

## Answers to Audience Questions - WSPOS Worldwide Webinar 5: Superior Oblique Palsy - What, Where, When & Why?

### WWW 5 Panellists



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#### 1. John Lee would have advised ipsilateral horizontal rectus inferior transposition for comitant deviations in primary right and left gaze if there is no significant torsion!

SG: The problem is that SOP has incomitant vertical deviation and the inferior transposition of the horizontal muscles is useful for comitant deviations.

GG: Sounds useful if there is comitance- usually in IVn palsy I find there is still a significant difference in R&L gaze so I haven't done what you suggest in the past - thanks for this useful tip.

SA: For me, vertical shift of horizontal muscles is not very predictable (compared to the many alternatives). I agree that a significant recession of a single vertical rectus muscle with comitant strabismus is likely to produce an incomitant result. My favourite procedure in this situation is recession of the SR on the higher eye and recession of the IR on the lower eye, which is a very comitant procedure. If it's under 12 PD, I do partial tendon recessions, which are even more predictable.

RK: Yes, works for small 6 PD vertical comitant deviation, may not be applicable in SOP, where it is usually incomitant.

#### 2. Is success our measurements? Or the patient resolution of problem?

SP: Resolution of the problem

SG: We always seek the patient's satisfaction. Generally, it corresponds to the surgery success.

AM: The patient always comes first. If symptoms are resolved, and the patient is happy, I call this a success

GG: The success in our measurements is secondary - I usually like < 5 pd in primary. However, the patient's resolution of the problem is most important.

SA: Some of both. Fixing what bothers the patient is the goal. Some adults with long-standing SO palsy do not tolerate full correction of their deviation; success is making them straight enough that their symptoms go away but not so straight that they have diplopia. On the other hand, there are patients who have a large under correction that they can fuse for now; they are happy in the short term, but you know the likelihood of them remaining symptom-free over time is low.

MG: both

SK: I think it's a bit of both and not one or the other. I'm happy when the patient is happy post-op but if at post-op visits 1-3 months after surgery, I measure a moderate size residual deviation especially in downgaze, I highly suspect it's going to be only a matter of time till my patient is no longer happy with the result and further intervention will be needed with either more surgery or prism glasses to accomplish fusion in the reading position.

HL: For me, it's the patient's point of view. Even if sometimes I am happy with the results but the patient is not...

RK: I think it is both. Orthotropia in all positions of gaze, diplopia free field and disappearance of head tilts and full ocular movement is IDEAL. These cannot be achieved in all patients. Hence, I would say that some of which can be corrected to 100% and some of which can be corrected up to 60 % or so. This should come during the patient counselling.

### **3. Is success what we find or what the patient wants?**

SP: What the patient wants

SG: Sure

AM: The goal is to improve the patient's life. What we find, what we measure is to help us understand what the patient has and figure out the best way to help him/her

GG: Hopefully the two will be the same

SA: See Answer to Q 2

MG: both

SK: See Answer to Q 2

HL: See Answer to Q 2

RK: See answer to Q 2. Please see this open access article: Kekunnaya R, Isenberg SJ. Effect of strabismus surgery on torticollis caused by congenital superior oblique palsy in young children. Indian J Ophthalmol. 2014;62(3):322-326.

### **4. What is the choice of IO surgery in SOP with DVD?**

SP: For dvd, I feel more comfortable with anterior transposition

SG: It is rare to find a SOP with DVD but in these cases it would be indicated to perform a bilateral IO anterior transposition

AM: Anteroposition of the IO reduces movement in upgaze, so perhaps SOP with DVD is the best indication for it.

GG: If DVD is also present, I usually do inferior oblique anterior transposition. This always causes a deficit in elevation so you can't do unilateral surgery if the patient needs upgaze for their work e.g. yacht rigger, roof tiler or they like to ride a pushbike with their body flexed so they have to look up to ride the bike. In this case, you would need to consider inferior oblique recession and a superior rectus recession on an adjustable suture

SA: I don't believe I've ever seen SO palsy with DVD.

HL: This is very rare. In cases of Inf. Et with DVD, if there is also OAIO I will do myectomy and wait, and if there is no OAIO I will recess the SR

RK: Very rare to see this condition. Mostly these are DVD cases with V pattern of IOOA. My choice of surgery would be anterior transposition.

**5. Do any of you ever use the Bicas Manoeuvre to show a masquerade bilateral SOP?**

AM: I don't.

GG: I don't know what this is - not listed in Medline or Google search

SA: No, I have not heard of the Bicas manoeuvre and could find no reference to it.

MG: The Bicas Manoeuvre is useful for more comitant cases where one can maximize muscles actions and it might allow the possibility of diagnosing a masked bilateral SOP. [Please view the article here.](#)

SK: I have never used the Bicas Manoeuvre to unmask a bilateral SOP. I honestly have never heard of it before and had difficulty finding anything about it online. What I did find and I am not sure we are talking about the same thing, was an article published in April 2014 titled, Influences of body position on Bielschowsky's test by Souza-Dias CR et al in Arq. Bras. Oftal. Addressing the change in measurement of the hypertropia in SOP when the patient was erect, supine or upside down based on the otolith static reflex. There was no reference to its application to unmasking a bilateral SOP. I use other methods to uncover a bilateral versus a unilateral SOP pre-operatively. It has been my experience that if a so-called bilateral SOP is uncovered post-operatively it is due to a surgical overcorrection and not an underlying initial bilateral SOP. Especially with inferior oblique weakening procedures. Most congenital SOP are unilateral.

HL: No

RK: NO

**6. What is the differential diagnosis of long standing Hypertropia with compensatory head tilt to the same side of hypertropia?**

SG: The differential diagnosis is Manifest DVD.

GG: Still can be a IVn palsy with paradoxical tilt to the same side. – DD RSR palsy, myasthenia, TED etc.

MG: DVD, restrictive strabismus (TED)

SK: I am not sure just "how long" longstanding hypertropia is in my list of differential diagnoses, but these are the conditions I would include:

- (a) Skew Deviations - there are some similarities but mostly significant difference to the 2 conditions. The biggest of which is torsion. As expected, patients will have excyclotorsion in the hypertropic eye with SOP but with Skew they subjectively report incyclotorsion in the hypertropic eye.
- (b) Thyroid Eye Disease can give a positive Bielschowsky head tilt test but is secondary to a restrictive situation mimicking a SOP
- (c) Third Nerve Palsy – can give this impression when patient prefers fixation with the paretic eye. The non-paretic eye can appear down and out.

HL: Look for bilateral SOP, and if the deviation is really large look for other reasons for head tilt like astigmatism etc.

RK: DVD, TED, Skew deviation and even SOP in some cases.

**7. How you check fusional range? And with or without head tilt?**

SG: I usually do it without head tilt

AM: With the prism bar. I measure in primary position, without the head tilt.

GG: This is checked with a vertical prism bar which increases the prism up and down until diplopia is relieved or occurs.

SK: I check vertical fusional amplitudes with a vertical prism bar held over the hyper eye with the prism Base DOWN while the patient fixates on a distance accommodative target starting with the 1<sup>^</sup>BD slowly increasing it till the patient reports diplopia or when I observe a break in their fusion if they suppress. I will then decrease the BD prism till they recover fusion. Notating the break and recovery points. I often test this for near too. Typically, I'll test it with their compensatory head position because when I straighten their head, they often become tropic and demonstrate no vertical amplitude. I find it better to do the test over the non-preferred eye which is usually the paretic eye but not always. So on those occasions, I'll perform the test on the hypotropic eye with the base UP.

HL: I do it very rarely either by binocular visual field or with a small target (pencil for example) moving Back and forth with and without tilt

## **8. Why is a sup. oblique tuck done in lax SO if a lateral rectus tuck is not done in lax LR?**

SG: We can perform LR tuck with similar outcome than resection

AM: In congenital SO palsy the muscle has been found to be hypoplastic in 73% of cases, so it's a different pathology than LR laxity

GG: SO is a muscle with complex actions so tuck solves complex issues. Lateral rectus tuck/resection on its own seems to undo over time and undercorrect

SA: The concept is that a "lax" superior oblique is a normal muscle with an anomalous tendon, so the treatment is to fix the tendon. While there are anomalous superior oblique tendons, I think most tendon laxity is a function of severity and duration of the palsy, just as with the LR in 6<sup>th</sup> nerve palsy. So for most cases the decision to do an SO tuck, just as with the analogous procedure of LR resection in 6<sup>th</sup> nerve palsy, is a function of the incomitance pattern and the residual muscle function (although that's not usually knowable for SO) and not the laxity of the tendon.

HL: Tucking of the LR will cause a big ugly dome shame scar forever, plus the SO tendon is less friendly for resecting and will definitely cause Brown

RK: Not similar but one could do LR plication as strengthening procedure.

## **9. Isn't torsion an obstacle to prescribing prisms?**

SG: Not at all

AM: It all comes down to the particular patient, they may not be bothered by torsional diplopia and accept vertical prisms well.

GG: In my opinion- yes.

SA: It can be for bilateral cases. Torsion is rarely the factor that prevents fusion in unilateral cases. In these, it is the incomitance that may limit the usefulness of prism.

MG: yes

SK: It can be but not always. Many or even most patients with SOP with excyclotorsion less than 5 degrees can fuse when the horizontal and vertical deviation is offset. After I've done all the measurements including the torsion measurement with Double Maddox Rod or the Synoptophore, I will put the least amount of prism needed to accomplish fusion in primary position and approximately 10-15 degrees laterally and downgaze for distance. I ask the patient if they are fusing or if they still notice the tilt. If the underlying deviation is not too large (mild to slightly moderate SOP) and it is unilateral, many patients are very happy with incorporated prism and do very well. Once I've established what works for the distance, I will check them at near to make sure it works there too. In cases where there's a significant distance/near disparity, my patients will need to understand the limits of the prism glasses and may need separate pairs. Occasionally, I've been able to manage different prism requirements for distance and nearby prescribing a slab off or a reverse slab off.

HL: Yes, it is, it is very difficult to but possible

RK: Not always, in some cases it can be tried and they fuse.

#### **10. How do the panellists manage acquired brown syndrome after tuck?**

SP: I tend to go back and undo the tuck quickly as it is harder to do later and I am very worried about it but I may be risking an unnecessary procedure as I'm sure it could potentially loosen up over time

SG: Waiting as long as possible

AM: I have not encountered it, but it is said to alleviate itself over time.

GG: If seem in acute post-operative period- go back and undo some or all of the tuck

SA: If done very soon after surgery, it is often possible to remove the suture to "undo" the tuck. Later, the arms of the SO tendon are scarred together and a guarded (chicken-suture) SO tenotomy needs to be done on the nasal side of the SR. However, I have never had to do this for Brown syndrome after a tuck that I did myself.

MG: usually disappear with time. If symptomatic has to undo the tuck

HL: The effect fades with time so patience and reassurance is needed. Very rarely you have to untuck it.

RK: If it is mild, it disappears. If moderate to severe, they need immediate surgery to "take down the tuck". The more you wait, the more scar you will notice and undoing is difficult and ineffective more often than not.

#### **11. Did the panellist select 20 pd of upper limit for IO myectomy?**

SP: I do not do myectomies

SG: Yes

AM: An upper limit of 10, 15 or 20 PD for IO surgeries is of course arbitrary, but it gives you a rough idea of what is most likely the correction you can obtain with this surgery, based on what we have seen in patients in the past. Again, it comes down to the particular patient's response to the particular surgery.

GG: I use 15 pd - figure form most of North American literature

SA: That's more than I would expect. More like 10-12 PD and only that much in cases with a lot of inferior oblique over action. However, in many cases you don't necessarily need to correct all of the deviation and for them, IO weakening alone may be close enough for 15 or even 20 PD.

MG: yes, if IO overaction is +3 /+4

HL: No, this is my favourite operation. And as I mentioned during the symposium, I work in steps, almost never doing 2 muscles in one procedure for SOP

RK: Yes, that much can be corrected unless the SO is very lax (in which case I add SO tuck)

**12. Do adults require different glasses for near and distance with prism?**

SP: Typically, they do if their deviation is larger in downgaze

SG: sometimes.

AM: If they are presbyopic, yes. Bifocals / multifocals already pose a technical challenge there.

GG: Generally, yes

MG: many times yes, but if prisms are needed for distance and near you can prescribe on progressive lenses

SK: Answered in Q 9

HL: It depends on the patient

I usually begin with prisms for the most needed distance even for patients that already uses multifocal glasses

**13. In the text for 15 pd HT just IO myectomy.**

SP: I do not do myectomies

SG: It is a good indication

AM: In congenital SO palsy, you can always try it as a first procedure, and it is highly likely it will be enough.

GG: also applies to recession but anterior transposition gets up to 25 pd in my hands

SA: See my answer to Q 11

MG: in my hands, a large IO recession can also correct 15PF

HL: See my answer to Q 11

RK: Yes, I would perform IO myectomy. Please see my answer to Q 1 and refer to this open access article for the different procedures performed and to know the etiological profile and neuroimaging details. Ray D, Gupta A, Sachdeva V, Kekunnaya R. Superior Oblique Palsy: Epidemiology and Clinical Spectrum from a Tertiary Eye Care Center in South India. Asia Pac J Ophthalmol (Phila). 2014;3(3):158-163.

**14. Don't you use botulinum toxin to treat traumatic superior oblique palsy?**

SP: I do not

SG: No

AM: I would be hesitant to do that. Traumatic SO palsy is likely to be bilateral, and is typically mostly bothered by a big amount of cyclotorsion, so you would need to treat the obliques and that is technically very challenging with botulinum toxin.

GG: No

SA: No. I have seen 1 patient who was treated with Botox injection to IO that did not end well.

MG: No

HL: Never tried

RK: NO

**15. Have the panellists seen superior oblique palsy with sinusitis?**

SP: I have seen it with mucocele from sinusitis

SG: It is possible, yes

AM: I have not.

GG: No

SA: No, Brown syndrome but not palsy.

MG: No

HL: Not as a mono-neuropathy

RK: Yes, with mucocele due to sinusitis

**16. Is botox used in IO after a traumatic or acquired SO palsy?**

SP: I have not done this

SG: I do not use botulinum toxin in these cases

AM: I would be hesitant to do that. Traumatic SO palsy is likely to be bilateral, and is typically mostly bothered by a big amount of cyclotorsion, so you would need to treat the obliques and that is technically very challenging with botulinum toxin.

GG: Not in my hands

SA: See my answer to Q 14

MG: I have no experience

HL: Did not try

**17. Dr. Mauro: Regarding bilateral IO Palsy with very little vertical deviation, is the problem mostly the torsion?**

MG: torsion, V pattern (more ET in downgaze), HT in lateral gazes and down right and left

**18. 61-year-old Cardiologist s/p midbrain hemangioblastoma resection with bilateral SO palsy and torsional diplopia - 3 degrees excyclotorsion right (synoptophore and double maddox rod), 0-3 degrees excyclotorsion left (double maddox rod only not synoptophore), 4-5LHT in primary gaze, 8LHT and ET4 downgaze, can fuse in upgaze. Interested in the panellists approach to SO surgery in this case.**

SP: Maybe bilateral IR recessions asymmetric with adjustable sutures

SG: Bilateral SOP cases are challenging. This patient could be treated by right Harada Ito and Left SO small tuck

GG: I would do Left Harada-Ito as first procedure

SA: I need all of the diagnostic gaze position measurements to offer an intelligent plan. Why are you calling this bilateral SO palsy? The double Maddox rod and synoptophore findings are not providing any evidence of that. Functionally, torsion is the difference between the two eyes, just as esotropia is. You would never say a patient had 10 PD of esotropia in one eye and 15 PD of esotropia in the other eye. If I understand correctly, this patient has as a 3-6 degrees of extorsion? It sounds like he notices the torsion when he has diplopia, but does he fuse this in primary position with prism correction of the vertical? — most people will fuse 6 degrees of extorsion. However, the torsion in reading position is often much worse and needs to be specifically measured. Too many possible answers depending on a complete set of measurements.

MG: need to have all measurements to decide

HL: I would try Dr's Pineles's method... never did it

RK: Very small excyclotorsion; I would perform left Harada Ito

**19. What suture does Stacy use?**

SP: Vicryl

GG: I thought 6/0 vicryl

**20. Do the panellists do ant. or post. fibres of superior oblique tucking? and what is their experience?**

SP: I do anterior tucking as described. I have never tucked just the posterior fibres

AM: In central Europe (Dr. Kaufman in Germany, Dr. Klainguti in Switzerland and probably many others too) it is classical to tuck the anterior fibres (anterior 1/3) to specifically treat excyclotorsion, and I have seen this procedure work very well. See: Hoeckele N, Kaeser PF, Klainguti G. Results of anterior tucking of the superior oblique muscle tendon in bilateral fourth nerve palsy. *Klin Monbl Augenheilkd.* 2015 Apr;232(4):452-4.

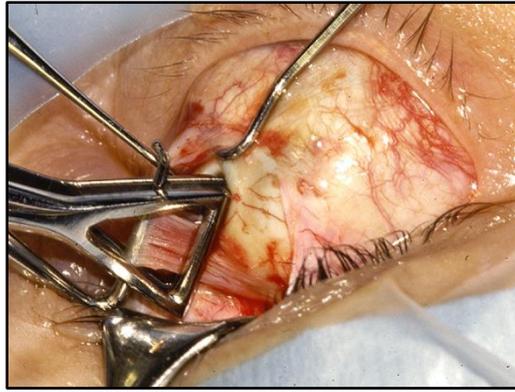
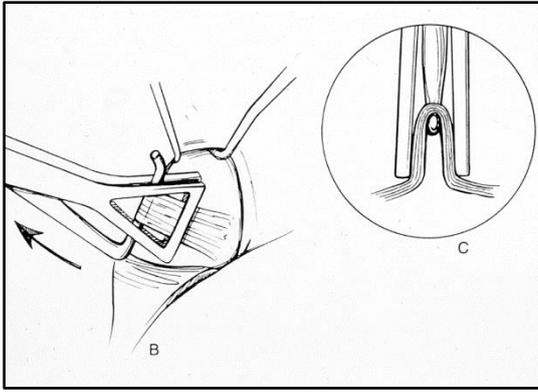
GG: I tuck full tendon

SA: I generally tuck the entire tendon. Occasionally, I tuck the posterior fibres and do a Harada-Ito on the anterior fibres when the amount of torsion correction is more than I can get with just a tuck.

MG: I do the whole tendon

**21. Please show the video of tendon tucker use.**

SA: I don't have a way of sending a video, but these figures might help.



RK: I use "Namaste sign" for SO Tuck. Video will be available soon in JAAPOS.



**22. Does superior rectus weakening aggravate extorsion? Does the panellists that take into account?**

SG: most of patients with SR overaction / contracture have large Hypertropia in PP and they tilt the head because of the vertical. Torsion is not the problem here.

GG: Generally, not

SA: Yes, but not enough to matter.

MG: usually no

HL: Very minimally

RK: We perform SR rectus mostly in combination to IO weakening / SO tuck surgeries (in cases of SR contracture). Hence doesn't matter much.

**23. Why does SR restriction develop?**

SG: For long-standing deviation

GG: Long standing vertical on that side will lead to SR shortening and spread of committance

SA: Presumably contracture from the eye spending a lot of time in an elevated position in patients with a manifest deviation a good part of the time.

MG: the muscle become shorter when there is a long standing deviation

SK: The SO muscle and the SR muscles are synergists for intorsion but antagonists for vertical movements. Because the SO is weak and not effectively depressing the eye with longstanding SOP there can be a limitation of depression in abduction presumably secondary to a restrictive SR.

HL: Just like the IO, according to Sherrington's law of reciprocal innervation

RK: Due to longstanding and large hypertropia, SR becomes tight.

**24. When do the panellists consider contralateral IR recession? How much do they recess IR, do they go by the rule of 1mm for 3 PD?**

SP: I do 1 mm for 3 pd and I use it as my first choice in a deviation worse in downgaze and ipsilateral gaze (as opposed to a tuck)

SG: I choose to recess the contralateral IR when the hypertropia is larger than 20 pd in Primary and he has more than 10 pd in ipsilateral downgaze

GG: If deviation is worse in in downgaze when in field of palsied SO- or if there is still an undercorrection after ipsilateral surgery – IR recession is indicated. I take 4 pd per mm

SA: As a primary procedure, only when the deviation is greater in down gaze, not very different in right and left gaze, minimal torsion and no ipsilateral SR restriction. Not very often. Usual 3 PD/mm, but tends toward late over correction, so leave a little under corrected if done with adjustable suture.

MG: important to know the distribution of the deviation in all positions of gaze. The IR recession can be don alone or mostly associated to IO recession

HL: Yes, but only for residual hypertopia

RK: Yes, when the deviation is more in downgaze (and when the SO is not lax)

**25. How long does it take the Brown Syndrome?**

SG It depends on the magnitude of the tuck

SA: A mild Brown syndrome, which you should have after an adequate tuck, is usually not symptomatic but improves over several months and is often completely gone in 1-2 years, especially in children.

HL: Immediately after the tucking, actually we are aiming for a "small brown"

**26. Do panellists perform primary inf. Rectus recession and do they do nasal shift in bil. SO palsy?**

SG: Yes. I have some cases treated by primary IR recession only. I do not do nasal shift in bilateral SOP

GG: If necessary when torsion is maximal in down gaze

SA: See my answer to Q 24. For bilateral SO palsy I only do bilateral IR recessions when all else has failed. I do not shift for recessions less than 6 and I shift 5 mm for an 8 mm recession, which is actually just keeping the muscle on the same line to the orbital apex.

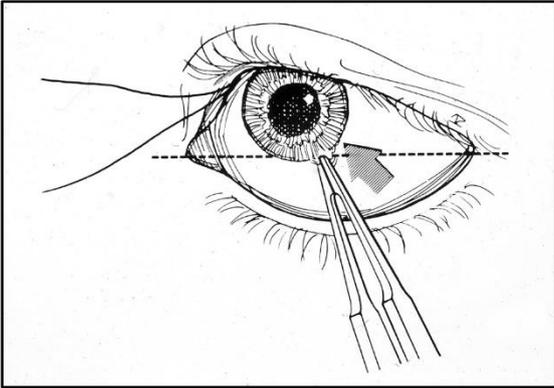
MG: Yes, I perform bilateral IR recession without nasal shift

HL: No

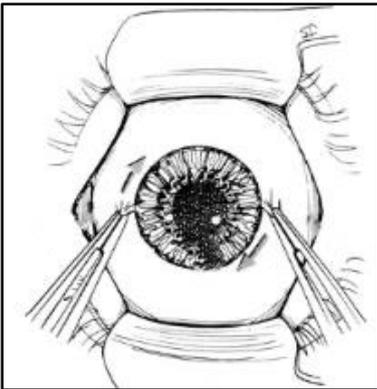
RK: Just IR recession (without shifting) in very rare cases of Bil SOP, esp. when ET in downgaze.

**27. Dr Archer: How does he decide the amount of tuck?**

SA: The amount of tuck is by feel. It should be just loose enough to be able to easily lift the tendon tucker away from the sclera in order to pass the sutures beneath it. For me, placing the sutures would be very difficult if the tendon is too tight, so do as much as is easy. For those who don't have a good feel for this, Rick Saunders's test is helpful, which I demonstrated at the end of the video. Lift the eye up and in with forceps at the inferonasal limbus and you should feel resistance just as the inferior limbus hits the line between the medial and lateral canthus.



A secondary test that I do is passive extorsion, also demonstrated at the end of the video. You should still be able to easily extort the eye 5-15 degrees. If you have a hard stop almost immediately as you try to extort the eye, you are too tight.



Some people tie the tuck temporarily so to make it easier to change if they're not happy with the tension and then do these tests before final tie down.

RK: Just after tuck on table there should be mild Brown and also use Namaste sign as a gauge.

**28. Do you have Brown syndrome secondary to oblique superior tuck?**

SA: Always some mild Brown syndrome with an adequate tuck, usually not symptomatic. I have never had to re-operate for Brown syndrome after a tuck that I did myself.

MG: some limitation of elevation in adduction happens

HL: Almost always

RK: Yes, Mild Brown is desirable.

**29. Has Steve caused a Brown syndrome tucking a non-lax tendon?**

SA: See my answer to Q 28. The minor Brown syndrome that you expect after an adequate tuck is no different for lax or non-lax tendons if an appropriate amount of tuck for each case has been done.

**30. I agree (to the above - Q 28). I only do inferior oblique weakening first, because even with deviation up to 20 PD< the large fusional vergences often get them back into a comfortable alignment.**

SG: If the patient has 35 pd in PP IO weakening alone is not a good option, he will be under corrected and not happy.

SA: See my answer to Q 28. Doing the proper amount to tuck is important to avoid causing problematic Brown syndrome. If you are not comfortable doing a tuck, then it is probably safer not to do them. You can certainly make patients straighter in primary position and improve head tilt with IO weakening, contralateral IR recession, or a variety of other procedures. But for patients with greater deviation in down gaze, predominantly reading symptoms, and children with large head tilt, better alignment in secondary gaze positions and more improvement in head tilt can be obtained with a tuck.

**31. Does Antero nasal transposition of Inferior Oblique correct more than 20 PD hypertropia?**

SP: Not in my experience

SG: IO Anterior and nasal transposition is a very powerful procedure, it could correct more than 20 pd.

GG: No experience

MG: I haven't done this procedure

HL: I use it only for DVD + OAIO

RK: Not really, it can correct up to 20 PD only.

**32. SO is not lax, Hyper >25, IO is recessed, which muscle to operate next - ipsilateral SR or contralateral IR?**

SP: For me it depends on whether the deviation is worse in up or downgaze – if downgaze, then IR. Unless the SR is tight on forced duction, then I would recess it regardless.

SG: It depends on the incomitance pattern

GG: If incomitant, do contralateral iR. If there is spread of comitance so that there is a vertical away from the field of the palsied SO- then do ipsilateral SR recess on adjustable if possible

SA: Could be SO tuck (I don't care if it is lax), or recession or resection of any of the 4 vertical rectus muscles in the two eyes, depending upon where the residual deviation is worst. If you mean that the residual deviation is >25 PD after IO weakening, then we are probably talking about 2 more muscles.

MG: it depends on the measurements. If the HT is greater in down and out gaze of the affected eye, I do ipsilateral SR recession; if greater HT is greater on the field of action of the affected SO, I do the contralateral IR.

HL: If there is hypo on down and adduction, I will tuck the SO even if it is not lax

RK: Depends on presence of incomitance in downgaze, if that is the case, contralateral IR recession.

**33. Do we only do IO recession if there is significant overaction?**

SG: Yes, and when larger deviation is in upgaze

GG: I prefer myectomy if there is 1-2+ SO underaction

SA: Yes, or if the greatest deviation is in up-contralateral gaze. They should normally be the same thing, but not always.

MG: No. If the HT in PP and contralateral upgaze is not large, different amounts of recessions can be performed according to the amount of IO overaction

HL: This is my approach

RK: I prefer IO myectomy when deviation is larger in contralateral upgaze.

**34. What position do we measure? 10 degrees? 20? 30? If we do it differently, how do we compare our decision making?**

SG: That is a difficult problem to solve, comparing different measurements of different strabismologists

AM: We should measure in all positions of gaze. Most important ones are of course primary position and downgaze (reading, going down stairs, etc.) and decisions should be made upon deviations in these positions of gaze.

GG: Measure in primary then about 20 deg off axis in 9 positions

MG: maximum up and down gaze, extreme lateroversion as maximum as possible

SK: 30 degrees from fixation for all gazes except direct upgaze, up/right and up/left where I'll measure more like 20 degrees. Sometimes I'll measure greater than 30 degrees in direct downgaze. Occasionally, I will measure more in the upgaze position if my patient is a serious cyclist and has a chin down head position when riding his bike.

HL: If there is OAIO - I will do myectomy first

**35. If IO surgery failed to correct the head posture in the 1st sx, what are the second and third sx to be done?**

SP: Depends on up/down gaze deviation and whether the SR is tight on forced duction.

SG: It depends on the incomitance pattern

GG: Look at remaining pattern- general rule is to operate where the deviation is maximum

SA: Same answer as Q 32. It depends on the measurements in diagnostic gaze positions, assuming that the residual tilt is due to residual hypertropia. SO tuck often does a better job of correcting head tilt in children so, if that was not the first procedure, I will look for a way to do a tuck as the second procedure.

MG: in my experience IR recession, SO tuck and if there is a contracture of the SR, recess it

HL: If there is hypo on down and adduction, I will tuck the SO first

RK: Depends on a cases to case basis; if more in downgaze SO tuck, If tight SR, SR recession or else Contralateral IR

**36. Does it matter what IO weakening you do?**

SP: Probably not but I like to recess the inferior oblique so I can find it later if I need it.

SG: Different weakening procedures can obtain similar good results

AM: Despite every one of us having their favourite one, it appears that all procedures work well if you succeed in getting the whole of the muscle and do not miss those most posterior fibres.

GG: Myectomy preferred unless you are doing other vertical muscles at the same time, especially with adjustable sutures; then you need the IO to be anchored so I do recession in this instance

SA: If properly done, myotomy (my preference), myectomy, terminal myectomy, disinsertion and recession are all functionally equivalent—they all move the effective insertion of the IO to Lockwood's ligament. Myotomy has the least extraneous steps and results in the least scarring in the vicinity of the lateral rectus inferior border. Recession can be more easily converted to anteriorization, if necessary, but may be more prone to develop Dave Guyton's "inverse Brown syndrome" over time. Anteriorization and nasal transposition are functionally different procedures though.

MG: I perform IO weakening accordingly to the amount of deviation in PP and contralateral gaze and to the amount of IO overaction

HL: In the last decade I do mainly myectomies

RK: I mostly perform IO myectomy in cases of SOP, If IOOA is very minimal I perform IO recession.

**37. How much vertical deviation in primary position can you expect to correct with IO recession?**

SP: 10-15 PD

SG: 15 -20 pd

AM: Up to 15PD, I would say. In larger deviations, you may still relieve symptoms by correcting most of the deviation and placing the patient within range of fusion that they can accomplish. In any case, we aim to slightly undercorrect, to avoid the risk of overcorrecting which is intolerable for the patient.

GG: 15 PD

SA: See my answer to Q 11.

MG: around 18 PD

HL: Up to 15 PD usually

RK: Around 15-20 PD

**38. At what age do you to operate for congenital SOP to prevent facial asymmetry and torticollis and stiff sternocleidomastoid muscle?**

SP: I would operate as young as 1-year-old if measurements are reliable but typically end up doing it a bit later

SG: As soon as possible, when I am sure of the diagnosis and can measure the patient.

AM: I would not jump in to do it, unless asked to do it by the parents/other doctors.

GG: Any time after one year or so, when I can get reliable measurements

SA: There is still some debate as to whether the facial asymmetry is due to the chronic head tilt or the same developmental anomaly that affected the superior oblique in the first place. If the latter is true, then correction of the

head tilt might not prevent the facial asymmetry. But I operate as soon as I'm sure of the diagnosis. This may be too young to get measurements in all the diagnostic gaze positions that I would normally need for optimal surgical planning. But in this case, with a large head tilt, I'm doing a tuck anyway.

MG: as soon as the exam gives me information about measurements and versions

SK: The sooner the better but maybe a test age 5

HL: The youngest I did was 18-months-old

RK: If the measurement is reliable or child is cooperative for complete assessment including head tilt, around one year of age or else as early as possible. Please refer to the article mentioned in my answer to Q 3

**39. What is the specific indication for Anteronasal transposition of inferior oblique? In which conditions do you perform pure anteropositioning and in which conditions do you prefer anteronasal transposition?**

SP: I don't use this procedure

SG: The absence of the SO muscle is a good indication for IOANT, I perform IOAT for cases with IOOA and DVD

AM: For me, coexisting DVD is the most important indication for IO anteroposition.

GG: In my hands 15-25 pd of vertical with spread of committtance (Answer to 'What is the specific indication for Anteronasal transposition of inferior oblique?' portion of Q).

HL: Only for DVD with OAIO, and only ateropositioning

**40. Does anyone use neck support devices post op?**

SP: No

SG: Not me

AM: I don't.

GG: No

SA: Yes, especially in adults when there is no residual deviation. They don't really know where straight is and just go to their habitual position. The pressure from a cervical collar when they tilt their head helps to remind them where straight is.

MG: no

SK: I've never seen this

HL: I never did

RK: Not me

**41. Do you image vasculopathic 4th nerve palsy even where we are reasonably sure? for e.g. in an uncontrolled diabetic?**

SP: No, I do not, if the patient is reliable for follow-up

SG: No

AM: Yes, I would image an acquired non-traumatic IV nerve palsy. It's the only way to exclude a coexisting tumor or other pathology that needs treatment.

GG: I don't, if there is an obvious cause and no other neurological signs

SA: No. Maybe, if it doesn't improve after 1-2 months. I don't see a reason to treat this any differently than vasculopathic 6<sup>th</sup> nerve palsy. 3<sup>rd</sup> is different only because of concern for aneurism.

MG: if it is an acquired case, with known etiology such as diabetes no, but other cases yes to rule out other possible neurological causes

HL: Usually not, unless there is something else in the anamnesis like headache or anything else. I had a case who also had bruit and a CCF was found

RK: No, if I suspect vasculopathy. If they don't improve after 6 weeks, I will get an imaging done.

**42. Is this a heterogeneous problem with a final common phenotype / presentation?**

SP: Yes, I agree with this statement

SG: The clinical characteristics of the SOP can be very different in different cases

AM: SO palsy encompasses quite a few aetiologies and a relative variety in signs and symptoms, but a typical picture does exist, and points to the most likely cause and the most likely treatment to work.

GG: Yes- some represent a cranial nerve disinnervation disorder

SA: Probably. There are certainly tendon anomalies such as failure to insert into sclera, and congenitals sometimes have very tenuous tendons. Most of the others are probably paresis, but are occasional patients whose deviation tends to recur, no matter what you do, who may have complete paralysis.

MG: some authors recognize it as a CCDD

RK: Yes, agree.

**43. Do we get different results in similar patients because they have different causes for their SO palsy phenotype?**

SP: Possibly – there may also be compartmental innervation/denervation effects, differences in surgical and measurement techniques

SG: I don't think the difference in the result is due to different cause.

AM: Yes, and perhaps they have different fusional ranges, and different expectations from their vision.

GG: I suspect so- pulley heterotopy can so cause an apparent SO palsy.

SA: Yes. See my answer to Q 42.

HL: This is what makes our profession so interesting

RK: Many factors are important while selecting surgery for a particular patient.

**44. How to differentiate decompensated congenital SO palsy and acquired SO palsy when the family album is not available?**

SP: Fusional vergence (sometimes a 30-minute patch test can help uncover a larger compensated deviation that helps with the diagnosis), facial asymmetry, patient history, intermittent vs constant diplopia

SG: Large fusional amplitude, facial asymmetry

AM: Facial asymmetry, large vertical fusion range, little or no torsional diplopia in congenital SO palsy. Also, chronicity allows spread of comitance.

GG: Large vertical fusion amplitudes usually in congenital SOP, torsional diplopia is absent and if the vertical measurement in upgaze is equal or greater than the deviation in downgaze, congenital SOP highly likely

SA: The Ivanir, Trobe article that Hana cited claims that the deviation in up vs. down gaze distinguishes between the two. This article came from my department and I have discussed with Dr. Trobe that this is not true in my experience. I guess you could say that whether it really proves congenital, no patient in this series with greater deviation in up gaze had a brain tumor. But this is a very small series so I don't think you can conclude that patients with a tumor never have deviation greater in up gaze. Mike Siatkowski, in his discussion of this paper, described a patient who had greater deviation in down gaze from a neurosurgical 4<sup>th</sup> nerve palsy who evolved to a pattern with greater deviation in up gaze over the following year or two. Large fusion amplitudes are a clue, but I have several adult patients who acquired their vertical deviation due to myasthenia gravis or Graves eye disease with >20PD vertical fusion amplitudes. But whether it's congenital or acquired isn't really an important question—only whether it is too chronic to warrant a scan.

MG: vertical fusional amplitudes presents in congenital SOP; no torsion/diplopia

SK: Facial asymmetry, large vertical fusional amplitudes with compensatory head position, spread of comitance in the lower fields and suppression

HL: And if there is an OAIO and facial asymmetry, it is usually a sign for a long standing condition

RK: Facial asymmetry, large vertical fusional range, no diplopia, spread of comitance, early onset during childhood.

**45. What about surgery to prevent the development of hemi facial atrophy?**

SP: If this is a consideration, typically there are other reasons to operate as well such as torticollis

AM: I would not do that. Facial asymmetry is usually not that bad.

GG: Operate early

SA: See my answer to Q 38

MG: plagiocephaly occurs with an important head tilt that needs to be operated as soon as possible

RK: Early surgery

**46. Will torsion be noted in unilateral or bilateral in diplopia charts in all cases of SO palsy?**

SP: either

SG: Torsion is almost always observed in the diplopia charts

AM: No, I think it largely depends on the patient. It is of course more likely to be noted in bilateral cases.

GG: Almost all

SA: Most acquired SO palsy will have some measurable extorsion. Daryl Ellis originally observed that >15 degrees is always bilateral. This has been misconstrued to mean <15 degrees is not bilateral, which is not true—many bilaterals have < 15 degrees. Patients with congenital SO palsy often have sensory adaptation to the extorsion and so may subjectively see none of it or only part of it (compared to what you see on fundus torsion).

MG: mostly on bilateral cases

SK: Very small extorsion < 5 degrees/usually asymptomatic will be noted in unilateral and > 5-7 degrees extorsion with possible symptomatic diplopia in bilateral. Not sure if in all cases of SOP. Sometimes with suppression it is difficult to evaluate subjectively. Although it can be observed objectively on fundus exam that does not always mean they are symptomatic with diplopia. And the converse of that is also true. Sometimes minimal extorsion on fundus exam can measure more significant torsion subjectively. Why I'm not really sure.

HL: In medicine (like in love and war) there is never "always or never"

#### **47. What is your preferred neuroimaging and what specifications do you request?**

SP: MRI brain and orbits with contrast with FIESTA images through the course of the 4<sup>th</sup> nerve to evaluate for small schwannoma

AM: MRI of brain and orbits. I ask the radiologist to look for IV nucleus and nerve in specific.

GG: Unless you have a specialist neuroradiologist, just get coronal views of the orbits.

HL: I would prefer MRI of the brain and the orbits, if there is nothing in the orbit and a lot of microinfarcts in the brain it is easier to diagnose a vasculopathic etiology

RK: MRI brain and orbits with contrast with FIESTA sequence for skull base view and trace fourth nerve and quasicoronal cuts to check and compare the size of SO on both sides.

#### **48. Dr. Klein: What about traumatic SO palsy during birth?**

GG: I'm not sure how you prove that this occurs

SA: I'm not sure who this question is for, but I'm not aware of any description of this. There is a transient neonatal 6<sup>th</sup> nerve palsy that is related to the birth event and is probably closest to what you are asking regarding 4<sup>th</sup> nerve palsy. But they all resolve by 2 months of age. If there was a similar neonatal 4<sup>th</sup> nerve palsy, I don't know how anyone would be able to document it in an infant < 2 month old.

SK: I suppose possible, but have not seen this.

RK: Not sure about this. Can happen, but I have not seen a case and I don't know even if I see, I can document unless the hypertropia is large (cause and association is difficult to establish).

#### **49. How do you identify a floppy SO tendon? What are the characteristics?**

SP: Exaggerated traction test mainly for me and then when I hook it I confirm

SG: Performing intraoperative Guyton forced ductions and comparing with the normal fellow eye

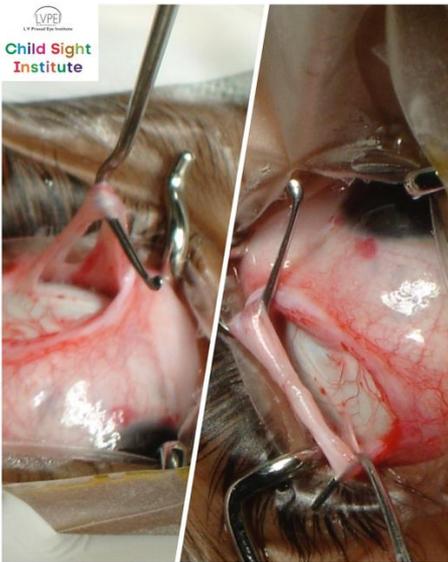
GG: Exaggerated forced duction test (in standard text books- originally described by David Guyton) under GA at time of surgery

SA: Unusually severe presentations are sometimes floppy tendons—or anomalous or absent tendons. In the operating room, Guyton’s exaggerated forced duction test can be used to demonstrate it. At the time of surgery, with a hook under the tendon, it will be easy to pull out a large amount of tendon if it is lax.

MG: Guyton’s exaggerated forced duction test and the feeling when you hook the tendon

HL: Only during the operation

RK: Guyton’s exaggerated traction test can help. While hooking also one can feel it as you see in this figure.



**50. Is SO palsy a CCDD?**

SG: Could be

AM: I think this is a matter of terminology consensus.

GG: Some cases definitely are. Yang HK et al Ophthalmology 2012:119: 170-177

MG: some authors are defining it as CCDD

**51. How often do you see this pathology / palsy?**

SP: Very often we see congenital etiologies

SG: It is very common in my practice

GG: In a busy strabismus practice, one or two cases a year

MG: around 10 cases/year

SK: According to the NIH 2017, the incidence rate was 5.73 per 100.000 per year. The most common cause with Congenital SOP (49%) followed by hypertension (18%) and trauma (18%).

HL: Very often in all ages

RK: 25-30 cases per year (Mostly congenital and traumatic cases)

## 52. Kindly explain the Parks test

SP: The 3-step test? Measuring the deviation in primary position, side gazes and head tilt allows you to map out the deviation to a SO paresis if it is acute onset and is due to a single palsy.

GG: this is clearly described in American Academy of Ophthalmology Eye Wiki

SA: [https://eyewiki.aao.org/Three\\_Step\\_Test\\_for\\_Cyclovertical\\_Muscle\\_Palsy](https://eyewiki.aao.org/Three_Step_Test_for_Cyclovertical_Muscle_Palsy)

SK: I am assuming the Park 3 step test is the same as the Bielschowsky head tilt test. Both tests are performed to isolate which cyclovertical muscle is paretic. You do this by evaluating where the hypertropia (vertical deviation) is greatest. There are 3 steps using RSOP as the example.

- (a) What is the hyperdeviation in primary position? This will give you the 4 possible cyclovertical muscles involved. If RHT, then it's either the depressors in OD = RIR or RSO or the elevators in OS = LSR or LIO that are paretic.
- (b) Is it greater in left or right lateral gaze which will eliminate 2 of the cyclovertical muscles? If RHT is greater in Left gaze, then it has to be either the RSO or LSR because the hyper will be greatest in the direction of the paretic muscle.
- (c) Is it greater on left or right head tilt which will isolate the one paretic cyclovertical muscle it is? If the RHT is greatest on Right tilt as in the example of RSOP, the theory is both the RSO and the RSR are incyclotorters but if the RSO is paretic and is NOT intorting OD, the unopposed RSR acts alone and because the SR's primary action is elevation, the eye will elevate and the hyper will be greatest on the paretic side. Hence pointing to the RSO.

## 53. Depending upon the measurements and what gaze the HT is max?

SA: I assume this is a question about choosing the procedure. If so, yes, the pattern of incomitance over all of the diagnostic gaze positions, including which is the greatest, is the most important factor in making the plan. This was the great insight of Phil Knapp. It only makes sense to do a procedure that has the most effect where the patient has the biggest problem.

SK: Typically, one would think the measurement would be largest in the example of the RSOP, down and to the left but this is not always the case if other muscle sequelae have occurred, such as RSR restriction or a contralateral inhibitional palsy of the LSR in this example.

RK: Depends on a case to case basis, Knapp's classification is based on this.

## 54. What is the indication for nasal transposition of IO?

SP: I don't do this procedure

SG: SO absence and some cases of DVD with IOOA

GG: See above

HL: I left it many years ago

RK: I don't perform this procedure for SOP, but there reports in selected severe cases of SOP with fairly good outcome.

**55. In the case of masked bilateral Superior oblique palsy, what is your Surgical plan?**

SG: If I suspect that the patient has bilateral SOP I perform bilateral and asymmetric surgery

AM: If I suspect it but have no measurements to justify bilateral surgery, I go with unilateral surgery first, but advise the family of the possibility it will reveal the bilateral condition and more surgery will be needed in the future.

GG: Operate the second eye when it presents as a new case - generally you repeat the surgery from the first eye

SA: I assume you mean “almost masked”—a case that looks like a unilateral but there are some subtle signs that tip you off to the bilaterality. I don't know what I would do for the minimal SO weakness on the other side, so I just treat like any unilateral. If the surgical plan is appropriate for the pattern of incomitance and the size of the deviation, the presence of minimal SO palsy on the other side doesn't seem to adversely affect the outcome.

MG: I perform surgery as a unilateral case but I talk to the patient/family about the possibility for a second surgery

HL: I suspect it and we might need another operation

RK: We need to do the same as the first eye surgery in the other eye. If one detects pre op asymmetrical surgery can be done.

**56. Dr Archer: How many prism diopters can SO tuck correct in primary position?**

SA: In the series on the graph in my presentation, the greatest effect in primary position was 18 PD.

**57. Nasal transposition of IR, will it worsen extorsion?**

SG: Nasal transposition of the IR muscle weakens the extorsion

GG: Not usually

SA: Yes, if the transposition is more than what occurs with the normal course of the IR, which angles slightly nasal as it courses back toward the orbital apex.

HL: I do it only in DVD cases with OAIO, can't recall a case with complains of torsion

**58. Does Inferior oblique recession improve downgaze?**

SP: Yes, it often does but it effects primary and upgaze more

SG: Only if the SO recovers and has residual function

AM: Yes, it can! But of course not in all patients, it depends on many factors.

GG: Generally, not very much

SA: Sometimes, but not reliably and, when it does, usually less than in primary. So for a patient with a deviation worse in down gaze, while IO surgery sometimes helps, it generally leaves down gaze (and especially reading position) more under corrected than a SO tuck or contralateral IR recession would.

MG: not much

HL: Why should it?

RK: Yes, to some extent

### 59. What's the best way to differentiate between 4th CNP and skew deviation?

SP: Skew deviation typically has other neurologic findings. A fourth step in supine position has been proposed by Agnes Wong from Canada to show that in supine position, a fourth nerve palsy persists but a skew deviation typically improves.

SG: Torsion sets them apart. In SOP the hypertropic eye has extorsion and in skew the hypertropic eye is intorted.

GG: Head tilt disappears

SA: I will leave this to the neuro-ophth people, but I think the Agnes Wong paper that Hana cited is wrong. Agnes claims that skew deviation decreases >50% when measured in supine position. I don't see many skew patients, so I haven't measured them. But I have tested many SO palsy patients and some of them have a marked decrease in deviation in supine position (in fact, this is the basis for the Caputo test for superior oblique palsy) and some do not, so I don't think this is a reliable sign.

MG: See paper by Agnes Wong

SK: SOP does have similarities to Skew, both present with a Hypertropia in primary position and both have a head tilt towards the side of the Hypotropic eye but after that this is how I differentiate between a SOP and Skew. (HT = Hypertropia)

	<u>SOP</u>	<u>Skew Deviation</u>
i.	<b>Excyclotorsion</b> of the HT eye	<b>Incyclotorsion</b> of the HT eye
ii.	Usually no other neurological signs (unless caused by trauma or brainstem lesion)	Usually has other neurological signs (e.g. ataxia, gaze palsy, dysarthria, gaze-evoked nystagmus, hemiplegia)
iii)	Incomitant: HT worse on contralateral gaze	Incomitant, comitant or alternating
iv)	HT worse on ipsilateral head tilt	HT may or may not change with head tilt

I would add that because the head tilt in Skew Deviation is secondary to a Supranuclear dysfunction causing asymmetric input into the otolith pathways and has nothing to do with the SO muscle or the Trochlear nerve, correcting the vertical in primary position with prism and/or surgery, will NOT necessarily improve the head tilt toward the hypotropic eye. The patient is tilting his head to compensate for a visual perception of tilt thereby correcting his vertical orientation. It is the hope that the prism or surgical management will eliminate the diplopia but not necessarily the head tilt. The only other option is occlusion to eliminate the diplopia. I would also like to mention that sometimes the supine test that Dr. Wong has described is not always positive with Skew. If there is a decrease of 5^pd or more of the HT when lying down, I would consider that positive but if there is no change which one would interpret then as indicating a SOP, it's not always a SOP, it could still be a Skew.

HL: There is no "best way". Usually in skew it is not an isolated paresis. You can try the Upright position, if it is negative than it is better to think about skew,

### 60. What criteria do people use to differential unilateral from bilateral?

SP: Large V-pattern, excyclotorsion more than 15 degrees, reversal of deviation in up/side gaze

SG: the pattern of incomitance make the difference: in bilateral cases we can see hypertropia inversion in lateral gazes, Bilateral Bielschowsky sign, V pattern larger than 10 pd, and bilateral extorsion

AM: The pattern of the deviation, the amount of cyclotorsion, the symptoms of the patient.

GG: Clinical exam- positive forced head tilt to both sides, and measured cyclotorsion of > 10 degrees

SA: Extorsion > 15 degrees = bilateral (except in some orbital trauma cases). A reversal of the hypertropia (even if tiny) in any gaze position or head tilt. A large V pattern.

MG: measurements in all positions of gaze. On bilateral cases there will be RHT in left gaze and LHT in right gaze; LHT on left head tilt and RHT on right head tilt; larger torsion

SK: Differentiating between unilateral and bilateral SOP:

	<u>Unilateral</u>	<u>Bilateral</u>
Cover	HT reflects extent of SOP	HT usually small
Test	<u>in primary position</u>	<u>in pp</u>
Ocular	No reversal of HT in	Reversal of HT in
Motility	<u>ipsilateral gaze</u>	<u>lateral gazes</u>
Head	Chin depressed with head	Chin depressed
Position	<u>tilt and turn</u>	
Torsion	Slight extorsion < 5 degrees	Extorsion > 5 Very diagnostic >7
Head	+ with head tilt to affected	+ with head tilted
Tilt Test	<u>side</u>	<u>either side</u>
V Pattern	Slight to absent	Present to large

HL: My preferred method is to look for a change in the change in the deviation' plus an "unreasonable" results on the 3 steps test

### 61. Transposition of IO is done in DVD cases with IO overaction?

SP: Yes, I do an inferior oblique anterior transposition

SG: Sure It is the main indication for this surgery

GG: YES- prefer to do bilaterally if possible

SA: I sometimes do anteriorization in this setting, but not nasal transposition.

MG: IOAT is a restrictive operation that I don't indicate for SOP because of binocularity

HL: Yes

### 62. Do we cause the "masked" bilateral as Steve said?

SG: Yes, we can cause something "similar" to masked bilateral SOP if we overcorrect a unilateral palsy

GG: Yes- mild overcorrection can produce this

SA: There was an epidemic of "masked" bilateral superior oblique palsy in the 1980's after it was first described. As Rick Saunders and Dave Guyton have pointed out, most of these were probably just surgical over corrections. For example, imagine a patient with RSOP who has deviations that measure 5 RHT – 10 RHT – 15 RHT with 15 RHT on right tilt and 5 RHT on left tilt. If you do surgery that produces a comitant 20 PD change, this patient will now have 15 LHT – 10 LHT – 5 LHT. Head tilt produces the same changes as it did pre-operatively, i.e. less RHT (or more LHT) on left

head tilt, so this patient will now have 5 LHT on right tilt and 15 LHT on left tilt. A perfect 3-step test for LSOP—exactly the same pattern of measurements as pre-operatively except now it looks like an LSOP instead of an RSOP.

SK: Yes, in my humble opinion

RK: Yes