefore aggressive treatment with elective neck dissection is warranted. T3/T4 cancers can still be treated surgically. A hemiglossectomy or total glossectomy may work. A good strategy for surgical intervention is best described by Obrien and associates

Initial surgery for primary cancer

- Preservation of mandible when possible
- Selective Neck dissections for level 1-4 negative neck, and modified radical neck for clinically positive neck
- Tracheostomy for advanced cancer

Speech therapy should be considered after treatment.

Postoperative radiation is often indicated for the following:

- T3/T4 lesions
- Positive surgical margins
- Poor differentiation
- Perineural invasion
- Involvement of multiple nodes
- Extracapsular spread of nodal disease.

This applies to all carcinomas of the tongue, but can be used with any other primary cancers involving the oral cavity. Primary closure of the defect or skin graft can be used for partial glossectomies. Again, a
selective neck dissections is needed for N0/N1, and modified radical neck for N2 or greater. Patients should be examined for tongue motility and otalgia preoperative. An evaluation for alcohol use is critical to workup withdraw and malnutrition. Otalgia suggests perineural or deep invasion. Deviated tongues with protrusion suggest deep infiltration of muscle.

The lesions should be described as exophytic or endophytic. Sparana et al has suggested that the tumor size is a factor of survivorship. Tumors of ≥ 4mm in thickness have been show to have 59% chance of neck metastasis. Tumors of ≥3-4mm have been shown to have worse regional recurrence and survivorship. Therefore, the bimanual palpation of the tumor is essential. Surface measurement should be performed to help with the staging as well. Indirect laryngoscopy should be performed. Dental evaluation with workup of any periodontal disease. Full mouth extraction should be done before any xRT.

**Surgical techniques**

Patients should undergo either nasal intubation or tracheostomy placement. A mouth gag or block should be used to open the mouth. A silk suture can be used at the tip of the tongue to provide retraction of the tongue. At least a 1 cm margin should be taken around the lesion with frozen margins as well. Hemiglossectomy uses the same principles, except the incision is at the midline raphe. The more extensive the resection, the less likely a primary closure will work, as this will cause significant restriction of the tongue. However, skin grafts became a good choice with the hemiglossectomy. With T3/T4 lesions, management is much more complex. These may infiltrate the floor or involve the mandible. The tongue base is much more difficult to manage. A laryngectomy is indicated if the lesion extends to the hyoid region. With the advanced stage patients, the preoperative planning is key. A CT scan will help plan out the course. Surgical approach depends on size, location, invasion, and need for neck dissection.

The main types of approached for advance disease are the

- transoral,
- midline mandibulectomy or mandibulotomy, and
- neck approaches.

The transoral is better for small lesion of less than 1.5 mm, but can be used for advance cases. Often combined with other approaches. Limited but simple.

A mandibular release of the tongue is used with midline mandibulectomy. The lip is incised in the midline with a curved incision around the chin pad. The incision of the floor of mouth is made and the mandibular periostium is elevated. Posteriorly, the tongue is released across the vallecula. With the median labio-mandibular glossectomy, the lip split is midline with the incision of the tongue being midline. This provides better access to midline lesions. Using the apron flap, the hyoid bone can be identified, and division of the strap muscles made. With the lateral pharyngotomy approach, a good exposure can be achieved. First, a lateral neck dissection is typically carried out. Then, the hyoid bone is identified, and resection at the greater cornu is achieved. And retraction of the superior laryngeal, hypoglossal and lingual nerves can be done.

**Reconstruction**

Small defect of 1/3 tongue volume can be closed primarily. If resection of ½ of the tongue occurs, then contracture will occur with primary closure. Also, decrease in lingual contact with the palate, lip and teeth can result. This will lead to impaired articulation and propulsion of food. Therefore, these defects need reconstruction of some sort. Local vs. regional flaps are typically used. Again, the goal is to achieve mastication, speech, and achieve aesthetic results. Local flaps have limited tissue, inferior results, and not
helpful at all tongue defects. Regional flaps, however, have well vascularized tissue, need only single state reconstruction, and harvest is not too hard. But, their limited reach and bulkiness are difficult to overcome. Concern for tip necrosis as well.

Types of regional flaps are

- pectoralis major,
- latissimus dorsi,
- trapezius, and
- SCM.

Micorovascular flaps can overcome the limitations of regional flaps. They can come from the forearm, thigh, latissimus dorsi, rectus abd, and iliac crest. The preferred method of reconstruction of near total glossectomy is free flaps. They also provide donor site match to meet the requirements of the defect.

Complications from flap failure reach 0-15%. Aspiration events from free flaps are 5%, which is similar to 3% with primary closures.

Survival rates for 5 years are 82% for stage I/II disease and 49 for stage III or more. However, if salvage surgery is done, the five-year survival is 15-35%

Key indicator cases

The key indicator cases for otolaryngology residents have changed from needed to have total laryngectomy to performing glossectomy procedures. The ICD-9 definition of glossectomy is when a significant portion of the tongue is removed, the procedure should be reported as a glossectomy codes. These codes vary according to 1) the amount of tongue that is removed, 2) whether a neck dissection was performed, 3) whether a resection of the floor of the mouth was also performed and 4) whether the mandible was resected.

The new key indicators are:

- Glossectomy; less than one-half tongue: 41120
- Glossectomy; hemiglossectomy: 41130
- Glossectomy; partial, with unilateral radical neck dissection: 41135
- Glossectomy; complete or total, with or without tracheostomy, without radical neck dissection: 41140
- Glossectomy; complete or total, with or without tracheostomy, with unilateral radical neck dissection: 41145
- Excision of lesion of tongue with closure; posterior one-third: 41113
- Excision of lesion of tongue with closure; with local tongue flap: 41114
- Excision of malignant tumor of mandible: 21044
- Excision of malignant tumor of mandible; radical resection: 21045
- Excision of benign tumor or cyst of mandible; requiring extra-oral osteotomy and partial mandibulectomy (e.g., locally aggressive or destructive lesion(s)): 21047
- Glossectomy; composite procedure with resection floor of mouth and mandibular resection, without radical neck dissection: 41150
- Glossectomy; composite procedure with resection floor of mouth, with suprahypoid neck dissection: 41153
- Glossectomy; composite procedure with resection floor of mouth, mandibular resection, and radical neck dissection (Commando type): 4115

With these cases not being added as key:

- 41100 - biopsy of tongue; anterior two-thirds
- 41105 - posterior one-third.
- 41110 - excision of lesion of tongue without closure
- 41112 - excision of lesion of tongue with closure; anterior two-thirds (BUT POSTERIOR 1/3 IS CODABLE)
- 41115 - excision of lingual frenum (frenectomy).

Conclusion

Tongue anatomy knowledge is essential for surgical purposes. There are a variety of surgical treatment options available. Workup is key for any surgical intervention. Reconstruction is challenging for these tongue defects.

DISCUSSION: Dr. Resto's remarks on Dr. Martinez's Grand Rounds presentation on Glossectomy November 30, 2011

That was a nice presentation. I have several comments, which are in the line of giving you a little bit more background regarding some comments you highlighted. Others are things that I'd like you to update and correct a number of things in your presentation.

Firstly, when you think of managing oral cavity lesions, I'll say that you really have to think, in my mind, of separate resection from reconstruction. They have completely different goals, and you cannot bog yourself down in the whole reconstructive reconsideration and sacrifice the management of a tumor.

In the oral cavity, the biggest key is margin control. The tongue musculature is complex and highly retractable, just like any other muscle is and you have to be very certain and very deliberate as is to where you're going to introduce your cuts to incorporate your margins of tissue because it is notoriously difficult to come back after you have excised something and then say "Oh, I have a close margin" and then go back and take another piece. It doesn't behave physically the same as many other tissues in the head and neck do. The pearl that I trained with was that you designed your margins around as you purposely measured them and I was taught to put some sutures to mark the margins and make sure that your cuts actually come around outside the sutures that you placed. That is critically important.

Now, as to how much margin, you know, this is a high priced real estate area so you clearly don't want to sacrifice your oncologic treatment especially in the ones that you're going to be able to manage with a simple glossectomy since that's in theory a very curable case, a very curable lesion, where you potentially can leave your patient with some excellent functional results afterwards.

So, there's no doubt that one centimeter is well accepted. Two centimeters in my opinion is too aggressive. Simply stated, when you take two centimeters around the whole tumor you already have a total of four centimeters on
each side of normal tissue and the problem of that is that the patient is not going to be able to talk or swallow as well as he otherwise would. So there needs to be a way in as to how much margin you handle and I think that most people would agree that one centimeter is the target. The key is to do a good one centimeter margin with good control around that lesion and not only is it challenging on its side, but remember that there's always a deep margin to control as well, and there's no better way of doing that than just simply using your fingers and palpating. There's simply inherent variability and that is the reason why a lot of these tumors have a relatively higher rate of recurrence locally than in other sites. In my opinion, this has to do with technical shortcomings more than anything else. I'm not sure that the biologies are necessarily different.

**Depth of invasion:** So the rationale for depth of invasion is simply trying to avoid a neck dissection in an early lesion. It is really about cosmetic, about operative time, and about healing morbidity because it adds nothing to your management if you're willing to go in and do a diagnostic staging neck dissection. What you're really trying to achieve is can we stratify patients that have T1 tumors that do not need a neck dissection versus those that do in order to try to avoid occult neck disease. And that gets to the idea that not all T1 lesions are made equally though by size criteria they are and you do have a significant number that have delayed metastatic disease and those are correlated with finding microscopic disease on a stain setting diagnostic neck dissection. But it is a big cut in the neck, another wound to manage and the threshold has been found to be four millimeters. The problem with that is that it's really logistics. Are you going to trust a frozen section cut to tell you how deep the invasion is? Most people would say "No." So then you have to be willing to use an algorithm by which you'll do a partial glossectomy and have the patient counseled that if the depth of invasion is greater than x, y, or z, then you're going to come back and do an interval diagnostic neck dissection. Not everybody likes to do that for simple logistic scheduling reasons and the patients, psychologically, say, "What are you talking about? Are you going to do two operations? Why can't we do this all in one?" And lastly, the fact that when you go in and assess your resection, not uncommonly you'll find that what you thought was going to be a great margin isn't such a great margin after all and you'll end up considering radiation therapy. In which case, if you're going to do radiation, you going to do radiation. But that's the lesson behind depth of invasion, useful in some cases, but I don't think as useful as some hope it would be.

**Healing:** So you talked about primary closure a lot. Is there any difference in closing a defect primarily than letting it granulate? So it turns out that from a healing perspective and a functional outcome perspective there isn't a heck of a lot of difference between one and the other. The only reason that you'll really try to close it primarily is because your pain management is going to be a lot easier. It'll heal faster; it'll have a lot less exposed surface and basically it's just symptomatic control with the patient. This is important because not only do you need to know that you can leave it open and in fact you didn't discuss this but in robotic approaches most of the healing is done by secondary intention. So it is absolutely a well accepted way to handle something if that's what you need to do.

The second is practical. You talked about how everybody advocates a mattress suture in the closure, well, that's simply because the tongue is a tremendously strong muscle and if you put anything less than that you're just going to rip him open. So back to the issue. When you see him back in the office for follow up and your entire closure is busted open, what do you do? You try to re-close it? The answer is "NO." You basically allow it to heal by secondary intention, very acceptable- you're not going to have any kind of an inferior result especially when you're focused on the mobile tongue area.

**Some other releases:** I'd like you to be a little bit tighter about terminology; precision is important. Otomies are access procedures. If tissues are excised, then this is an extomy. So there's not a lateral pharyngectomy – that would be excision of pharyngeal tissue . It's a lateral pharyngotomy. So there's a lot of fixing to do in the presentation.

**Lingual release:** You described something which may be how it is described in a textbook, but I would disagree with it. If you do a mandibular split approach for access then in my opinion you do that to minimize the amount of lingual release that you need to do. If you do both of them at once you're simply cutting for the sake of cutting and you're just making a bigger wound. You actually can deliver most of tongue lesions inclusive of many tongue base lesions strictly with a lingual release and delivering the tongue down through the neck and it avoids the morbidity and the complication of a mandibular split such as occlusion issues and all the other stuff. Now, the important technical consideration there is that most folks release from the mandible down to the floor of the mouth. The problem with that is that you can never sew that shut. You have to take the attached gingiva off of the mandible and posteriorly from the teeth simply because there is a much stronger character to the tissues and the periosteum associated with it and then you re-suture using circumdental stitches. The second thing is that most people come in and do their U-cut around what mandible they can visualize when in reality when you pull tissue down into the neck you end up ripping so you have to introduce cuts to control your tear. If you do not introduce them, your tear will naturally go deep into the pharynx making it a lot harder to close with an intact
mandible. So you want to purposely extend those cuts up into the tonsillar pillar area so when the rip happens, it tends to happen superiorly where you can still close it transorally. Now, if you're going to split the mandible, you're simply going to release whatever you have to release. Clearly you're going to have to release one side if you're going to swing things open and in that case you may or may not release it from the gingiva, the most superior aspect of the gingiva, but that's kind of a judgment call. You clearly are not going to release the floor of the mouth from the other side. You're going to try to keep that together so it's simply going to be faster to heal.

**Reconstruction:** In my opinion, it's a little bit of a misnomer. We really can't reconstruct tongue. To really reconstruct tongue we'd have to introduce functional muscle into the residual muscle to have full function restored. Really, what reconstruction tries to achieve is firstly, wound healing, above anything and what tissue you choose to use has to first satisfy your ability heal the wound. If you have a through and through defect which goes into the neck, you perform the neck dissection with primary closure which is okay if you have enough tissue, otherwise granulation, and that's not an option. If you do a lot of mattressing from the bottom the Pittsburg group has taken skin grafting to its finest art and so you can never say "never" with a skin graft. It's certainly very challenging and failure rates are higher once you have a through and through defect, and of course, failure implies a fistula. Since the amount of tissue becomes important, I don't think there's ever a role for a tongue flap, and this is of historical importance only, in my opinion. It's simply robbing Peter to pay Paul. But there are a number of local flaps, with skin grafting whenever you have a suitable wound. Sometimes granulation is the right choice, except in any defect which includes the floor of the mouth, because you want to prevent healing with contracture, which will secondarily impair tongue function.

You had a nice list of flaps. I would only the submental flap. It has a nice range of uses in some folk's hands, and it does have some limitations mostly because it's rare that you're going to have a defect a kind of reconstruction where you haven't done any neck dissection, and because of the vascular supply to that flap when you haven't done a neck dissection in that area, it's often placed at risk. But if you're cognizant up front that that's what you want to do and you have the right case with the right N0 neck the like and it's still useful and you can swing it in very nicely, based off the submental branch of the facial artery and brings some muscle with it and some skin and you can flip it up under and it works the same as any regional flap would. Otherwise the list is rather good.

Lastly, there is an emerging field of minimally invasive approaches to the oropharynx. There's not a whole lot of things you can do through the mouth to the oropharynx. The challenge comes with the posterior aspect of the base of the tongue, where your angle changes. The two major innovations in this have been in transoral laser work with laryngoscopic exposure techniques where you use a l mirror back there and you use a laser technique for resection, and mainly for its hemostatic ability.

The second one of course is the robotic approach and that does have a really significant advantage in that you now have a substantial degree of freedom in orientation and visualization and that now you can you can truly approach the lesion en face from a posterior direction. And why both of these are incredibly favorable is that it is not uncommon for the approach to a base of tongue lesion is more morbid than the resection of the lesion itself. If you know how you're going to get back there if you're going to do a suprahypoid release or if you're going to do a lateral pharyngotomy you're likely to need to do a neck dissection prior just to get tissue out of the way. Big wound already whether there's any disease there. Same with a mandible split. Big wound, a lot of healing. It clearly has a role in early isolated lesions and in terms of vascular support of those tissues it could change the way you think about the whole deal. When you do these large open approaches you take down a lot of the anastomotic connections, a lot of the vascular supply to these areas, so you have to have a good understanding of what form the axial supply to all of these places which is why you must know where those linguals are, lest you take both linguals and cause the tongue to necrose. When you do a superficial approach, like laser, you have retained intact the collateral supply to these areas and it turns out that the patients are a lot more tolerant to the extraction of tissue inclusive sometimes of taking both of those lingual arteries, which breaks with your traditional teaching. They tell you that taking both linguals amounts to a total glossectomy but that notion is being challenged as we develop these minimally invasive approaches to tongue lesions. Obviously the morbidity is much improved, and the morbidity has been much more related to the approaches than to the resection. The drawback is that we wonder which are the right lesions to go after with the newer approaches and we're trying to define what the upper limits are. We still have not come up with much better approaches for managing occult neck disease beyond the performance of a diagnostic neck dissection, so once again you find yourself with what remains a somewhat algorithm as to when do I use adjuvant therapy, when do I use neck dissection and if you are doing a therapeutic neck dissection at what point is it more of a hoopla to go in and do a transoral resection and then come back and do an open neck approach .I think that cases will fall on both sides. You should include here something about transoral laser resection in your presentation, just to indicate recognition of the fact that these are important developments, going forward.
References