

Dr. John Marinelli:

Hey everybody, welcome back for another episode of ENT in a Nutshell. My name is John Marinelli. And today we're going to be discussing one of the fundamental areas of sleep surgery. And that is maxillomandibular advancement surgery, we have the privilege of being joined by Dr. Stanley Liu who is an oral maxillofacial surgeon with subspecialty training in sleep surgery. And so, Dr. Liu, thank you so much for being here today.

Dr. Stanley Yung-Chuan Liu:

John, thank you very, very much. I'm really excited to be here from California to really share this topic where I'm going to do my best to put this procedure within the context of all the advances that our mentors and everybody has made in terms of comprehensive care for our sleep surgical patients. So thank you for having me.

Dr. John Marinelli:

I just want to start off by asking you about the history of MMA, and maybe also if you could just give some context as to broadly where is MMA fitting into the management of OSA and adults right now.

Dr. Stanley Yung-Chuan Liu:

So again, MMA, a very iconic procedure in sleep surgery, which is a part of a continuum of care for OSA that readily incorporates medical, dental, pharmacologic and behavioral therapy. The mechanism for OSA is complex, there are certainly non anatomic contributors, such as arousal threshold loop gain, that are really not altered by surgery.

So all surgery for OSA affects what we call the Pcrit or the critical negative closing pressure of the upper airway during sleep. So again upon inspiration, the diaphragm, you breathe in and the lateral pharyngeal wall or the airway tends to want to collapse and the upper airway muscles, they're responsible for dilating and counteracting that force, essentially.

So, whatever surgery it is, that's the goal, if the surgery were to be effective, it needs to be able to counteract that force. And MMA tends to be a very, very strong one. Originally in the phased protocol, so the phased approach, part one and part two, so phase one was the classic UPPP, or UV flap and genioglossus advancement.

And then phase two would be the MMA or the maxillomandibular advancement. And that's classically where I fit in. And this phased approach developed in the early 90s really had two premises. One is that multilevel surgery for the airway is always more effective than surgery at the single level. Hence, the nasal, the UPPP, and the genioglossus, which was what the original phased approach like to use. And then after sleep study for the non responders, phase two, then would be the MMA.

Dr. John Marinelli:

And when you're talking about phases here, you're referring to the Stanford sleep surgery algorithm.

Dr. Stanley Yung-Chuan Liu:

Yes, so the classic, Paul and Riley algorithm.

Dr. John Marinelli:

Maybe just kind of building off of that, transitioning more to patient presentation and that sort of thing. What is the typical patient you're seeing nowadays, with OSA that you start to think MMA might be a good fit for this person.

Dr. Stanley Yung-Chuan Liu:

In general, there are three main categories. And I should say that the original Stanford phase protocol, if I may use an analogy here, it was sort of the classic approach to sleep apnea in that think of it as almost like a football game and there is a definitive touchdown marker, the age had less than five, or if you want the shares criteria for surgical success, and you kind of do this phased approach in order to score a touchdown in order to get your age less than five.

And of course, you win the game and sleep apnea never comes back. And you know that's not true. And so the MMA remains a very critical piece in sort of a more modern day contemporary approach that is a lot more continuous. And that is to say that it's not this linear approach. And the goal is not just about a success criteria that we define a purely based on the AHI.

So within the new context and the new paradigm, if you will, the new protocol. The three main groups of patients that we begin to think about the MMA include. Well, we'll start with one which is a classic. So say they were non responders to phase one surgery, still have significant sleep apnea. And you think about phase two, which is the MMA.

A second category, of course, is sleep apnea of any severity where the patient has a comorbid dental facial deformity, meaning they have some kind of jaw misalignment. So you're essentially tackling two issues with one procedure.

Number three actually would be based more on dynamic airway phenotyping. And that is to say that we have found the MMA to be very effective in addressing patients who have concurrent. And the key here is concurrent, a concurrent concentric collapse of the velum, and lateral pharyngeal wall collapse that is seen during drug induced sleep endoscopy.

We found the MMA to be very reliable in reversing that pattern. So these three sort of indicators, the patient we're walking with that type of history, or that examination, we begin to think about the MMA.

Dr. John Marinelli:

And if we think about the procedure itself, maxillomandibular advancement mechanistically how is it leading to improved airway during sleep for patients?

Dr. Stanley Yung-Chuan Liu:

It's a really good question. And if I may go into a little bit of history here. Let me ask you this classically, on imaging, what did people like to use, to look at sleep apnea patients or to assess something like the MMA.

Dr. John Marinelli:

You're talking about like lateral cephalometric data?

Dr. Stanley Yung-Chuan Liu:

Yeah, exactly. That lateral ceph from day one was popular, and for good reasons because it's cheap. It's got very little radiation, and it does give good information. It gives good information about either the

mandibular to the [inaudible 00:06:40] distance, it gives great information about the post to your nasal spine to the palatal length. So it is good.

Now, the problem with that, and this is the problem with sleep in general, you cannot use any single modality whether it's imaging, or endoscopic examination, you can't use anything by itself and make broad sweeping claims. So if you look at the lateral ceph, before and after the MMA, you'll see this huge airway space behind the tongue. And so the MMA tends to get classified as a hypopharyngeal surgery, it tends to be classified as such that, "Look, there's this big airway space behind the tongue."

So a couple of years ago, when I started systematically looking at the MMA before and after with a drug induced sleep endoscopy, I got a totally different view about this. When you look at the airway now dynamically before and after the MMA, what you discover is it's about the stability of the valem and the stability of the lateral pharyngeal wall that predicts for success.

And that does make sense, because if you were to look at this operation, if you think about the lateral ceph, it's one mid sagittal slice. It is not looking at things in different views. And what's funny is, when you look at publications that came afterwards, whether they use CT scan, or MRI, they still like to use them as sagittal slice.

And yes, based on that, you get the sense that the MMA what it does is it creates this huge room, and it creates this huge space behind the tongue. But when you look at it under sleep endoscopy, you get a whole different appreciation for it, especially the stability of the lateral pharyngeal of wall.

So now let's break it down a little bit. When you move the jaw bones, the MMA in its essence is moving the jaw bones to treat a soft tissue problem, is to treat an upper airway problem. So the skeleton, the maxillomandibular skeleton is moved in such a way so that the airway is stabilized, right?

Remember what I mentioned, counteracting that negative critical closing pressure. And in the end, that's how it works. It strengthens your levator muscle, your tensor muscle, your palatoglossus, your super hyoid muscles, that's essentially what it's doing. And so really important as from a conceptual standpoint, really important to assess any procedure you do with multiple, not only with multiple modalities or imaging, endoscopy, but looking at your modalities in as comprehensively as possible.

So veer away from just the lateral ceph, but look at in the coronal view, look at it from an axial view and correlate that with your sleep study and correlate that with your endoscopic examination.

Dr. John Marinelli:

If we could transition now to workup. When you're seeing a patient who you're working up for potentially undergoing MMA, what is going through your mind in terms of the history and physical exam, particularly the cranial facial exam, when you're seeing these patients?

Dr. Stanley Yung-Chuan Liu:

And offer a few interesting clinical pearls here, if you will. First of all, you want to be a great historian. So what I mean is the examination of the patient. I'll use one example to make it a little bit less nebulous here, let's say the nasal exam. We all know how to do the nasal exam, you're going to use your rhinoscopy, you're going to scope the patient, etc. You're going to assess for allergies, you're going to do all of the above.

But the nasal examination begins from seeing the patient and hearing the story. Because one thing I tell patients all the time, sleep apnea is not infection, it's not like you just got it yesterday. Maybe you got your sleep study yesterday and discover that you have severe sleep apnea. But this is a developmental issue.

And aberrant facial skeletal growth that's corrected very well by the MMA as an example, is a result of things like chronic mouth breathing. And what's a typical phenotype? We talk about the adenoids bases, where the patient doesn't breathe nasally, and their mouth breathers and whatnot. And they end up developing these very narrow jaws, and then they develop a retrusive mandible.

And if your orthodontist doesn't do you a favor, and instead of letting the lower jaw grow, they hold it back with a face gear or something. Now you have a patient, where their upper jaw, lower jaw are now severely hyperplastic.

So being a good historian is very important. That does include the sleep history, and includes also a history of... We'll do all the routine stuff, you'll do their past medical, their past surgical. Actually, it's also important to ask them how they were sleeping as kids, were they ever diagnosed with ADHD, do they have a long protracted course of orthodontic treatment, that always rings a bell.

If an orthodontist had to take years to correct the bite. Something was going on that's not quite normal. Now things like headgear, meaning it's kind of a contraption that the orthodontist use to hold back jaw development. All these things you do want to capture in the initial workup.

After getting that history. Yes, you do correlate it with the sleep study. But remember that the sleep study is merely a part of the entire work up. Because, for example, your young patients, young patients like yourself, or your female patients before menopause, it is unlikely that they're going to show up with a high AHI, where you kind of start thinking about these more aggressive surgical options, because it doesn't capture it very, very well.

But it doesn't mean that they're not expending a whole lot of effort, keeping their airway open during sleep, and not complaining about fatigue the next day. So being a great historian, when I do my assessment, I spend the vast majority of my time trying to elicit the history of their sleep, the history of various treatment, as I have outlined before, then, of course, going through my endoscopic examination, intraoral examination.

And I do not routinely use imaging in my practice, I don't. It doesn't really add a whole lot in reality, at least not immediately. Now, there are situations where we need it, and we can go into that. But I would stress that being that great historian will point your way to thinking about it more holistically.

Dr. John Marinelli:

And what about the role for drug induced sleep endoscopy here? You had mentioned it a little bit already.

Dr. Stanley Yung-Chuan Liu:

For the older patients, and we're talking about middle aged males, although I say that and I'm a middle aged male, so okay, fine, for the older patient. You're seeing years of negative pressure, you're seeing... So when you do a sleep endoscopy, you may encounter these very challenging patients with concurrent concentric collapse at the velum, and lateral pharyngeal wall collapse.

This is tough. A very nice study out of Detroit a number of years ago, and even in the recent multicenter study that was part of where we looked at surgical success, examining it with pre and post drug induced sleep endoscopy, lateral pharyngeal wall collapse is a very difficult phenotype to treat. And so, if you encounter that as you are doing dice. You see your concentric and lateral pharyngeal wall.

You might want to do a little chin lift, and get a sense of, with a chin lift that lateral pharyngeal wall stabilizes. That patient may be a very, very good MMA patient. Now, in a younger patient that may not hold true, when you do dice on a younger patient who actually needs the MMA, what you see is that

they're able to hold the lateral pharyngeal wall, but you've got a tongue that is so big, and again, it's not the tongues fault. The house is too small, the oral volume is too small.

So what you end up seeing is the tongue really occupies any airway space there is, and you can see the hypoglossal nerve and the genioglossus muscle at work, you will see the tongue kind of push forward, push forward, and after a couple of episodes, it tires out and it collapses into the airway, and the patient has an arousal. So anyways, these are some of the things that sleep endoscopy really does help us in phenotyping the patients.

Dr. John Marinelli:

And you mentioned you don't routinely get imaging, but there were some circumstances where you might. Can you tell us about those?

Dr. Stanley Yung-Chuan Liu:

Absolutely. Imaging only comes into play when you're going to do a surgery, that involves a [inaudible 00:16:27]. Whether it's the MMA, or the maxillary expansion procedure, which we also pioneered here, when I started doing these, so the idea is to expand the maxilla of the patient with a narrow and high-arched palate, or you're doing a genioglossus advancement and you want to basically and again I published this as well to design a guide. To show you where you want to make the cut, so that you will capture the genioglossus muscle reliably, and avoid getting into the mental nerve, and nowadays you even have 3D printed plates.

And so imaging only comes into play when you're actually going to do a procedure involving the jawbone. Otherwise, if you think about it, there's not a whole lot of value getting an imaging study.

Dr. John Marinelli:

And when you're looking at, like virtual surgical planning, and kind of trying to evaluate some of the imaging that you do sometimes get preoperatively. Are there any key areas that when you're reviewing those studies that you like to be mindful of or look at?

Dr. Stanley Yung-Chuan Liu:

Yeah, absolutely. So the advantage, of course of virtual surgical planning, as you know, is that you can simulate the movements and see how it works out, whether it's certain rotations or whatnot. You're getting the advancement that you need, I'll start with a more straightforward example, in the genioglossus advancement. if you're able to... Because no one really, I know there's studies published where you take a ruler, you measure and you can predict the location of the genioglossus attachment.

But nothing's better than taking a CT and literally, you can draw on the CT scan, where the upper limits of your cut is and the lower limits of your cut. And if you only include the genioplasty with it to improve the patient's facial balance, you can do that. You can draw it out. And you'll get a guide, if you will, and then that's where you make your osteotomies.

And now with the MMA, I mentioned the rotation, because really, in this day and age, especially the MMA and MMA itself is a bit of a misnomer, maxillomandibular advancement, that's assuming that we advance everybody, and it's not entirely true, we do advanced critical landmarks that has to do with the airway.

But I'm telling you that we can advance a class one, class two or class three patient, there's never a setback needed. And let me come back to that point a little bit later. But anyways, with virtual surgical planning, you can plan this thing out as if you're doing the procedure. And you can make guides

and splints that guide your procedure, how you like. I do think that has been a major game changer in our field.

Dr. John Marinelli:

And the last part of the workup at least that I wanted to ask about was the dental models obtaining those preoperatively. Any comment on that?

Dr. Stanley Yung-Chuan Liu:

Yeah, the greatest thing about dental models is you no longer have to put the patient in a annoying alginate impression and pouring up stone models, most orthodontic or dental offices, or you can send them to a dental imaging center where they have an intraoral scanner.

So just imagine a little camera. They'll take a picture basically, an intraoral scan, and they can merge that with your CT scan. And then you kind of do your virtual surgical planning from there. I have never, ever used basically a stone model ever since. That era is long gone. With an intraoral scan and a CT scan, you can do all of this remotely.

Now as a sort of a tertiary referral center, we have patients or say if you were treating a patient from out of state or whatnot, in the post COVID era, you can have the patient actually get a CT scan and intraoral scan from where they are, and design the entire operation without touching the patient and whatnot. So that part of it has also helped us quite a bit.

Dr. John Marinelli:

Yeah, that's pretty impressive. And I guess just transitioning now, maybe before moving on to the surgery itself, but trying to tie together this workup and patient presentation and whatnot. Could we just review the current indications for MMA?

Dr. Stanley Yung-Chuan Liu:

Yeah, absolutely. Now this I actually have published in a number of texts, including sleep medicine and whatnot. And again, three major categories. One is you can go with the classic route, the phased approach, you can do a nasal surgery, a UPPP of your liking whether it's uvulopalatal flap, whether it's relocation pharyngoplasty, a barbed pharyngoplasty whichever one you choose, and then something for the tongue base.

Now classically, for Stanford again, the same protocol was the genioglossus advancement. But you can say the patient has huge lingual tonsils, and you decided to torse or you want to do copulation, tongue base procedures, what have you. Just remember that you want to make it multilevel. So then you would get a sleep study about six months later. And if the patient's not improved, you go for the MMA.

The second one would be whether it's mild, moderate, or severe sleep apnea. If they concurrently have a job problem, well, you're going to do the MMA, because you're going to fix two things at once. And remind me to come back to this point actually, after this question, there's a really key point here. And then number three, of course, is when you do your sleep endoscopy, and you find the patient with both concurrent, concentric collapse of the velum, and lateral pharyngeal wall collapse, then you got to give the MMA a thought. Those for me are the three main indications that I've been writing, again, in textbook chapters of various specialties.

Dr. John Marinelli:

I've read a little bit about an AHI greater than 65, or that sort of thing. But how does that fit into the indications?

Dr. Stanley Yung-Chuan Liu:

Especially for older patients, per se. And here, we bring in, of course upper airway stimulation, or hypoglossal and their stimulation of which would currently only have one that's FDA approved. And it's the Inspire, and you know the Inspire has a range, 15 to 65. In terms of the AHI as a criteria. Of course, it also has a criteria for the BMI, which we didn't mention, but it is important, believe it or not, in my opinion, there's a very important similarity between upper airway stimulation and the MMA.

It's crazy, right? Because they look like such vastly different procedures. But I classify both as extra pharyngeal surgery, meaning you're kind of doing things indirectly aren't you right? With MMA, you're moving the jaw bones to strengthen the dilator muscles to help them expand and counteract negative pressure.

With the hypoglossal nerve stimulation, you are doing something to stimulate the hypoglossal nerve at the right time to strengthen the genioglossus. But the key is that genioglossus muscle has to drive the tongue that has to drive the lateral pharyngeal wall muscles and you know what they are and drive open the vitem which is also why you rule out the concentric guys because it's very hard to do that.

They're both extra pharyngeal surgery. In fact, if you think about the CPAP itself as extra pharyngeal. Intraparyngeal would be things like UPPP tongue base, where you actually are intervening on the dilator muscles themselves. The 65 limit there is in a situation where say you had a patient where they had an AHI greater than 65. And what are you going to do about that.

You could do face one, bring them down below 65, they probably have concentric collapse and you can correct with the pharyngoplasty and we publish that in laryngoscope. And then you then use upper airway stimulation. So if you lool at the new Stanford algorithm, it incorporates all of these as a group, because the key in the end is, is not about surgical success with any one particular procedure. Sometimes it's about combining these procedures to achieve what I call treatment success.

Dr. John Marinelli:

And I guess on the flip side of this, we're talking about indications, but also can we touch on the contraindications that you kind of mentioned this with some of the age discussion, but anything specific on that.

Dr. Stanley Yung-Chuan Liu:

I think age tends to be an issue and age is not so much an issue from a surgical standpoint. You can operate on someone who's 60 some years old, and have them go through the MMA with a smooth recovery. But again, the key about the MMA is after you move the jaw bones, the upper airway muscles have to remodel properly. In a young patient, for some reason, it just seems to happen naturally.

So if you look at the systematic reviews, certainly the younger the patient, the better the result, and that's fine. So age is not an absolute contraindicator, but it's something that you want to keep in mind. Other things. Patients with connective tissue disease, I've encountered a number of patients with Ehlers-danlos and whatnot, those are probably not the best patients you want to do skeletal surgery for. Because you are not sure if their temporomandibular joint and whatnot will handle change in the mechanics as such.

The other one of course, again, not an absolute contraindication, but BMI. You know that past 32, your success rate continues to go down. So at some point, you want to enlist either medical or



surgical weight loss teams to help you with that. So those are key and in clinic in reality, I tell my patients two things, that if you don't like don't think about the MMA.

One is you don't like the numbness of the chin. So we're talking about the V3 paraesthesia. V3 paraesthesia is discussed in orthognathic surgery literature, but inadequately in MMA literature, and I want to make it a really important distinction right here.

When you do orthognathic surgery, orthognathic surgery essentially means straightening of the jaws, so that's using a bone surgery to treat a bone problem. Where there's malocclusion or misalignment of the jaws and whatnot. With the MMA you're using bony surgery to treat the soft tissue problem, that is the airway. Key point there being that with MMA surgery, you're advancing a lower jaw bone, on average, one to one and a half, sometimes two centimeters.

What I learned is that the jawbone you can fix very well, the muscles will stretch and strengthen, that's what you want. But unfortunately, your inferior alveolar nerve won't stretch with you. And they're going to have numbness for quite a long time in the chin. That is unlike teenagers getting jaw surgery.

So that's one deal breaker there. If you don't want your chin, literally the chin, not the motor movement, but just sensation wise, if you don't like it being numb for a long time, or potentially parts of it forever. Or if you have a problem with the fact that your facial profile will change. While it's usually for the better, but anyway, if you don't want it to change, then you don't want to consider the MMA surgery as well.

Dr. John Marinelli:

And before we transition to more than nuts and bolts around the surgery itself, did you want to make one more comment on the one piece with indications there.

Dr. Stanley Yung-Chuan Liu:

So two points I want to make there. One is that be very suspicious. If a patient comes in with jaw misalignment, that they have sleep apnea because if we think about this a developmental issue. Again, and I gave a talk at Facebook about this. If you think about the progression of this, you have a kid. Okay, and so a child born with huge tonsils and their mouth breathing.

What happens is you end up with very narrow upper jaws. The misalignment begins with the fact that the patient never established nasal breathing from day one. So be very suspicious when you see patients where their occlusion is misaligned that it is actually a breathing issue at work there. And then the second point really I wanted to mention is that the MMA is not orthognathic surgery.

A lot of oral surgeon would talk about it like I know how to deal with the MMA, it's about pushing the jaw forward. No, no, it's not. It absolutely isn't. Because if that's the case, you will never be able to treat a class three patient. A class three patient being someone with a lower jaw more forward than the upper jaw. And of course, you want to move the upper jaw forward and bring the lower jaw back and that is entirely not correct. With proper rotation of the procedure you can actually bring back the occlusion, but advance the airway. Yes, it's possible.

So the MMA is, again, as I stress, it's a bony surgery to treat a soft tissue problem. And that's very different than orthognathic surgery, which is doing a bony surgery to treat a bony problem. Anyway, I just want to make sure that, that distinction is made.

Now, it doesn't mean that we don't think about orthognathic issues, we'll make sure the bites perfect. You have virtual surgical planning. You have all the intraoral scanning thing that I've mentioned to you that we can make sure that happens. But the airway is very much in the realm of our expertise and our specialty.



Dr. John Marinelli:

And if we transition maybe to talking more about the surgery, I wanted to start, or at least ask you a little bit about patient counseling. You've talked a little bit about the chin numbness already, the cosmesis issues, any other key points surrounding patient counseling that you'd like to address?

Dr. Stanley Yung-Chuan Liu:

Absolutely. Recovery is a very funky thing about the MMA. Let's say we do tonsillectomy and pharyngoplasty. And you know, it's about two to three weeks of pretty bad pain, but then it ends there. Well, the MMA is not like that, you'll never have intense pain like that. But if your idea of recovery is to be able to do a T-bone steak, then we've got issues, because it takes some time, at least for me to release you from being able to chew properly.

So really, the things you counsel the patient, and this is literally the category that I go through in order of their complaints. Pain is not an issue, I can tell you that most of my patients, especially younger patients, two days post op, they're not on narcotic payments. Pain is not going to be your problem.

I talk about it with them, but hungriness is going to be a problem. Because you're going to do a liquid diet for two weeks. Now, the liquid diet is not so much that we don't want them to use their jaws, it's also that they have wounds in the mouth. All of the MMA approaches, the wound inside of the mouth, for the majority.

And so if you start eating food and food falls into your wounds, and you can't clean them, that create problems. So that's one thing. You have to counsel them on nasal congestion, because going through the fort means that your maxillary sinuses are blood filled for the first two weeks, and then clots and it breaks down.

So all of these things are tough for the patient, you have to talk about the numbness, and no matter really what you do the chin and when we talk about the chin, we're talking about the sort of the portion between, say canine to canine, it's always going to feel more numb than the rest of your face.

So you want to institute in a biofeedback exercise early so that the brain gets used to the fact that this is the new normal. So the counseling for the MMA post-op includes all of these things. I'll give you a funny example, my mentor Bob Riley, who pioneered the procedure would say, "If you work for yourself two weeks, if you work for the government take all six weeks off."

The idea here is that if your idea of recovery is being able to eat a T-bone steak, then you're talking about two months. If your idea of recovery is being able to get on Facebook, or Instagram and text your peers. That is the afternoon after surgery. I tell the patients this all the time, above your nose and below your chin you're entirely normal.

So yes, we encourage them to walk quickly after surgery. I feed them within 30 minutes after the procedure because we've found that out to be one of the key indicators of getting them out of the ICU, which 95% of my patients do not go to the ICU. And again, calling your friends, texting your friends and whatnot should not be hampered by the operation itself.

Dr. John Marinelli:

I wanted to ask you a little bit about the procedure itself, if you could highlight some of the key points of the procedure you made mention of the LeFort osteotomy is things like that.

Dr. Stanley Yung-Chuan Liu:

I sure will. And I'm really glad you asked that. One of the key problems I've heard from my colleagues, and from my good friends like Ryan Souse and Raj, and everybody is that, hey, the MMA is great for the hypopharyngeal airway, but it screws up the nose. Yes, it does. Because when you advance the jaw bones and you rotate it up, you're actually reducing nasal passage space.

And so when I looked at hold procedures, we looked at 300 some patients, a whopping 17% of these patients needed a septoplasty or cosmetic nasal surgery after the MMA, and that's not okay. Because remember that sleep apnea is a dual problem. And I tell patients this all the time, and you should use this as well. It's a flow and a floppy problem. Flow meaning you want to establish nasal breathing. And a floppy of course, your first year hypopharyngeal airway and muscles.

If you don't fix both of them, you're going to be behind the eight ball. So with the MMA surgery, very, very key point about the surgical algorithm, again the LeFort's not hard to learn, neither is the mandibular advancement, the sagittal split surgery.

But the key thing that everybody misses is reestablishing the airway and the nasal airway. So once you advance the jaws, and you rotate things up, and you start plating the patient away, you want to contour the nasal bone. By the way you have in your hands, if you've ever done the maxillary down fracture, the nasal floor is in your hands. And you can contour it so that it is widened. You can do a mega-antrostomy and you can really take down the vomer. You can do all those things and you can do a septoplasty.

And we've decreased that rate of needing a post-operative nasal surgery to below 6%. And this is really important. Again, you can [inaudible 00:37:30] for surgery and it's about the same everywhere. But the key about the Le Fort and so the upper jaw is that you need to reestablish nasal passage and the nasal breathing. What about the lower jaw?

In oral surgical literature. Believe it or not, they consider patients above the age of 32 to be high risk for jaw surgery? I can tell you that if I see a 32-year-old going through the MMA I'm really happy. Because my average patient is in their late 40s, early 50s. So what do you do there?

So there are a couple things. There are a lot of violent instruments used in maxillomandibular surgery that you don't want to use. You don't want to use Rowe's disimpaction forceps, because you're going to base again, that's for the upper jaw. And what happens there is you're going to hurt the cribriform plate, you're going to affect the breathing afterwards. It is not a way to mobilize.

The way to mobilize upper jaw advancement is not by pulling the upper jaw. But actually by rotating it sideways. And you do not need a violent instrument for that. For the lower jaw you do not want to read an oral surgery text and use what is called a Smith Spreader. Basically is a violent instrument if you go click and it basically tries to expand. And if you do that, you're going to have a pretty untore fracture, because what's one thing you lose in the mandible is marrow space as you age.

And so what we use is a very controlled osteotomy that allows you to see the nerve, see the bone split, and make sure that your bone splits properly. I guess the point I'm trying to make is that the technique that you want to use for your jaw surgery has to be a little bit modified if you will, compared to routine jaw surgery, but it works very well and it's very safe. And those are sort of the key points. So let me summarize it one more time for the upper jaw.

You need to make sure that they have no septal deviation and no nasal obstruction. When you mobilize it, it's not about taking a violent instrument and yanking the jaw forward. It's actually very gently rocking it side to side to free up the attachments from [inaudible 00:40:00].

Okay, coming back down to the lower jaw. The key there is, you want to make sure that you wedge this thing open very gently and move the jaw forward. Now, we published on this, we looked at is

it patient factors, I mean, maybe their age and maybe their AHI contributes the bad jaw split before you do the advancement.

And unfortunately, it's not about the patients, it's about your surgical technique. So if you do this surgical technique properly, as I have described, then you're not really limited to the age limit of the patients that you're doing the advancement.

Dr. John Marinelli:

And just a practical question here. When we talk about the immediate postoperative period, you mentioned that most of your patients actually aren't going to the ICU, which contradicts maybe some things that people might have read or you talked about feeding quickly after surgery. Can you touch on what your postoperative management looks like?

Dr. Stanley Yung-Chuan Liu:

John, I love your question here. It's a team approach. A couple things. Anesthesia has to help us out from the start. So what we do is we ask them to run under total Intravenous TIVA if you will. And so they're running the patient under propofol and remifentanyl, those two things here.

Propofol's great. It's anti-nausea anyway, and TIVA, so you running them under propofol and remifentanyl. That means you can quickly reverse that. Remi is great, because you can quickly reverse that, because you don't want airway obstruction post-op. So that's why you don't want to run them on their gas. And you don't want to run them after things that have a long tail so to speak, narcotic payments have a long tail.

So anesthesia helps us out. My average MMA is about three hours in terms of length, so you don't want them under the table for too long. And then postoperatively, you want them to drink quickly. Now, one thing that I must mention is this, please don't wire your patients shut. And anybody who asks you that after jaw surgery, you have the wire the patient shut is really coming from a very previous generation.

Because it is not about the MMF, the maxillomandibular fixation that keeps the jaws together. In fact, if you need a wire to keep your jaws together, your fixation is not very strong. But I know that's not going to happen because all of you have access to great material, titanium plus fancy material from great companies that have great fixation plates.

So if you fixate the patient properly, you do not need to wire the patient shut and I put a couple of rubber bands and that's it. And I'll tell you why. For two reasons. First, I'll tell you why we need the rubber bands. The rubber bands are not there to keep the jaw together. First of all, you can't use rubber bands to keep the jaw together.

And two, if you need them, then something happened during surgery. Number two is the rubber bands are there to fight muscle memory. Remember that once you advanced it, the jaws, the mandible and maxilla has to move to a new position but your muscles have a yet to adapt. So your rubber bands are there to help the muscles lay down more subunits and adapt from that perspective of why rubber bands instead of wires and anything fancy. Why do my patients, they can open their mouth after surgery.

You see, we're all trying to avoid the number one complication. And John, you know what that is, and that's airway complication. I've heard of centers where they've done a emergency trach for post MMA patient, but that's not necessary. Because if they can mouth breathe, I know if their nose gets plugged and I told you the sinus gets plugged and whatnot.

But let the mouth breathe. Suction through their mouth, they're going to be okay. But in order to do that, you can't wire them. I know you give patients wire cutters. But come on. I mean, it's even hard for me to cut through a patient in distress. By the time I go from my house to the hospital, or from my resident to show up in a hospital, it's way too late.

But with rubber bands, they can breathe through the mouth. So they don't have an airway emergency. And if you think about it, we're talking about the quality of life surgery. So we cannot afford anything with an airway embarrassment. And in that sense, we want to do the best fixation we can and just manage with rubber bands. So hence, again, the rubber band post-op is key. And that's what I use.

In fact, I've had a few not very compliant patients who decided to eat a cheeseburger seven days out of surgery, because rubber bands are pretty weak and they can just cut it out and they can do it. I don't advise it. But what I mean is, we cannot afford in their way situation. You never need to do a trach for an MMA patient. Even if you choose to use wires, cut the darn guy out and let the patient breathe through the mouth and you're fine.

That is really key. From a post-op perspective. The ICU study is a bit of a sort of thing. My mentors, when they started doing MMAs they did have to wire people for six weeks. That's a long time. So you're not surprised if they need to spend a day or two in the ICU, so that's okay. But we don't do that anymore. My patients actually right now, after MMA surgery, we put them in guiding elastic bands, so elastic bands and rubber bands in a class two fashion. And they go to an EMT specific floor.

Now, again this is assuming in your hospital, you have a ward that you send your routine airway patients too. But if you do that, for younger patients, I can send them out in one day. And in older patients, I send them on two days. Now you're saying, "Stanley, are you just trying to push them out of the hospital?" No, it's not that. You see, we are, at least in the US, we are quite limited by what our insurance companies will approve of.

And increasingly, they see our MMA patients the same as a 17-year-old getting jaw surgery, and they think they can get out in one day. And you have to kind of really document well, if you want to keep them for two days.

So in that sense, you really want to optimize who you send to the ICU and who you don't. And I think we have a very, very good protocol for that. But what I want to stress here is a team effort, anesthesia needs to help you, you need to do fast surgery, and you need to feed the patients quickly.

So I tend to go feed my patients, like in the morning I'll do an MMA, in the afternoon I'll do a hypoglossal. And in between, I'll go feed the patient. Because when the patient realizes, "I can swallow. I can drink?" Well, that's key, because their payments will go via that route. And as you know, the oral payments have a longer half life, at least than your [inaudible 00:47:40] or whatnot. Those are very, very key points.

Dr. John Marinelli:

And I'll qualify this next question with the obvious note that defining surgical success in OSA management is controversial. But when you think about talking to patients about how successful is MMA? How do you think about that question, or how do you talk to patients about that question?

Dr. Stanley Yung-Chuan Liu:

Well, John I was kind of hoping you wouldn't ask that question but you did ask the most important question. Look at the new Stanford protocol in a new way. The reason why this protocol came to being is that, they're a couple things. The new improved precision surgery protocol for OSA has three key

points. Number one is characterization of static and dynamic airway phenotypes. Number two is identification of new anatomic risk factors along with their solutions.

So we're talking about mastery narrowness and expanding their upper jaw. Number three is utilization of technology, that can improve safety and efficacy of your classic procedures, when we're talking about virtual surgical planning. We talked about that. But let's not forget one thing. This is elective surgery. So that patients choose what they want to go through.

Sometimes I walk into a clinic room and the patient goes, do the biggest thing you got, and I want to swing for a home run. I'm going to shoot for the MMA. Patient comes in and says I'm kind of the basic kind of guy. All right, we're going to do nasal surgery, CPAP, nasal surgery, palate surgery, oral appliance, nasal surgery, blah, blah, blah. There are stages, to all of these things.

There's no such thing as surgical success. What we use a surgical success that we publish with is very artificial. It's something along the lines of your very severe sleep apnea, you're going for the AHI below 20. But we all know that there are a lot of young patients with AHI below 20 that are highly symptomatic.

And the goal of treatment is not about the AHI. In a pediatric patient, the goal of treatment is about getting the kid out of mouth breathing so the kid doesn't develop a narrow jaw and a hypoplastic mandible, and peeing in bed within a recess until age 11. A teenager, is about someone who's not self medicating, and this is a really a big deal. And I hope some of the residents who's listening to this will pick up on this.

The teenagers are some of the most underserved population for sleep apnea. So they may self medicate with coffee. And then to tone down they might use cannabis or whatever, you know these teenagers exist. And if you don't treat them early on, then they'll end up with the patients that we see in clinic every day.

But you know, this was an ongoing process. And so these really important points to look at, where they are in the treatment phase. But let's walk away from surgical success rates, because all that allows you is to publish a paper, what you really want is a treatment success. And that may be MMA plus hypoglossal stim. That may be MMA followed by CPAP, like why don't you just use CPAP? The guy couldn't wear it before CPAP.

I have a patient with a BMI above 40. But he will not do bariatric, the guy's a chef. I'll do the MMA. And then he says he can use CPAP following and a year later I couldn't be more healthy. As surgeons, we have to realize that we are part of a team process to get the patient better. And it is about treatment success, and symptomatic improvement way more so than our ability to publish a paper and saying, "Because I advanced to this patient in different way, where I throw a different stitch. And my surgery of success is better." First of all, the evidence for those papers are low. And it's not what the patients are seeking.

Dr. John Marinelli:

And I guess the last question I want to ask you about just pragmatically, when you're talking about follow up for these patients, how are you designing that? Or what interval are they coming back? When are you getting a repeat sleep study? Do you get a dice afterwards?

Dr. Stanley Yung-Chuan Liu:

Love your question. Couple things, pragmatically you can do... The way I do my MMA is that we also throw in a few suspension wiring to take the stress off the plates. Because if you rely everything on the

plates, you think things are really rigid, but the force as you know, the upper airway muscles as such they may resorb. We use some old school techniques with wiring and that's great.

So when I take out the wires, I will do a dice and look at the airway change. And this is also where all the literature from the resolution of concentric collapse and lateral pharyngeal collapse comes from. The MMA has a very interesting post-op trajectory, here's what happens. You open up the airway. Patient are going to come back and tell you, I started training again, I feel great, don't get too excited. Because what's going to happen next is they're going to have a little bit of a dip in their sleep quality, but they will improve.

So how does this work? Let's go back to the beginning. And I'm so glad you asked this question. The MMA is a muscle-oriented procedure. So when you initially do the MMA, you'll open up the airway, it's kind of like the patient's getting CPAP for the first time, or those wearing CPAP can tolerate it. You get the REM rebound, you start dreaming again, you sleep well, great. But the muscles are still weak.

So about two months later, you're going to have a slight dip. And when you look at my mentors, Nelson Paul and Bob Riley, when they get a sleep study at six months mark, they get very diverse results. But when they get at one year mark, they MMA is that successful surgery that we all know about. And the reason is the muscles have readapted and strengthened.

And number two, they have communicated to the brain that it's safe. Patients, I tell them this all the time. One of the most common side effects after the MMA is actually insomnia. And I'll tell you why. They go to sleep for two hours and they wake up, they can't go back to sleep again. And the reason is the brain is so used to waking the patient up and opening up the airway. You and I know John that we've opened up the airway, but the brain doesn't know that.

And it takes a while for that coordination to occur. So the best time to assess your post MMA patient is one year out because you have gone through the phase of opening up the airway and the muscles becoming stronger. And the muscles communicating neurologically with the things that are very complicated beyond my understanding, but I know they're there. Which is in the [inaudible 00:55:16] control, because the brain has to trust you that your airway is better. And so the best way to assess your MMA is one year out, not six months out, not three months out. And that's key.

Dr. John Marinelli:

All right, well, that pretty much wraps up all the questions I had for you today Dr. Liu, but was there anything else that we didn't talk about that you thought is maybe worth mentioning?

Dr. Stanley Yung-Chuan Liu:

A couple of things. And John, thank you again for running this podcast because I can't think of another... The MMA and hypoglossal nerve stem, two of the most iconic procedures for sleep surgery. Here's what I want to say. The MMA makes everything you do better. And why do I say that?

I'll give you an example. I had a 65-year-old man with an AHI 145, he doesn't want to wear CPAP. So we've gone out of the way. And the oral appliance is not going to take care of a guy with an AHI of 145. I don't know what to do for him. I really don't. Instead he's non obese, he just happens to be like the tallest man you know. He's really tall with a long neck.

And when he comes to my clinic, and I do tend to fall behind, because I give every patient an hour of time, just kind of go through the whole thing. And by the time we get to him, he's always asleep. And I told him, I said, "Listen, I have no choice. But I think you're 65, you have an AHI of 145. The most predictable thing I can do for you surgically is going to be a combination of MMA and hypoglossal nerve stem." And guess what, that's exactly what we did for him.



And my MMA firm is very conservative. I only did a centimeter, which of course, for most centers will be big, but I usually routinely do more. But anyway, I just did a centimeter for him. But I told him, this is never going to be enough. We're going to have to do a hypoglossal nerve stem. And he's like, "I understand that." And then we explained all that.

And so we did the MMA, and the initial post-op results encouraging. We brought him from 145 down to 25. But I know that's not long lasting. If he were 22 maybe we'll just leave them at that but he's not. So he went from 145 to 22. And we did the hypoglossal nerve stem. And we did this whole thing within one year. And he ended up with an AHI of three, obviously with the hypoglossal nerve stem.

And I remember post-op with him, yes, sorry, I was running late again. But a gentleman was reading a book, and feeling great. Two things, you never want to wait until a guy who is 65 years old, or a lady is 65 years old with severe sleep apnea before you treat him. You treat the patient as early as you can. But if you must treat him that late in the game, sleep surgery is in a very cool era.

Because with things like the combination of the MMA and upper airway stimulation, hypoglossal nerve stimulation, you saw that what we were able to do with a gentleman like that, which I think in previous generations, it was really difficult. No, the guy did not have big tonsils, the guy did not have heavy palate, he's just a thin guy with a long neck.

So one thing for the surgeons who are listening in on the podcast is that we have to walk away from any one procedure being the only goto. It really needs to be combination of surgery and a non surgical procedures, or multiple like different kinds of surgeries. And don't forget, by the way, your patient chooses what surgery they want to do. Your patient might be a slugger, they want to go for the home run, or they're a basic kind of guy, and they want to go from first base to second to third to home.

You have to walk with them that path according to their preferences. So, never before is sleep surgery more exciting, because you have the tools in your hands to combine the various procedures. And I just caution that what you want to do is stay very humble. And know that all we can do is address the critical negative airway closing pressure, that's for one. And for two, being able to combine various entities in order to achieve treatment success, not surgical success. I know that's how we publish, but you don't want to do that anymore. You want treatment success.

And so if there's only one thing to take away from this entire podcast, and I know it's focused on the MMA, it's this and that is treatment success is what we're going for. If it requires MMA to get there, we ought to do it. If it requires MMA plus other procedures, we ought to do it.

But ultimately, it is treatment success that we go for. And if we think about it that way, remember that sleep surgery is not cancer. This is not cancer surgery which is reconstructive in nature, you take out the disease organ, you put in a fibula or whatever and this is not that. Sleep surgery is functional surgery. What you want to do is reestablish nasal breathing, reestablish proper genioglossus muscle function, reestablish dilator muscle function, and any surgery that could get you there, you do that. And so it's about restoration, but is not reconstruction.

So if you continue to think about sleep surgery in that way, I expect a lot of you to be able to come up with innovative ideas, more minimally invasive surgery, and achieve what is really the most popular course on campus we have today, which is a course called sleep and dreams. All right, because again, as you know, if you can't get into that deep sleep, you can't achieve your dreams. And on that note, I'll end this podcast and John, thank you very much for leading me through a topic that I am fiercely passionate about.

Dr. John Marinelli:



Yeah, well, we thank you for your time in being here today. So in summary of today's episode, maxillomandibular advancement surgery is really one of the classic procedures used in the surgical management of obstructive sleep apnea.

There's several goals of surgery. But overarchingly it's important to be mindful of maintaining patients cosmesis, preserving or improving their occlusion. And then the way with which MMA actually even works is this idea of stabilization of the upper airway and lateral pharyngeal wall, preventing the lateral wall collapse and preventing that concentric collapse of the velum.

And so that's beyond just what you see in a lateral cephalometric X-ray, for example, where there's expansion of the retrolingual airspace, it's really more about the muscle dynamics of the upper airway. So thinking about indications for surgery, there's really several and ultimately the patient decides this is elective surgery and there's nothing that is the standard of care or the only option that they have.

But some of the key indications that you'll read about is, one, patients with OSA and preexisting dental facial deformities. Two, if they still have severe OSA such as AHI greater than 65 in patients who have already failed phase one surgery for example, palate surgery or tongue-based reduction, for example, and then three, if drug induced sleep endoscopy reveals that the patient has complete concentric collapse of the velum as well as lateral pharyngeal wall collapse.

There's really no absolute contraindication to MMA but things you'll hear about and read about is that older the patient gets, the more challenging that procedure is to perform. But really, it's very feasible to do through patient at 60s even. And then generally speaking, patients tend to do very well with the surgery long term, especially when selected appropriately, you'll read published rates of surgical success, even though it's a controversial topic of about 85% and surgical cures being an AHI less than five in about 40% of patients. So really tolerated quite well with good outcomes.

Last portion of podcast here, I'll ask a couple questions, allow for some time for you to think about the answer and then give the answer in response. So first question mechanistically how does MMA address upper airway obstruction in OSA?

So answer here is historically it was attributed to the improvement of the retrolingual airway, which is true but really, we've come to appreciate that the primary driver surround stabilization of the upper airway at the lateral pharyngeal wall preventing lateral wall collapse and preventing that concentric collapse at the velum.

Second question in patients with OSA. What are the three overarching indications to pursue MMA? Before we get into that, obviously keeping in mind that this is elective surgery, this isn't a all or nothing you have to do this if these are present, but it's things to be mindful of. One, OSA in a patient with the preexisting dental facial deformity. Two, a patient with severe OSA like an AHI greater than 65 who has previously failed phase one surgery for example, palate surgery, or three if the patient undergoes drug induced sleep endoscopy and it demonstrates complete concentric collapse at the velum and lateral pharyngeal wall collapse.

And last question, what is one of the most feared complications of MMA and how do you avoid it? So, the most feared complication is acute airway compromise postoperatively. And the best way to avoid this is not locking the patient down in MMF because it's done necessary as we discussed. That'll wrap things up for today. Thanks so much for joining us, and we'll catch you next time.