

[MUSIC PLAYING]

ANNE MUCHA: Hi. Welcome to this talk, we're going to discuss the ocular motor problems that we see after a concussion and how we evaluate and some management principles of that.

So our objectives are to discuss this profile, the ocular or the visual profile, and treatments, as well as identify ways to evaluate and screen for these problems after a concussion.

So I think some of our other talks have focused on the idea that concussions are very heterogeneously. We know that there's diverse symptoms that occur, diverse profiles that we see after an injury. And so we certainly aren't treating and evaluating every concussion the same.

And this model that we use here at UPMC identifies six different subtypes or profiles of concussion with the visual or ocular profile being one of those. But other profiles which we discussed are the vestibular profile, the mood profile, cervical profile, migraine profile, and cognitive fatigue profile.

So why do we even think about these profiles individually or what gives us credence to identify these separately? Well if you look at what the risk factors are for more complicated recovery following concussion, we know about certain things such as age, gender, history of learning disability.

But then we get into some of these really inherent issues like migraine history and symptoms that we know predict longer outcome, where mood and psychiatric symptoms, both preexisting and post-injury, predict a longer outcome. And there's great emerging data looking at ocular dysfunction and how that is now predicting a longer recovery. So again, these profiles make sense, they're evidence-based, and they help us dictate management.

So more evidence about concussion and visual dysfunction. We know that visual dysfunction is definitely prevalent following a concussion. In different studies-- which I'll highlight a little later-- that varies and to the degree in which the type of ocular dysfunction we're discussing, but it's there.

These are associated with other issues, like even balancing gait issues or cognitive issues with reaction time. We see that these definitely predict longer recovery and we need to kind of treat this ocular profile a little bit differently.

So that's what I'm going to discuss, the ocular profile. And how do we identify it first and foremost? Well, some is just by-- as a clinician, we do our normal subjective and history examination with our patients. And that's where we glean actually quite a bit of information, just asking the right questions about their past medical history and what they're experiencing now from the injury itself. We'll talk about that.

We also, though, use some tools, and the first tool we use is the VOMS, the vestibular/ocular motor screening, because that gives us a good window into these deficits. And then from there, we have a lot of good, solid ocular motor assessment that's more detailed.

So the things that we see after concussion, these are, by and large, the most prevalent things that we see, and this is based on data both from military studies-- so this one was done in 2012 in blast-related TBI. And you see the problems that are manifest are convergence problems, problems with pursuits and saccades, issues with ocular alignment-- so ocular misalignments which then create binocular vision problems, and then accommodative problems. So we see that quite a bit post-injury.

And then our data also echoed that. We saw a high degree of problems with pursuits and saccades and convergence in our data sample where we used the VOMS, and you see that the numbers ranged somewhere in the 30% to 40% category.

So again, what do we see after concussion? Well, we see problems with convergence, and that's where you bring targets in close to you and you have to move your eyes in a way to make the object or make your eyes converge to seeing your object.

We see problems with accommodation, which is associated with convergence. It's the ability to see things clearly as they come closer to you, so that's the blur that you experience.

We see problems with pursuits and saccades, so moving your eyes together either smoothly in a slow fashion or rapidly, but again, in binocular function.

We see problems with decompensated alignment issues. So you can have your eyes not necessarily be lined up exactly perfectly like many of us don't have. This can be very overt, this can be very subtle, but when that problem isn't compensated for, then you see issues with an binocular vision.

And what we see a lot are symptoms provoked by visual activity. So even though the testing isn't always that abnormal, sometimes these activities provoke a lot of symptoms in our patients.

So let's start by talking about the VOMS and discussing what ocular motor screens are part of that. So the vestibular/ocular motor screening is a brief five-minute quick grab of vestibular and ocular motor function that you see commonly after concussion.

So it's meant to be obviously a screening, we're asking about symptom provocation on different items, including pursuits and saccades and near point of convergence. We also do a measure of near point of convergence. Plus, there's a couple of other vestibular items that are on the test as well, including the horizontal and vertical VOR items, as well as visual motion sensitivity items.

So this is a quick little video of the ocular motor parts of the VOMS. When you do that VOMS, you record what symptoms are before you do the test. So you record there their resting, headache, dizziness, nausea, and foggy. And then you assess or reassess those symptoms following each item on the VOMS.

And you test these in the following order. You test pursuits first, you test horizontal saccades, vertical saccades, followed by near point of convergence, followed by horizontal VOR and vertical VOR, and then finally, the visual motion sensitivity test.

So this is a glimpse into the ocular motor items which are the first ones.

I'm going to have you focus on the tip of my finger. We're going to do horizontal pursuits first. You're going to follow my fingertip without moving your head, so just follow your eyes. Back and forth. We're going to go a foot-and-a-half each way. And we're going to do two cycles side to side. And I'm going to go vertically.

And now same thing. Three feet total, foot-and-a-half up, foot-and-a-half down. And then I'm going to ask--

The second part is saccades. So saccades are rapid eye movements. We're going to use that frame, and I'm going to go hold my two targets like this, and I'm going to have Cindy move her eyes as quickly as she can from target to target, back and forth 10 times or 10 cycles. I'm going to have you move your eyes as quickly as possible from right to left 10 times. Good.

And then I ask about symptoms again. So this is going to be with your headache, zero to 10?

CINDY: Two.

ANNE MUCHA: Dizziness, zero to 10?

CINDY: A nine.

ANNE MUCHA: Nausea, zero to 10?

CINDY: Zero.

ANNE MUCHA: Fogginess, zero to 10?

CINDY: Zero.

ANNE MUCHA: OK. And we do the exact same thing vertically. So again, up and down as quickly as you can 10 cycles.

CINDY: All right.

ANNE MUCHA: And then can you give me your symptoms now?

So bring it in. And stop at any point that it doubles. And if it doesn't double, touch it all the way to your nose. So let's imagine right there is where she reported double. So at that point, what I'm going to do is measure between the tip of her nose and the target. We'll get the centimeters there, and--

So those are the ocular items on the VOMS, and then that's followed by those vestibular items which we talk about in another lecture.

So again, that's screening for ocular motor issues. So if you're looking for a quick way just to get a sense of whether the ocular motor system is involved in your patient, this is a good way to start, but this is a very brief screening tool, so there's much more ocular motor assessment that you would want to perform.

So it would include things like general observation. So there's a lot that can be gleaned just by, again, not just talking to your patients, but looking at your patients. Things like head tilts can tell you about problems with cranial nerve function. Ptosis, so a drooping eye can tell you about cranial nerve function. Looking at whether somebody is wearing sunglasses or squinting or having a lot of blinking responses or blepharospasms, those were the good ways to be able to determine about ocular issues with your patients. So just don't forget to observe your patients when they come into your clinic first.

And then, beyond, again, the VOMS, which is very symptom-based, you need to assess the quality of eye movements and the efficiency of eye movements. So you need to look at extraocular range of motion.

So in the VOMS, you're doing-- just looking at pursuits and saccades in a very specific pattern, but you would want to look at full range of motion with extraocular range of motion testing.

You would want to look at the quality of their saccades and pursuits. You would want to look at vergence responses, both convergence and divergence, and those are the binocular functions that we're looking to assess.

You also may, in some cases-- and this is not everybody that I see, but certainly in some cases where people are reporting real visual disruption, you may actually need to go in and look at visual field. So don't forget the confrontation testing that you do, which is monocular, and you're looking to see if people have full-- if there's any field cuts in their vision. So very important to at least consider in certain patients that are having complaints of maybe trouble with actually seeing things in certain parts of their vision.

Extraocular range of motion can be done a multitude of ways. So some people are used to the H test, which is what I have listed here. Some people use the Z test, some people go in circular fashion, but the idea here is that you're looking for binocular control and range of motion in all of those planes and full range, so you want to make sure that you look at all of those patterns. In reality, when you're doing smooth pursuit movements, you can look at this extraocular range of motion as well.

When you're looking at saccadic eye movements, you're looking for quick simultaneous movement of both eyes. These are incredibly fast, and while they do take a little bit of time to generate, once they're generated, they're among the fastest movements produced by the body, so they're incredibly important to life and function.

So these are guided by frontal and parietal influences, so that's why it takes a little bit time to initiate these movements. So patients that have issues with the brain in those areas may have psychotic deficits.

But it isn't always because of those issues. A lot of our patients just have slow saccades, or maybe they're a little hypometric so they're not moving quite as far as what they should. So you'll see a lot of saccadic eye movement deficits.

For smooth pursuits, again, we're looking for slow smooth movement without a lot of saccadic intrusions, which, again, we see quite a bit following a concussion. These are slow, so you're looking at moving between 20 and 40 degrees per second. So the one area that I see most clinicians make is that when they're testing smooth pursuits, they're really going very quickly, and that's not an engaging only the pursuit system, you have to use other eye or ocular motor functions whenever you go a lot faster than 40 degrees.

So make sure that when you do smooth pursuits and you're really trying to test those that you're going slowly. And then the VOMS, we do make sure that that's part of the instructions, we're going slowly.

But the things that you'll see with pursuit movements very frequently, like I said, are saccadic intrusions. You could see a lot of symptom provocation, just like with saccadic eye movement testing. And then you could see limited range of motion if you have some deficits with maybe a cranial nerve function or things like that, so that's why it's helpful to identify pursuit movements.

So again, convergence testing you saw in the VOMS, we're looking at near point of convergence, and we're looking to see when a target doubles at near or when there's an exodeviation of one eye and that's their near point of convergence, which is a very good basic test. But there's more to convergence than just near point of convergence.

So that near point of convergence or that break point is an important thing to identify, and it's also good-- like in the VOMS-- to do it multiple times because there can be a fatigue factor with it.

But the other component of convergence is looking at recovery. So in addition to looking at near point, you may also want to look at recovery. So once they have that break of convergence, at what point can they regain single vision as they move the target back outward?

In reality, what you want to see is that's within a few centimeters of where their near point of convergence was. So that break-- say that break was it five centimeters, which would be normal, you want to see that that recovery is within about five centimeters of that, maybe even more, so that that recovery happens at eight to 10 centimeters or better.

Sometimes you'll see that their near point of convergence looks pretty normal but they can't recover it until almost quite a bit out. That's probably also a more subtle convergence problem that may need to be addressed, especially if there are confounding visual symptoms and things in your exam in history that lead you into some visually-based types of problems.

Just know, though, that convergence insufficiency, there is a subset of folks who, without injury, have convergence insufficiency. The data is a little bit mixed about this. In some cases, I see reports of 3%, some are more like 10% to 15%, but it looks-- so we kind of split the difference and said maybe about 6% on average have abnormal near point of convergence in the normal population.

We see this, of course, based on what we showed you earlier, the data that I showed you in those earlier slides, near point of convergence problems are really common after concussion, certainly more than this kind of coincident or incidental finding in the normal population.

The other thing to remember when you're doing and testing convergence and recovery is make sure you're using a discrete target. What I mean by that is don't have somebody stare at just your finger or something that doesn't have a very fine focal point for them to look at. It needs to be something that is a single point that you can actually focus in on.

And again, just to reiterate what we have said in the VOMS, but it's also true if you're convergence testing outside of the VOMS, is remember, five centimeters is considered kind of the normal range for near point of convergence.

Now convergence insufficiency is not the only convergence problem that we see. Just like problems with having trouble with regulating convergence coming inward, we can actually have a problem with convergence excess or spasm. So I'll show you video of that.

So this first would be a convergence insufficiency case. So if you look at her and mainly look at her eyes as she's doing near point of convergence testing. Can you see how her right eye is moving inward towards the target but her left eye just kind of sits out there and never pulls in towards the target like her right eye does? So that's a convergence insufficiency problem where she's really not using both of her eyes to converge.

Now on the other side, this is done with video goggles so that you can see a little bit better. This patient is just being asked to move their eyes around. So I'm just asking them-- and they're in the dark, so they really don't have a focal point.

--right.

I'm asking them to move to the right. You see how that convergence response kind of kicks in without being volitional? They're trying to move both of their eyes to the right, and then to the left, and in all directions, but you can see like this convergence excess, this convergence spasm wants to kind of influence the eye movements in every direction first. So even with going up, that's even more pronounced. So again, as she moves her eyes over to the right, the eyes want to converge together first.

So you can see that, and this patient had a lot of visually-based complaints when they would read, when they would try to take notes in class and copy things from the board up and down. They were having a lot of problems.

And then the other thing I want to mention in the vergence system is not only can you have problems with convergence, some people can have problems with divergence. So divergence is the opposite of convergence where with convergence, your eyes are working together, moving in opposite directions as you bring things near. Well, your eyes also have to work that way to see a distant target as well, they have to move together to diverge to see things distantly.

And if you have problems with maybe convergence excess or other issues, you might have trouble with divergence just as well as convergence. Again, these are all things that we would look at when we start to dig deeper into ocular motor function.

So I mentioned accommodation, which is a partner to convergence because they're both about seeing things at near. However, accommodation is different than convergence. In accommodation, you're looking at the ability of the eyes to focus. Much like the focus in your camera and how it adjusts the lens, well, that happens the same thing visually with us. So that your eye, the lens in your eye has to accommodate and change shape so that you can change your focus near to far.

So the only difference about-- one of the main differences between convergence and accommodation is convergence insufficiency or convergence problems are not mediated by age. So it doesn't matter what age you are, near point of convergence should be at five centimeters regardless of your age.

That is not the case with accommodation. Accommodation, like those of us that are getting beyond 30 or well beyond 30 know, changes as you get older, and that's because the shape of your eye changes. So accommodative insufficiency does definitely-- or accommodation function changes as you get older. So younger kids should have an increased amplitude of accommodation as opposed to older folks.

So we kind of use a little more general descriptions. At least in my world, I tend to look at below 30 with a certain expectation for accommodation, and once you get above 30 and especially 40, you need to think about whether people have reading glasses or whatnot to measure accommodation.

So anyhow, you measure it with one eye at a time. Let see if I have it here. So when I look at accommodation, I'm covering one eye and I'm having the patient look at a target that is discreet. And I like it to be generally 14-point font size unless somebody has a real visual deficit and then I may up that depending on what their normal regular vision is at arm's length.

But I'm looking to see at what point do they report blur and where they can't see the target anymore, and that's their near point of accommodation or their accommodation point. And I'm measuring that now-- not from the tip of their nose like we do convergence, I'm measuring it from the bridge of the nose or the corner of the eye or trying to kind of get it to where the cornea is the plane of the cornea.

So you're measuring it from that eye and you do it one eye and then you do it the other eye. Ideally, unless somebody has a preexisting problem with amblyopia where their eyes don't see the same, that measure should be pretty similar between the right and the left eye.

So my rule of thumb, because again, this is an age-dependent phenomena, is if you're under 30, your accommodation should be within 15 centimeters Bilaterally . If you're older than 30, then that changes and there's formulas to be able to look for that. Remember, patients for both convergence and accommodative testing should have their glasses on.

So when patients have issues, what do we do? Well, it's nice to identify them, but it's even better to be able to treat them. So for convergence insufficiency issues, for problems with pursuits and saccades, then visual exercises, vision therapy done either in physical therapy or occupational therapy by therapists that know how to do vision training, or even in an optometry office where they have vision therapy can be very effective.

Sometimes prism lenses can be helpful as well. Medication and surgery are options, but they're rarely, rarely used, and that's only if some problems are very severe.

So these would be examples of some exercises on the bottom that we would do with patients who have these issues. For convergence insufficiency, a really common basic exercise is called a pencil push up where you're basically doing that near point of convergence measure as an exercise. For pursuits and saccade exercises, there's just a multitude of things that you can do. But basically you're trying to work those functions in a way that's interesting.

So there are actually lots of apps and lots of computerized things that work pursuits and saccades pretty nicely, but I think what my picture is just showing is I'm asking the patient to kind of just try a follow along on some squiggly lines to get from point A to point B, and then that way, I can tell that they're using their pursuit system.

And then on the right side is a Brock string exercise, which is another convergence insufficiency exercise. Very, very easy to use, very effective for mild to moderate convergence insufficiency.

And then vision therapy includes things like those exercises that I showed you as well as a lot of potentially high tech things, especially in the optometry practices, there might be computerized programs that can be utilized or prescribed. There's more complex tasks that kind of combine motor function with ocular motor function or balance function.

The top would be flipper lenses, which you would do for accommodative problems to work on magnification changes and try to work on that blur, and then a various amount of pursuit and saccadic and convergence and divergence-type exercises that are shown here.

So the good news is that there's more and more data showing that vision therapy is effective as well. I think years ago, there was I think one study done and it showed-- it wasn't a well-done study and it didn't really look at this type of vision therapy, but it kind of made the blanket statement that vision therapy doesn't work, and unfortunately, that word got out, but there's many more studies since then and good studies that look at the efficacy of vision therapy for these particular issues these ocular motor deficits. And more and more data is showing that it can be very effective, and then we find that also in our practice.

So just to summarize, hopefully I described these ocular motor problems are common after concussion. We see them in a certain subset of patients, and it's not a tiny subset, it's at least about 30%. These can be identified through some screening tools as well as some objective and subjective tools. And that vision therapy can be a benefit when you do have these ocular motor problems, and we should be thinking about doing these with our patients who have these deficits.

So thanks for your attention.