

FAKO DİNAMİKLERİ

MEHMET KOLA-2025

FAKODİNAMİKLERİNDEN ANLAMAMIZ GEREKEN

- Elimizdeki cihazın özellikleri
- Fizik presipleri doğrultusunda
- Kataraktın çeşidine göre
- Cihaz parametleriyle oynamak ve vakayı sıkıntısız bitirebilmektir.

Fako dinamikleri dediğimizde

- ❖ Cihazdan göz içine giren sıvı (irigasyon)
- ❖ Gözden çekilen sıvı (aspirasyon)
- ❖ Fako tipinin ucunda oluşan vakum (emme)
- ❖ Fako elciğinin ürettiği parçalama enerjisi (US power)

Charles Kelman (1930-2004)



Through My Eyes: The Charlie Kelman Story

Cavitron 7001



Fig. 8. Primul model de înaltăfrecvență, Cavitron 7001. Sebera la conectat la cablul și setului de bronze conectate a la vite de aspirare.

Niçin bilmeliyiz

- Yara yerine zarar vermeden
- Endotele zarar vermeden
- Kapsül bütünlüğünü bozmadan
- IOL'si uygun pozisyona yerleřtirmek

Phaco Parameters

Adel Abdelshafik

Professor of ophthalmology Ain Shams University





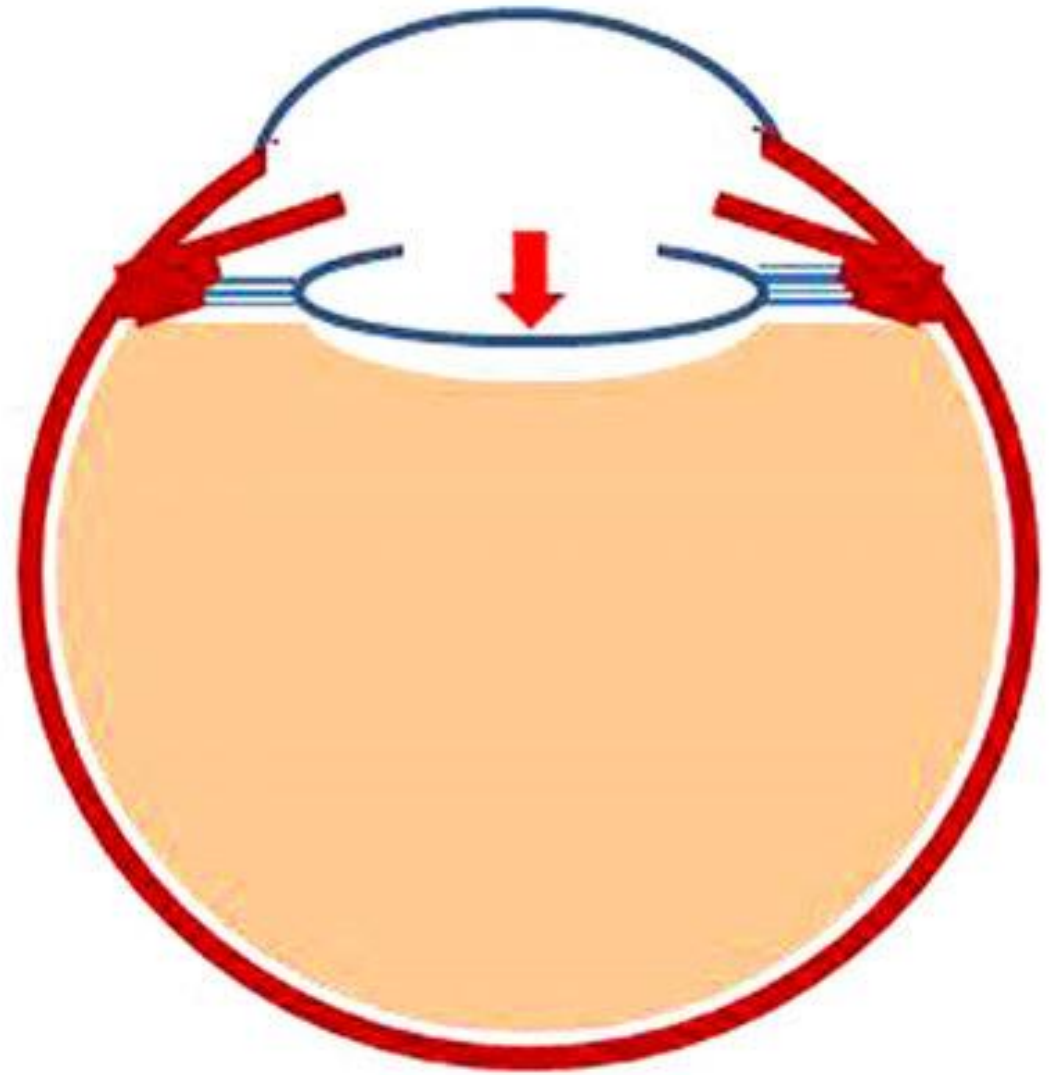
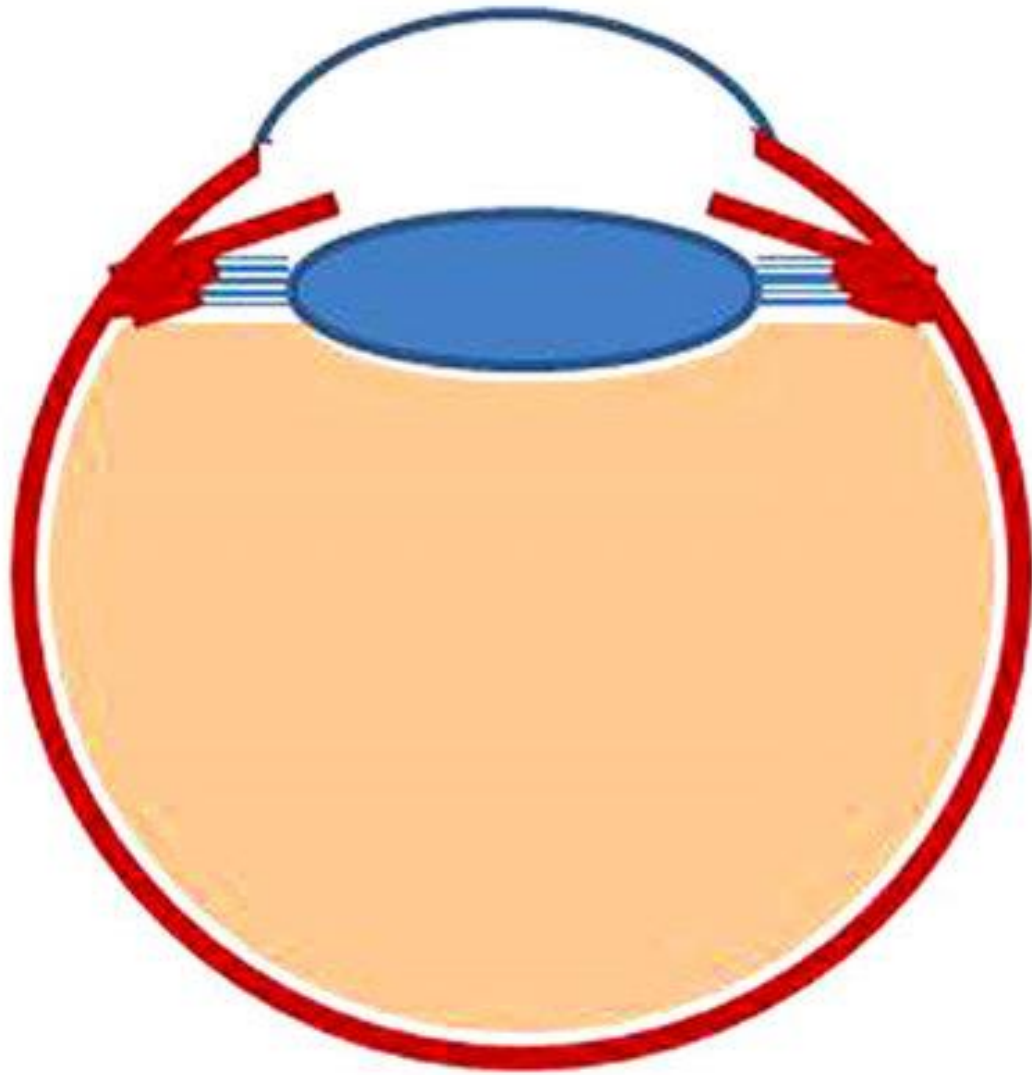
Hand piece

İRRİGASYON

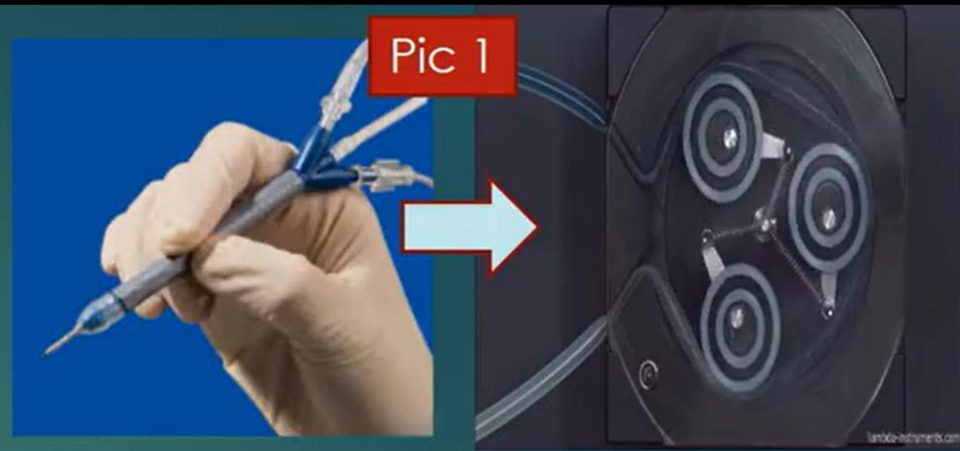
Ön kamaranın derinliğinin korunması
(HAYATİ ÖNEMLİ KISIM)

Fako iğnesinin(tip) titreşimleri sırasında oluşan ısının (KESİ YERİNDE VE ÖN KAMARADA) ortadan kaldırılması

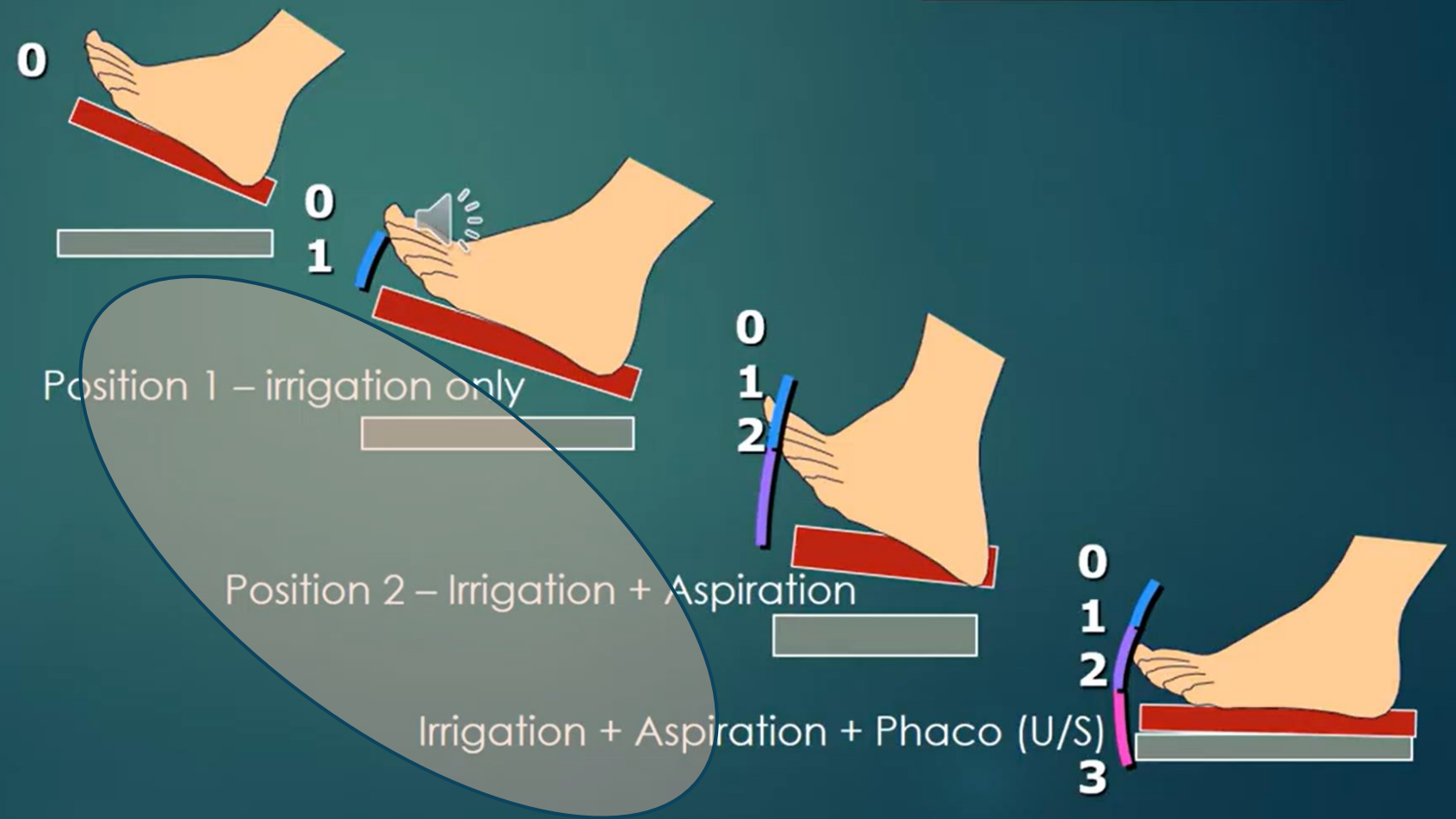
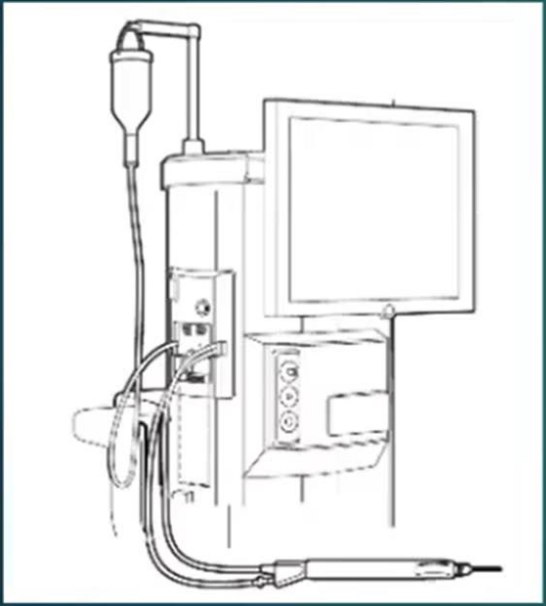
için ön kamaraya doğru olan sıvı akışıdır



- Dengeli bir tuz çözeltisi irrigasyon şişesinden plastik borulardan geçerek fako iğnesine ve son olarak gözün ön odasına gider.
- Birçok fakoemülsifikasyon platformu için sıvı akış miktarı ve infuzyon basıncı yerçekimine dayalı şişe yüksekliğiyle ayarlanır.
- Şişe hastanın başı üzerindeki bir yüksekliğe yerleştirilir ve hastanın gözünden her 15 cm şişe yüksekliği için yaklaşık 11 mm Hg basınç (ortam atmosferik basıncının üzerinde) göz içi üretilir.

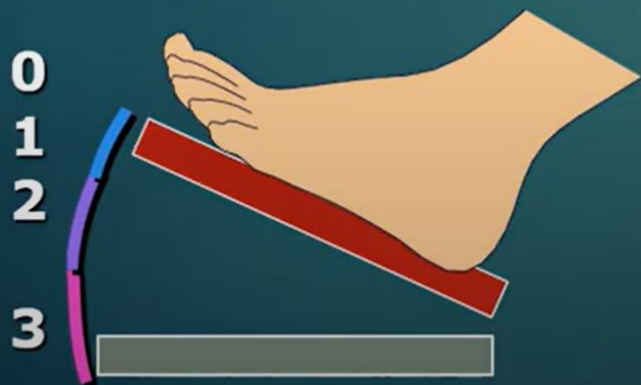
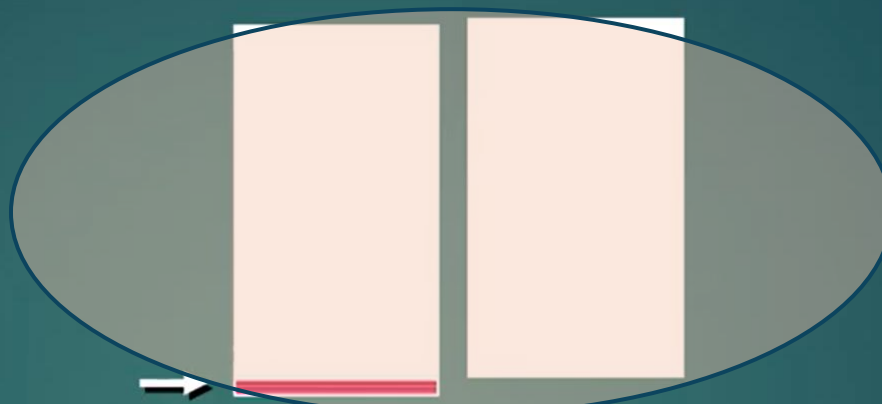
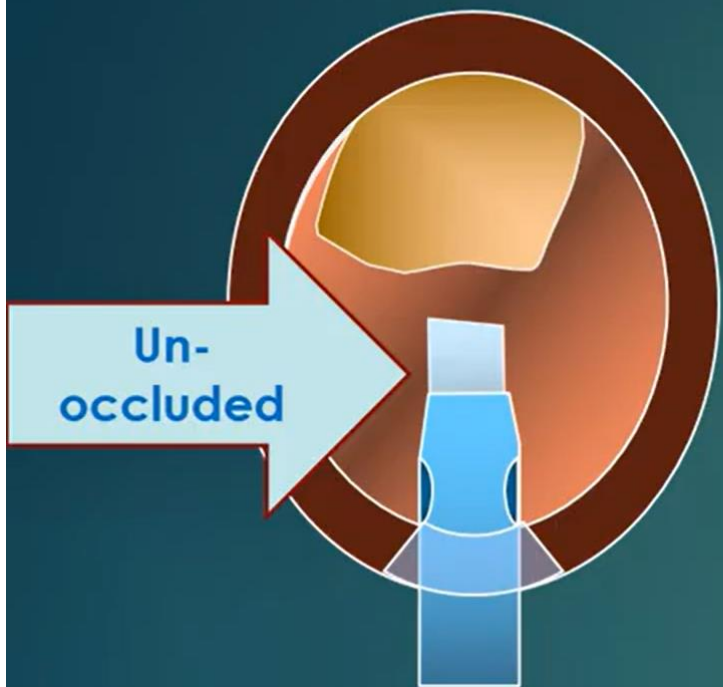


Pic 2



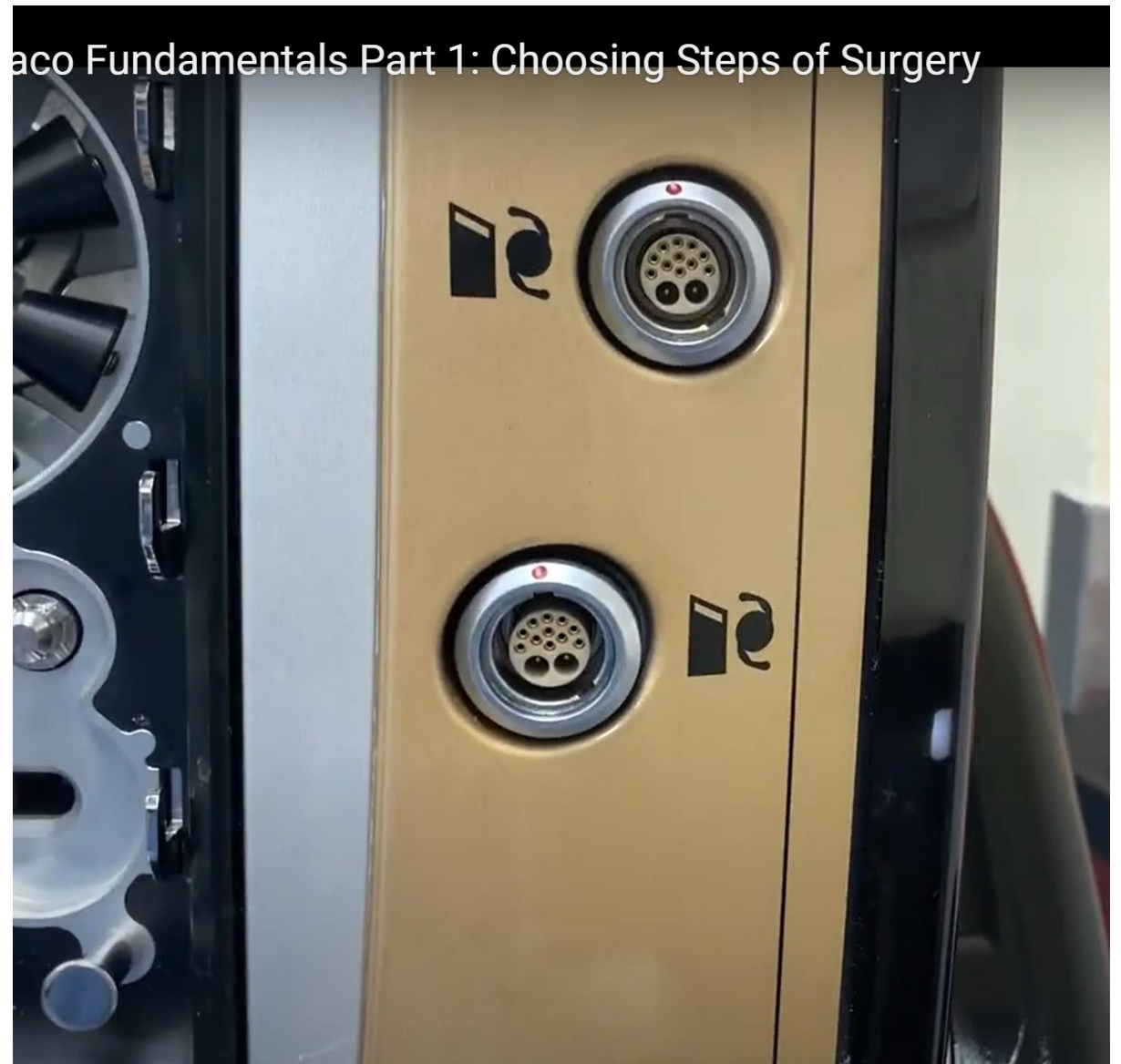
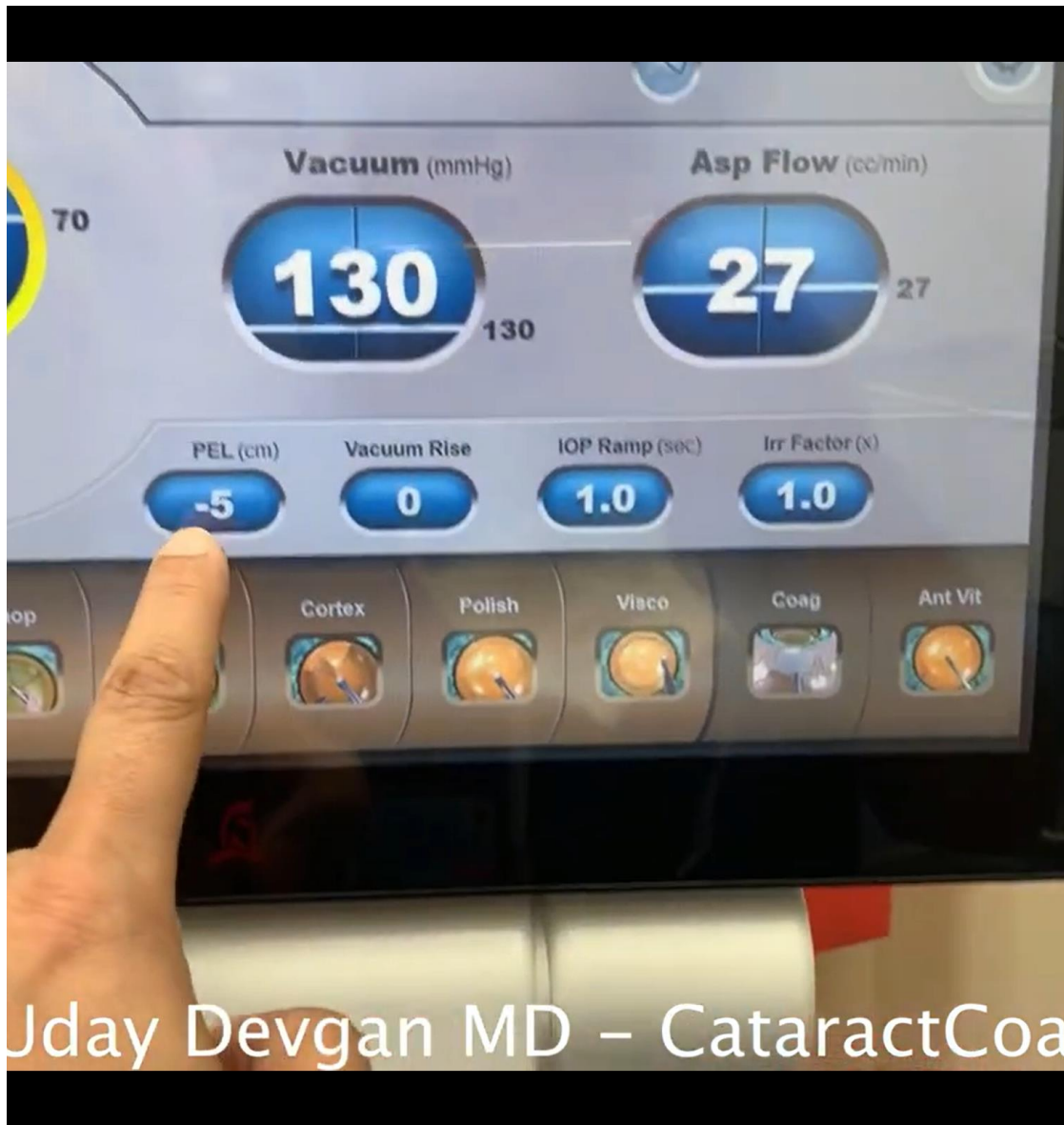
Footpedal Position 1

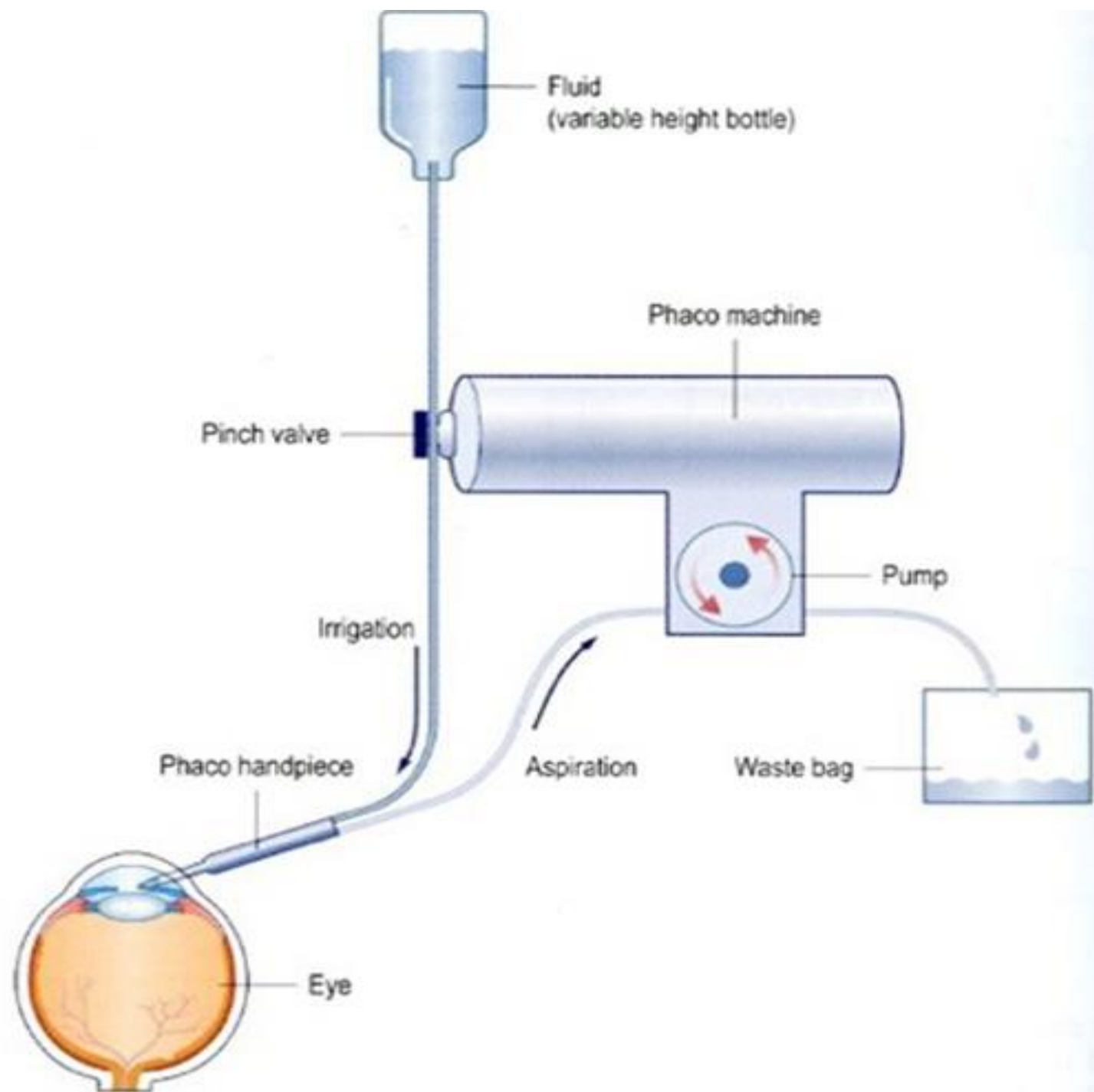
Footpedal Position 2



0
1
2



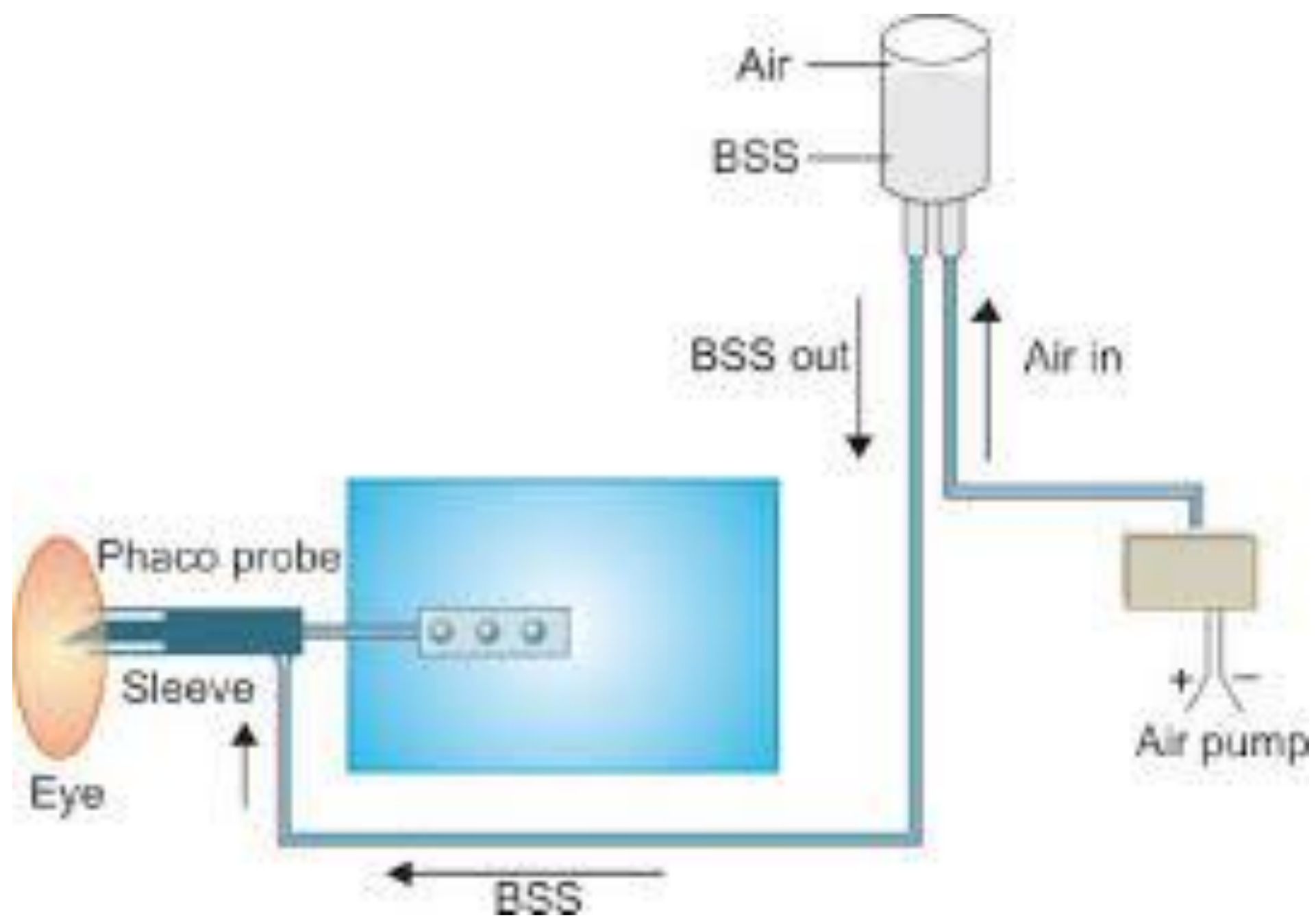


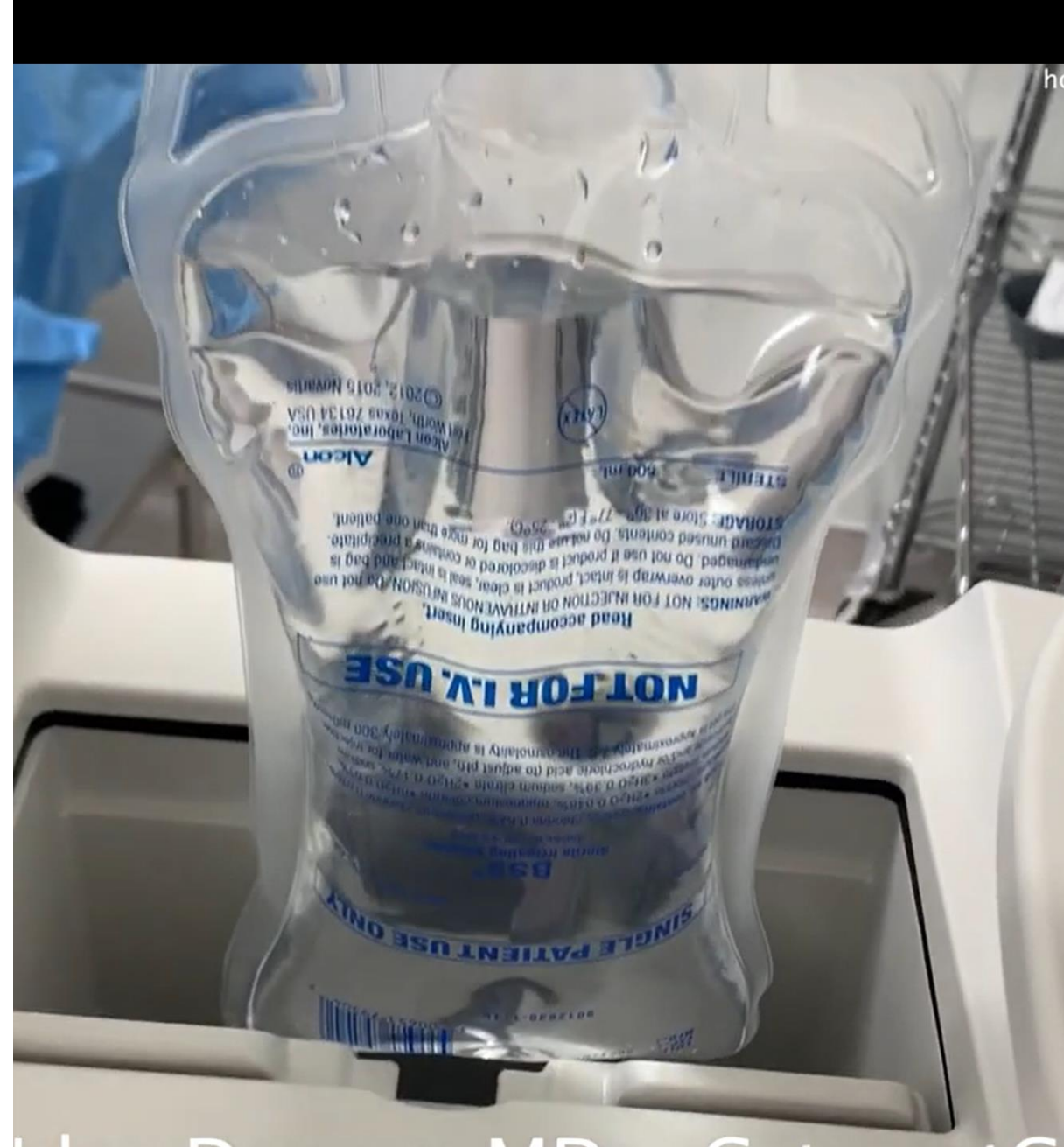


g up the CataRhex 3

Ensure that during this process, sterility is maintained

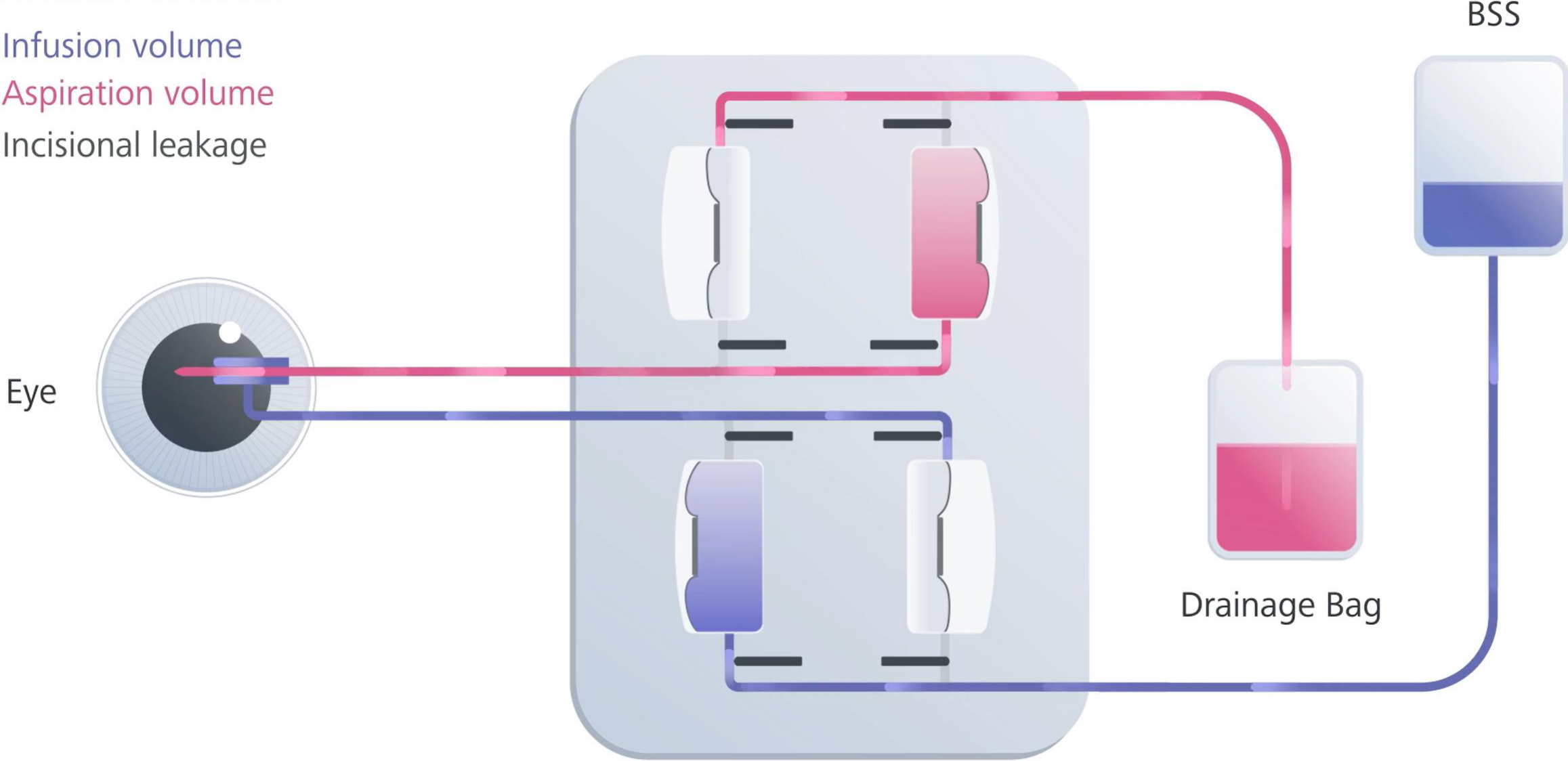




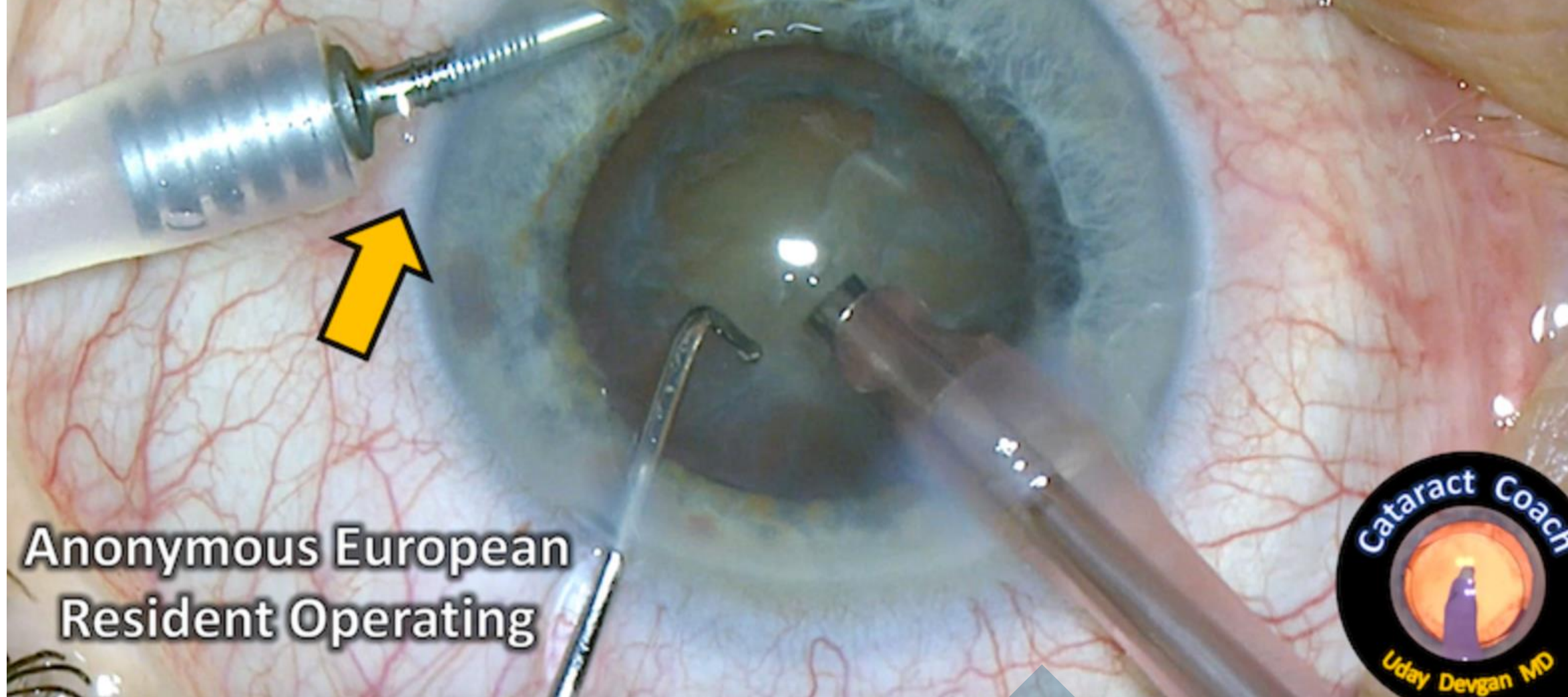


Sensors monitor

- Infusion volume
- Aspiration volume
- Incisional leakage



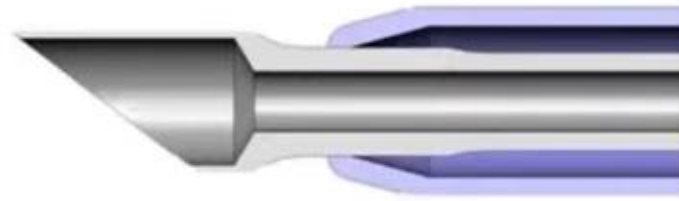
Resident Case with an AC maintainer



Anonymous European
Resident Operating

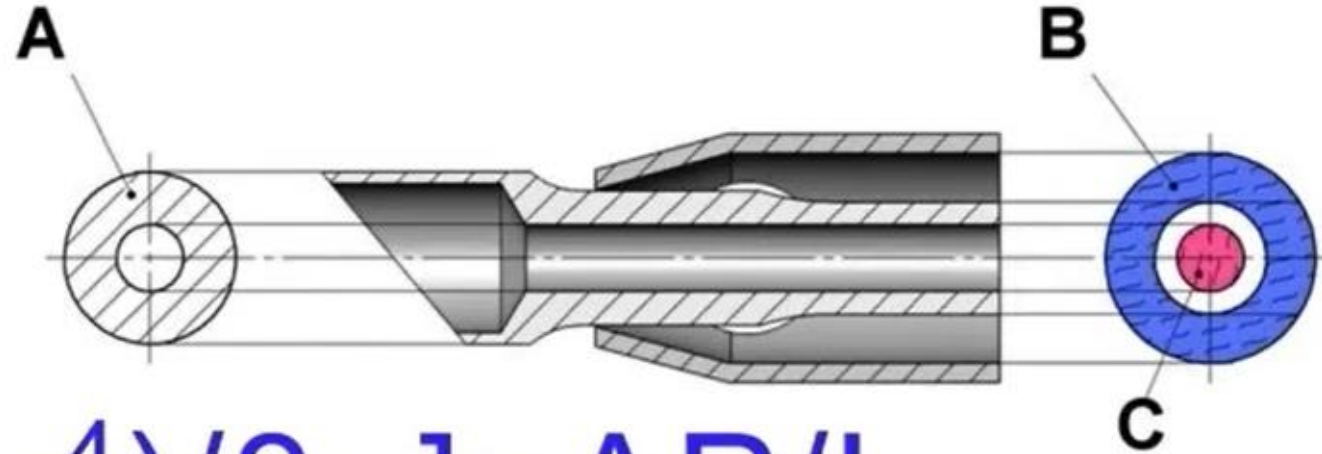


easyTip®CO-MICS
(1.4-1.6mm)



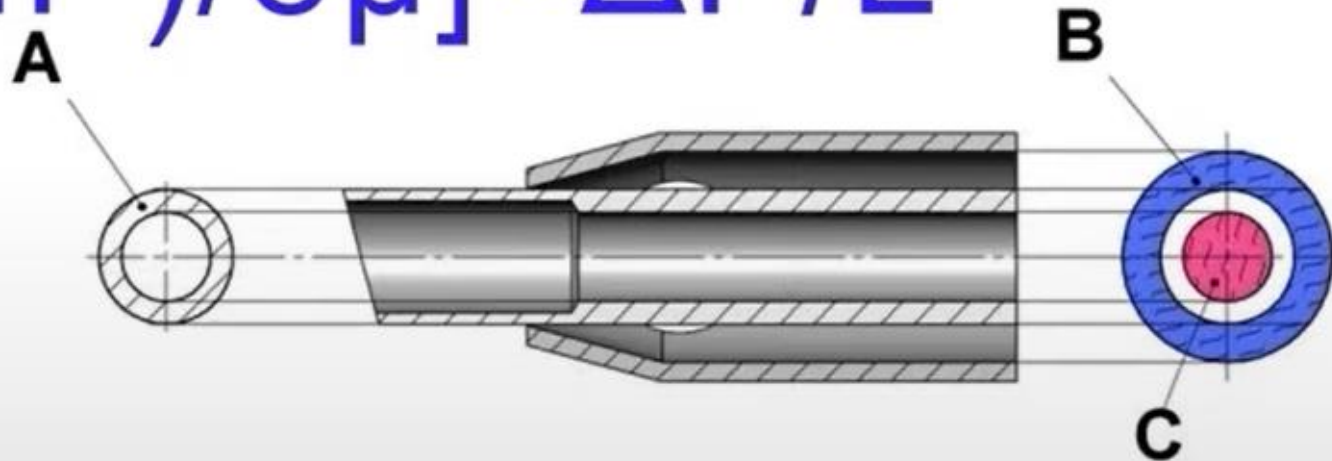
oertli
SWITZERLAND

easyTip®2.2mm



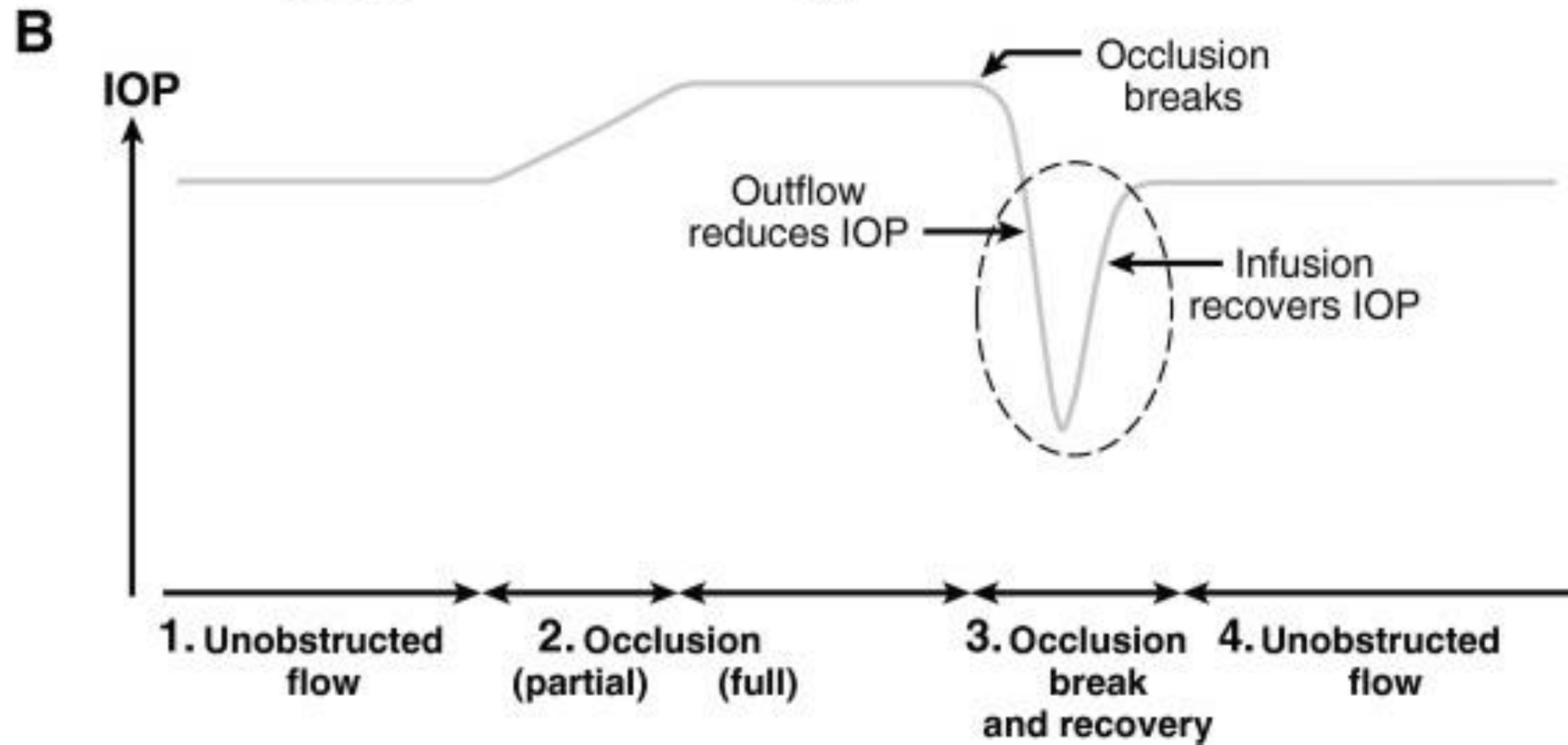
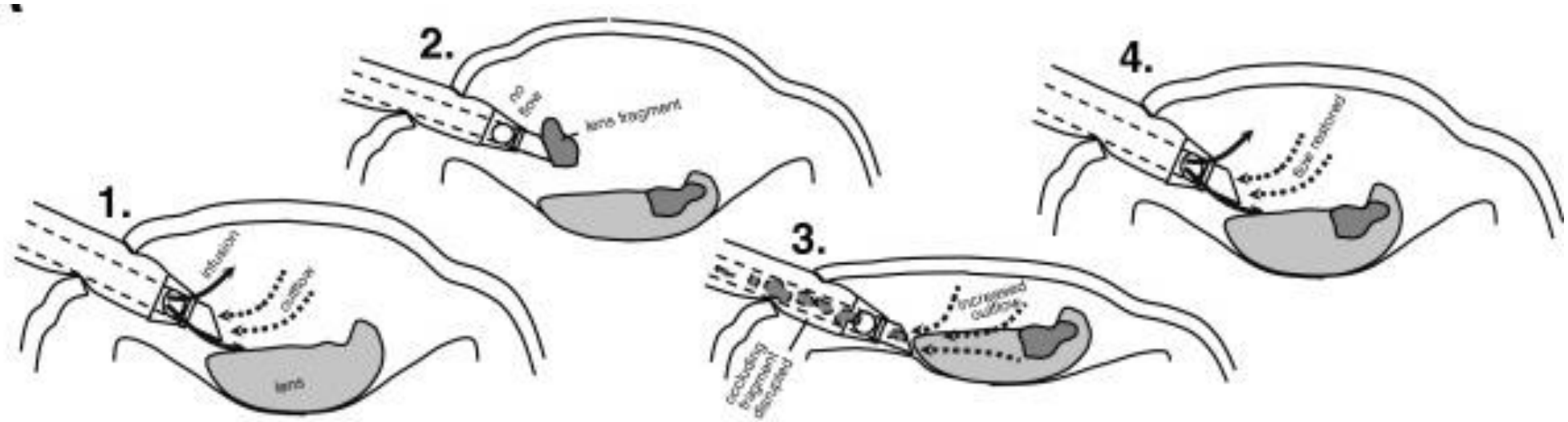
$$Q = \left[\frac{\pi r^4}{8 \mu} \right] \times \Delta P / L$$

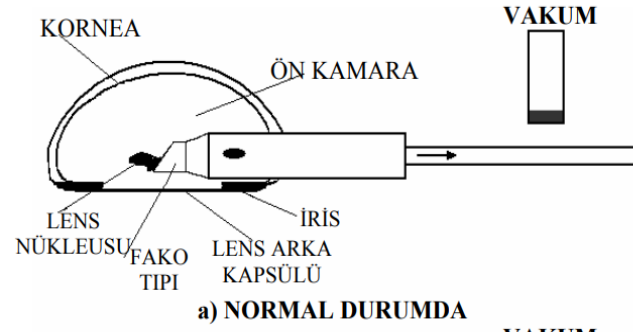
Standard Tip



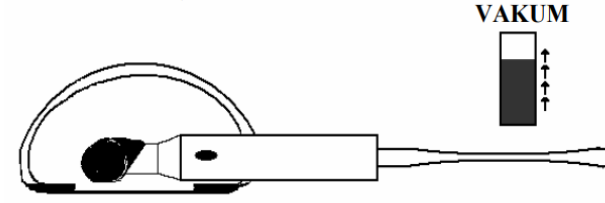
B: Irrigationsfluss

C: Aspirationsleitung

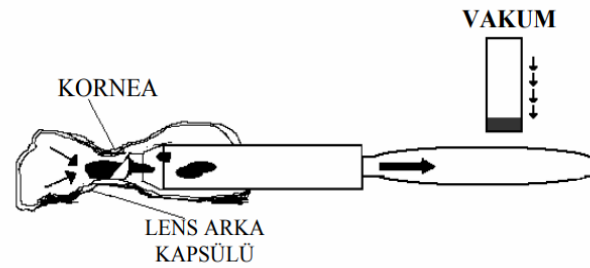




a) NORMAL DURUMDA



b) TIKANMA ANINDA



c) TIKANMA AŞILDIKTAN HEMEN SONRA

Şekil 8. Surge (çökme/dalgalanma) sırasında ön kamara değişiklikleri ve komplikasyonlar

Dalgalanma önlenmesi (Anti-Surge)

predicting a phaco wound burn

This sign means that you will likely burn the corneal incision

this white cloud



means a phaco wound burn

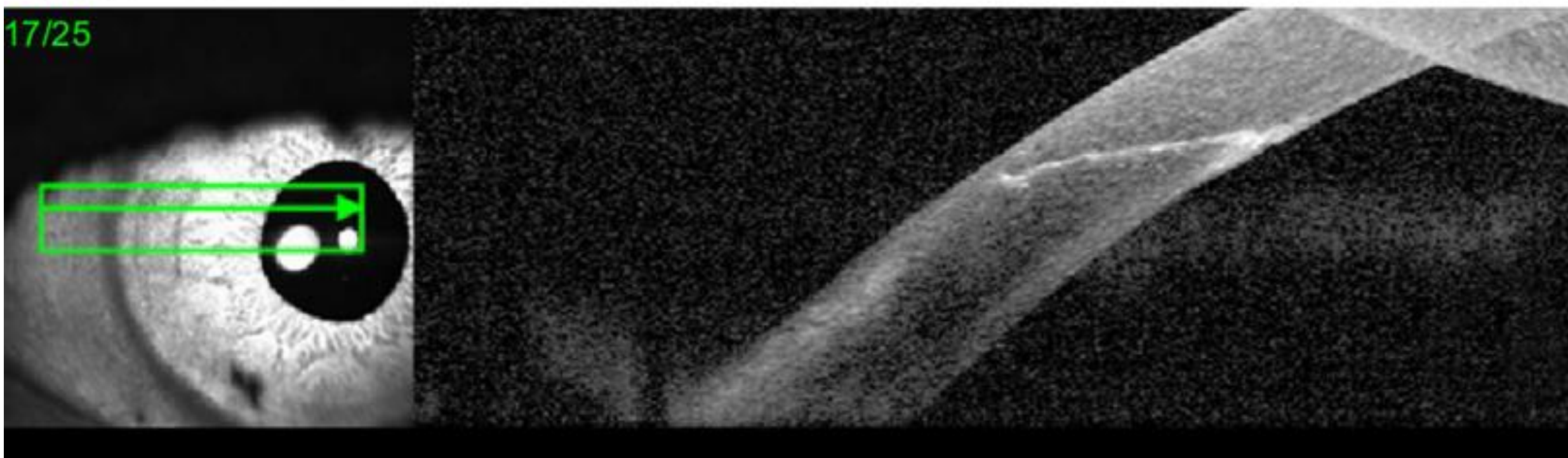
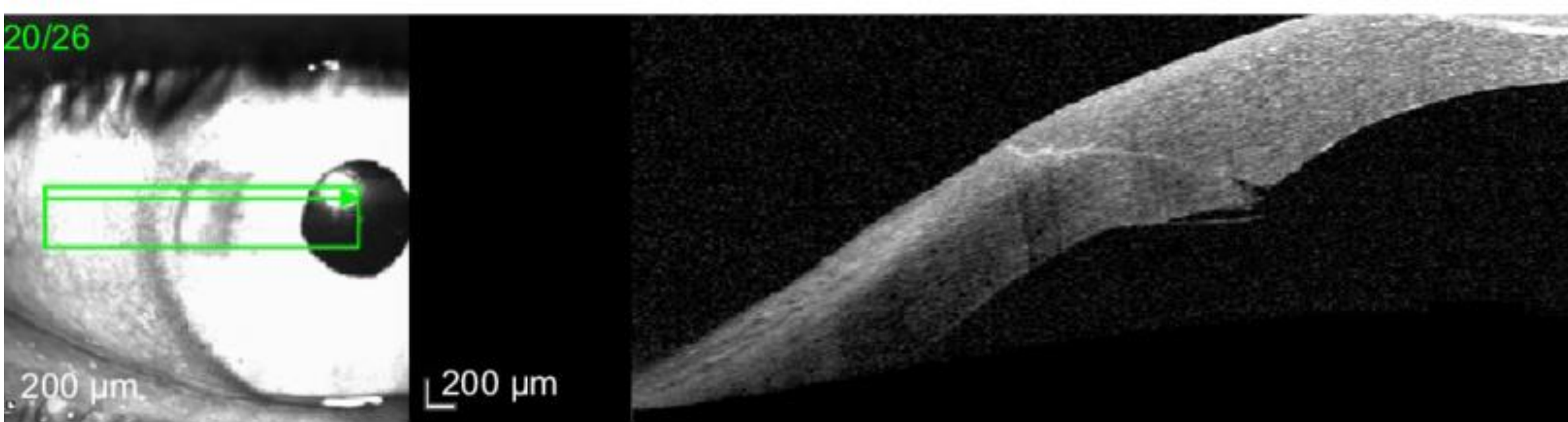


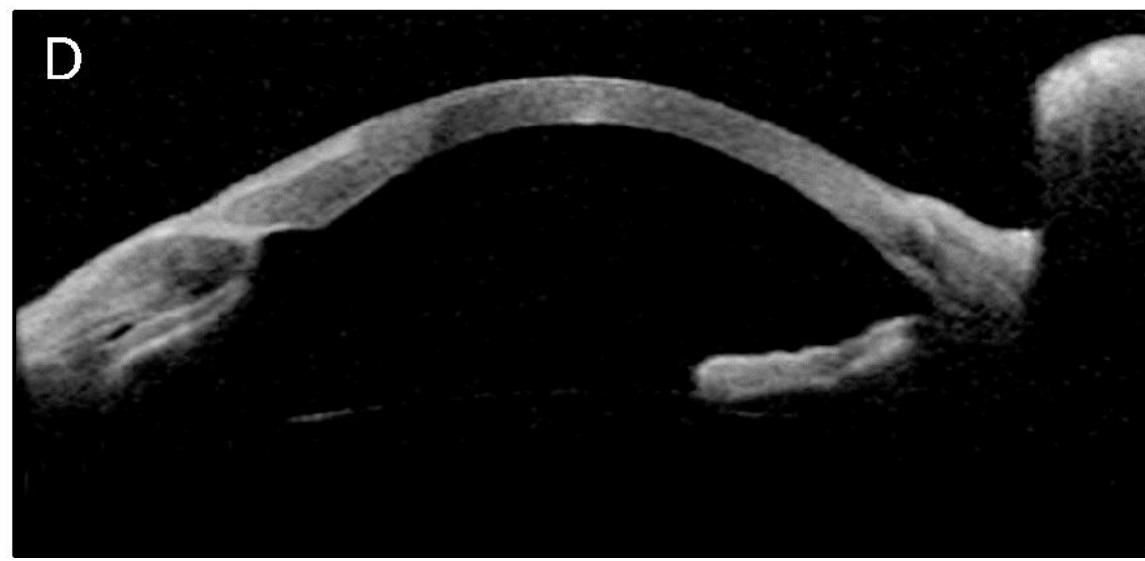
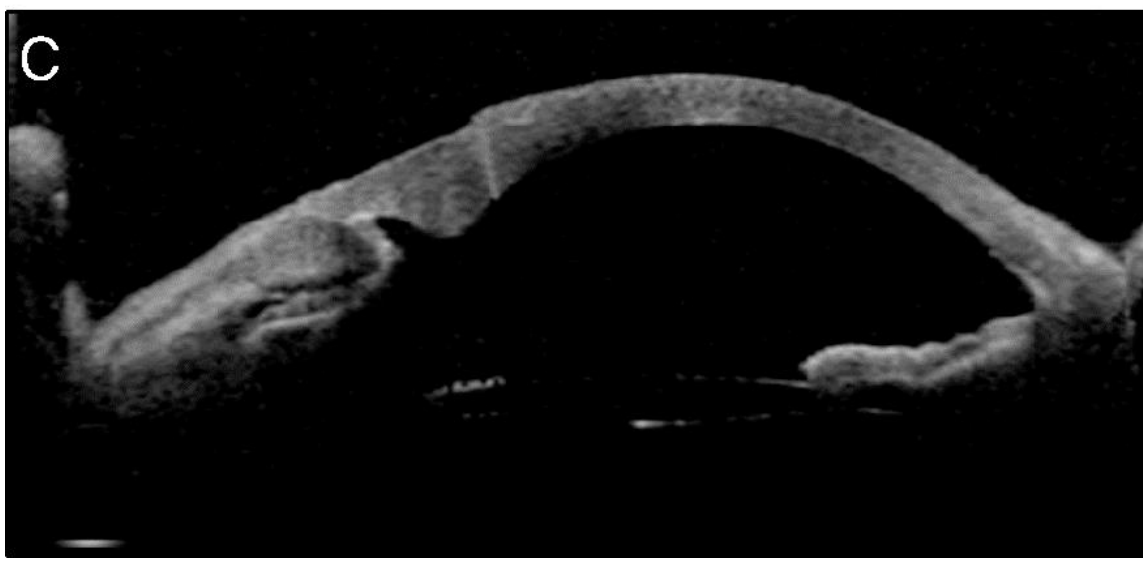
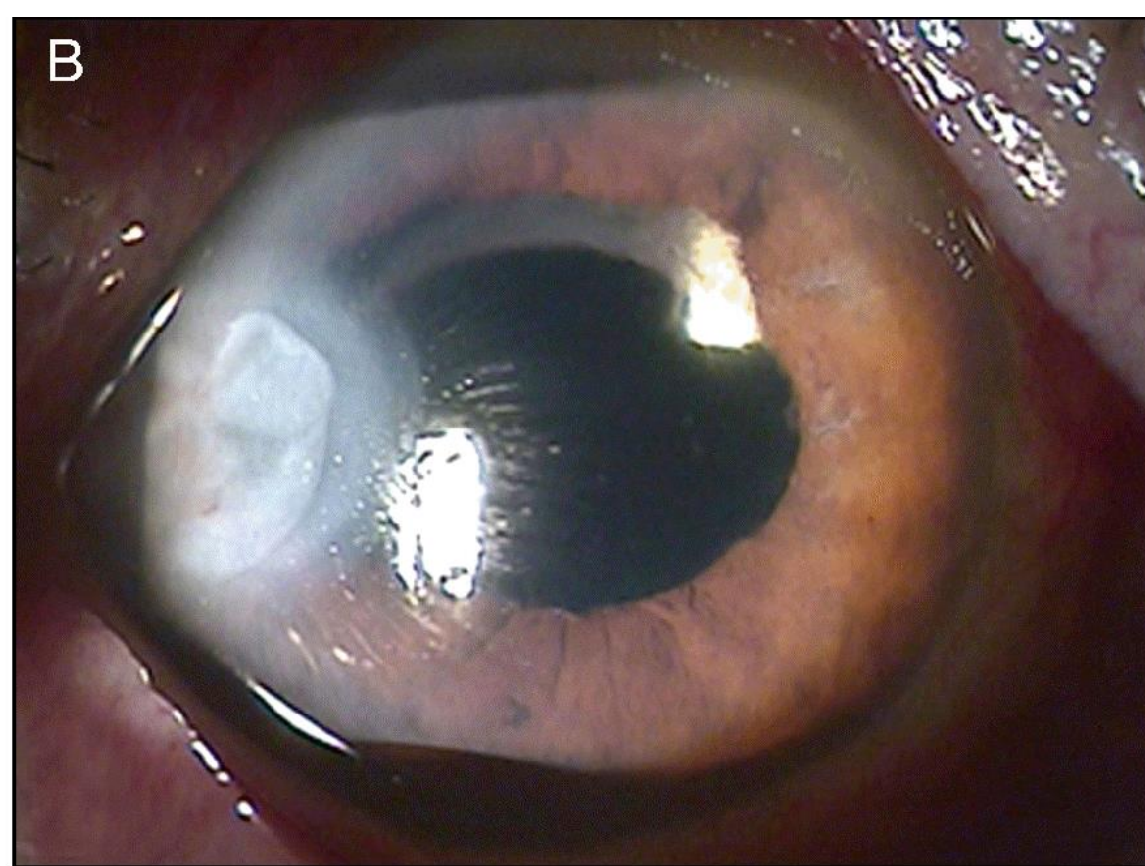
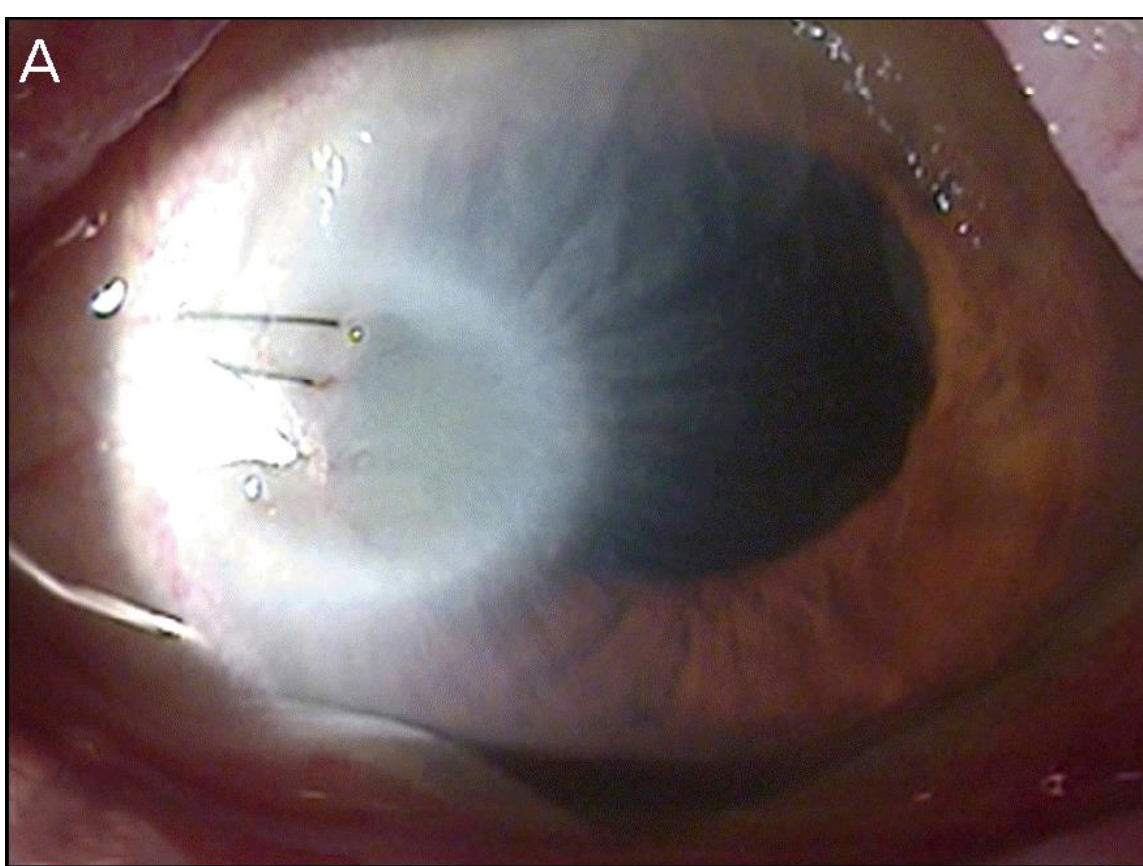
Anonymous surgeon
is operating this case

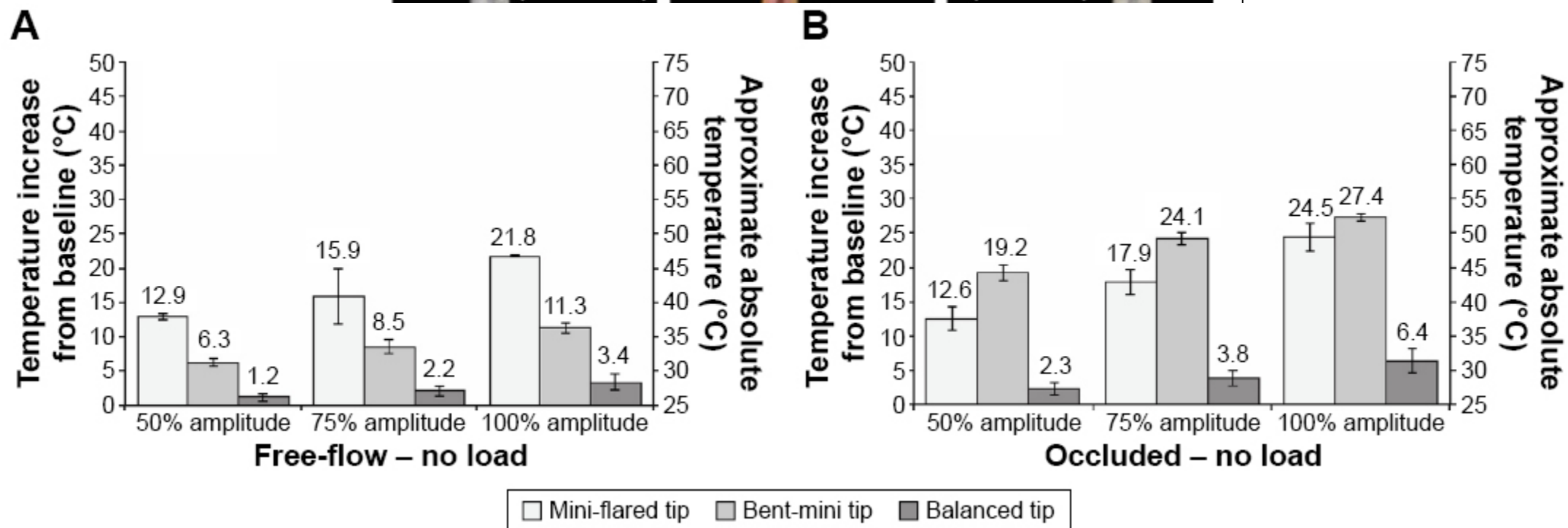
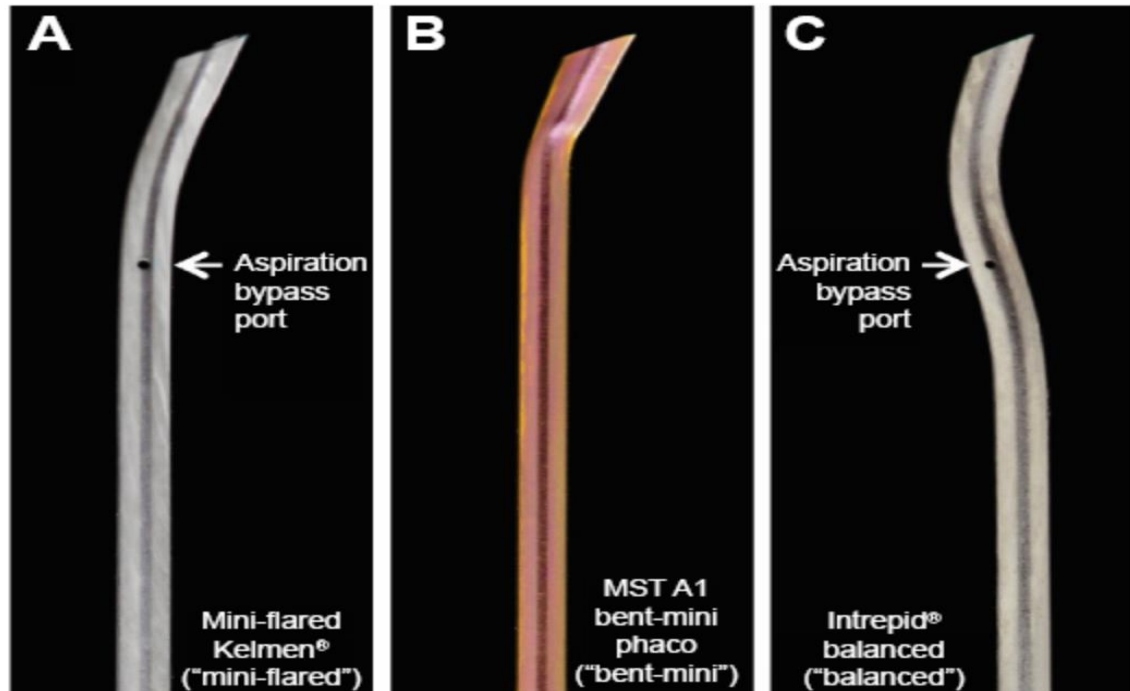
#1199



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- Ultrasonik enerjiden kaynaklanan ısıyı azaltmak için, fako iğnesinin etrafına bir silikon kılıf kullanıyoruz ve dengeli tuz solüsyonunun infüzyonunu göze, fako iğnesini yıkayarak getiriyoruz.
- Bu yüzden, sıvı çıkışını artırmak ve fako iğnesinin soğumasını sağlamak için kasıtlı olarak hafif sızdıran bir kesi kullanıyoruz.

ÇIKIŞ

Ön kamarayı terkeden sıvı

Sıvı kaybının bir sebebi kesi yerlerindeki sızıntıdır

Sıvının çoğu fakotipi tarafından aspire edilir.

Bu, aspirasyon miktarı akış hızı değiştirilerek artırılabilir veya azaltılabilir

Aspirasyon Akış Hızı

Aspirasyon akış hızı, belirli bir zamanda tüpten akan sıvı hacmidir.

Bu genellikle dakikadaki santimetre küp (cc/dak) olarak bildirilir.

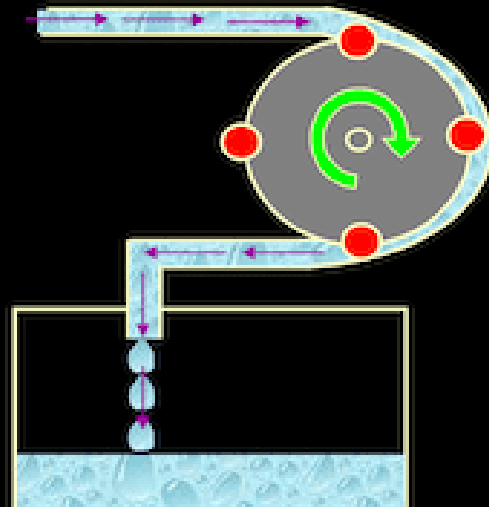
Peristaltik bir pompada akış, pompanın hızıyla belirlenir.

Akış hızının artırılması, partikül materyalin fako ucuna çekilmesini iyileştirir ve ön bölmedeki olayları hızlandırır.

Comparison of Pumps

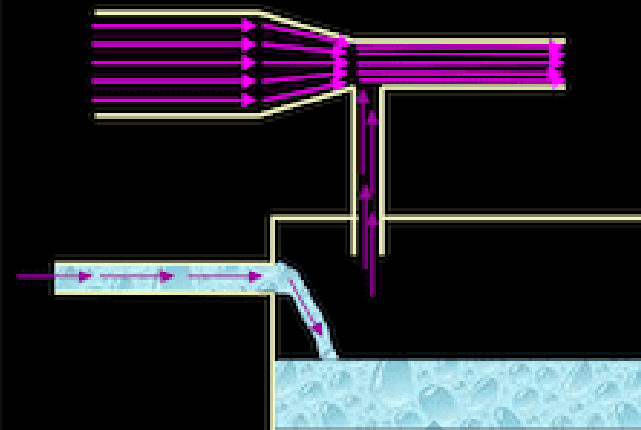
Peristaltic Pump

- Flow Based
- Vacuum created on occlusion of phaco tip
- Flow is constant until occlusion
- Drains into a soft bag



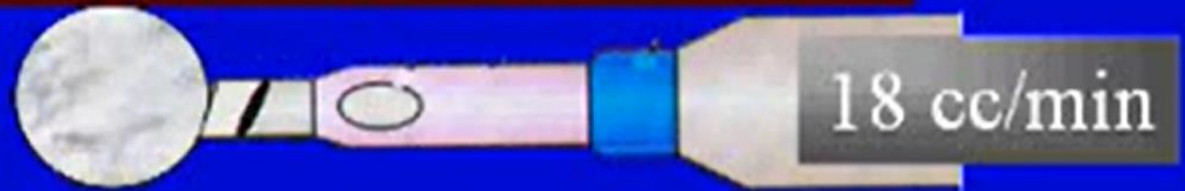
Venturi Pump

- Vacuum Based
- Vacuum created instantly via pump
- Flow varies with vacuum level
- Drains into a rigid cassette



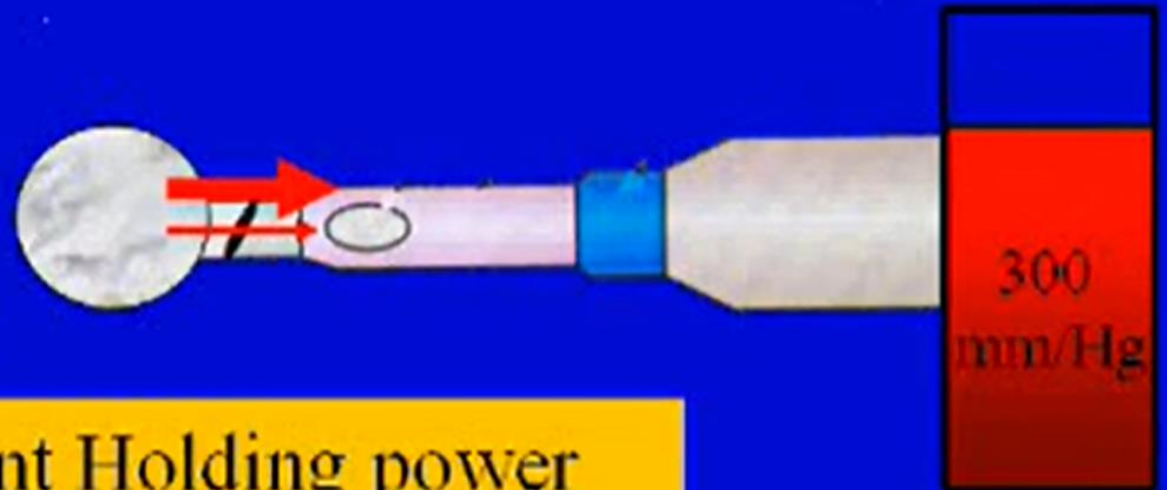
Speaker : Dr. Adel Abdel-Shafik. Ain Shams Univesity Cairo Egypt

Flow rate



How fast things coming to tip

Vacuum



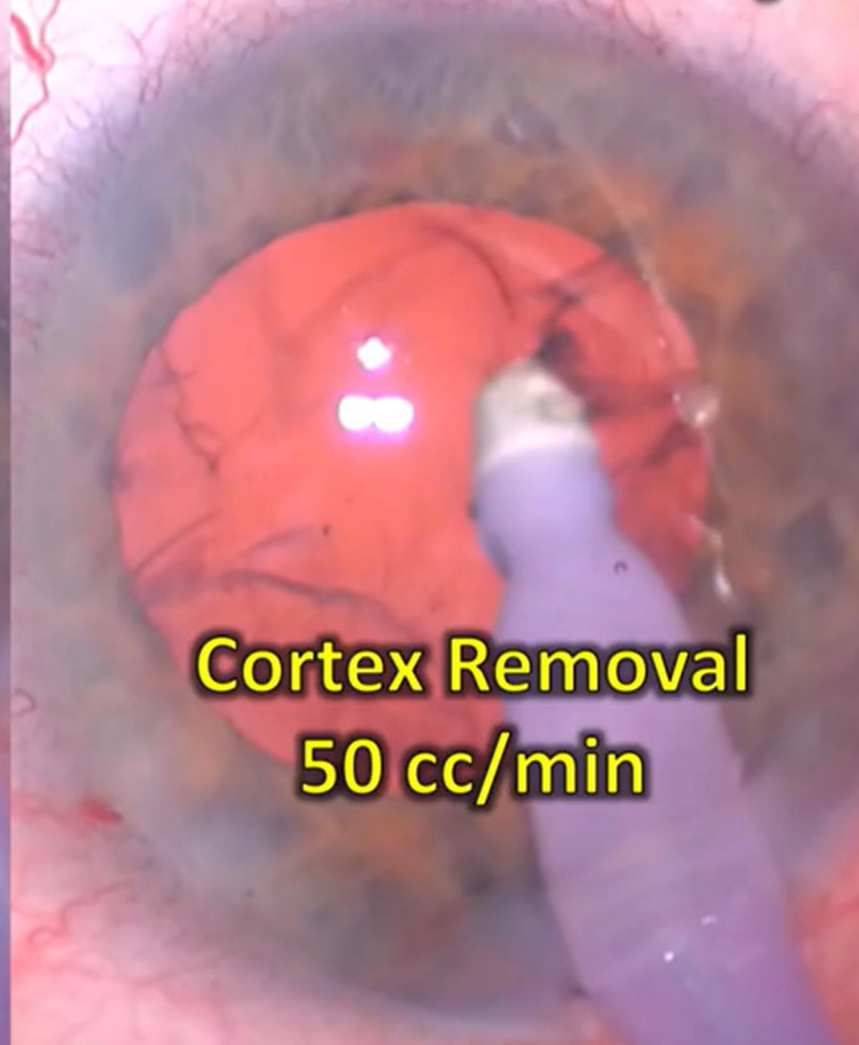
As tip is occluded Amount Holding power

adjusting aspiration flow rate

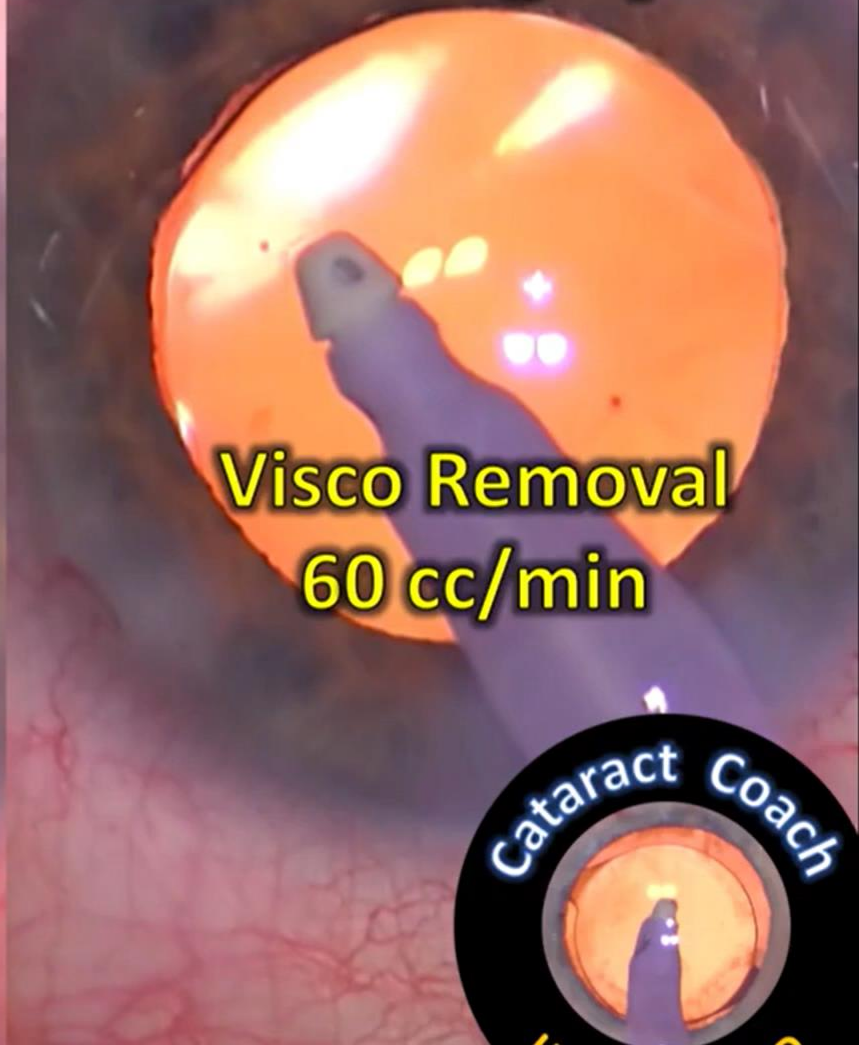
What is the ideal flow rate for each step of cataract surgery?



Phaco Chop
40 cc/min



Cortex Removal
50 cc/min



Visco Removal
60 cc/min



these values are for a highly



Small Bore Aspiration Tubing
• high resistance to flow



30-00317*
0.062" ID

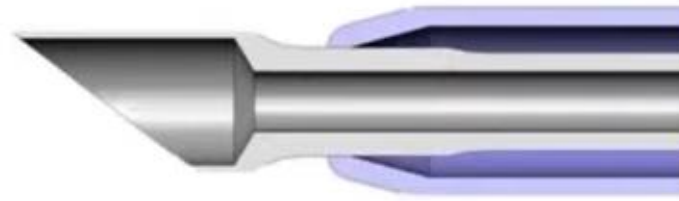


3014-0021 PLUS PMS
0.057" ID



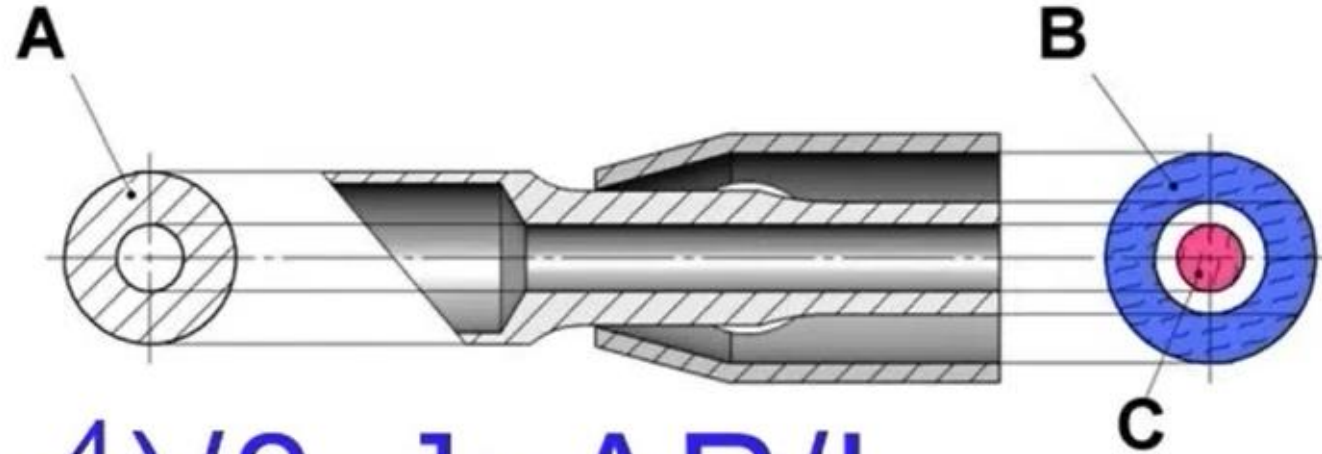
3012-0021*
0.046" ID

easyTip®CO-MICS
(1.4-1.6mm)



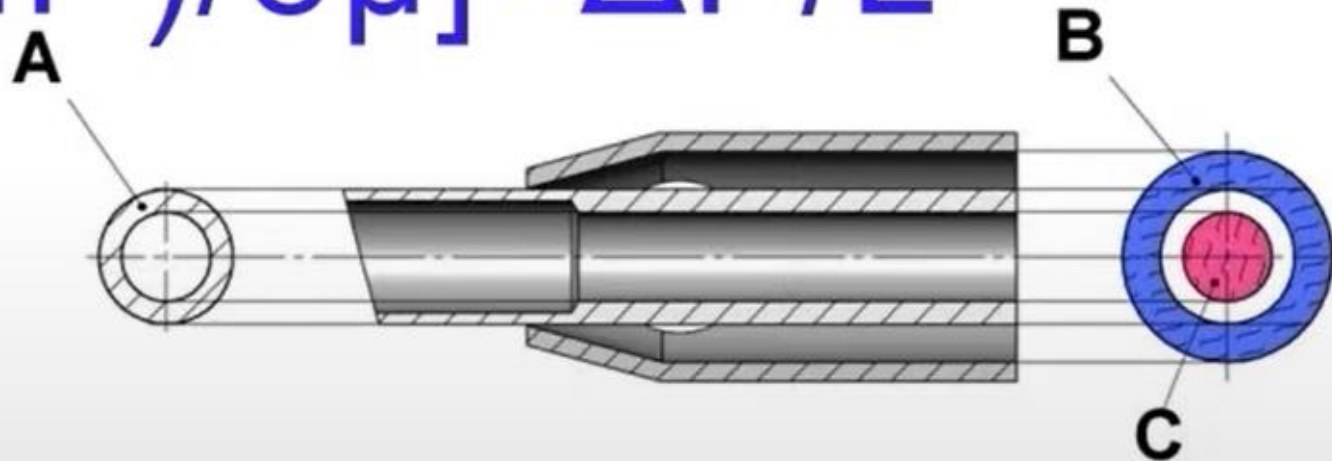
oerli
SWITZERLAND

easyTip®2.2mm



$$Q = \left[\frac{\pi r^4}{8 \mu} \right] \times \Delta P / L$$

Standard Tip



B: Irrigationsfluss

C: Aspirationsleitung

Vakum

İki nokta arasındaki sıvı basıncı farkı.

Milimetre civa (mm Hg) cinsinden ölçülen negatif basınç.

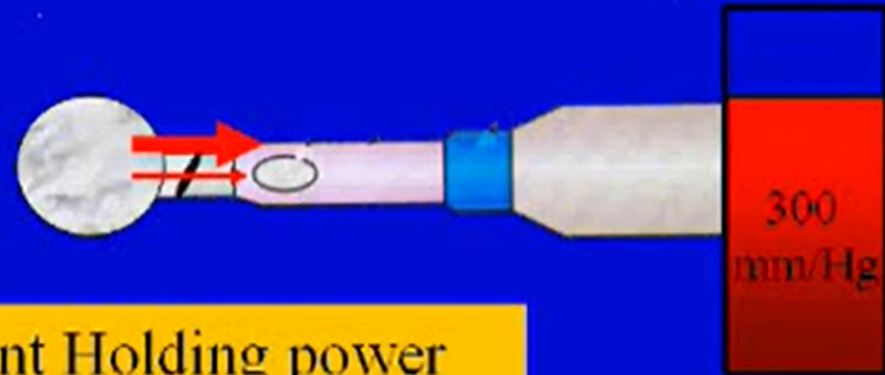
Vakum, fako ucuna tıkalı olduğunda nükleer materyalin uca ne kadar iyi tutunacağını (tutma gücü) belirler

Flow rate



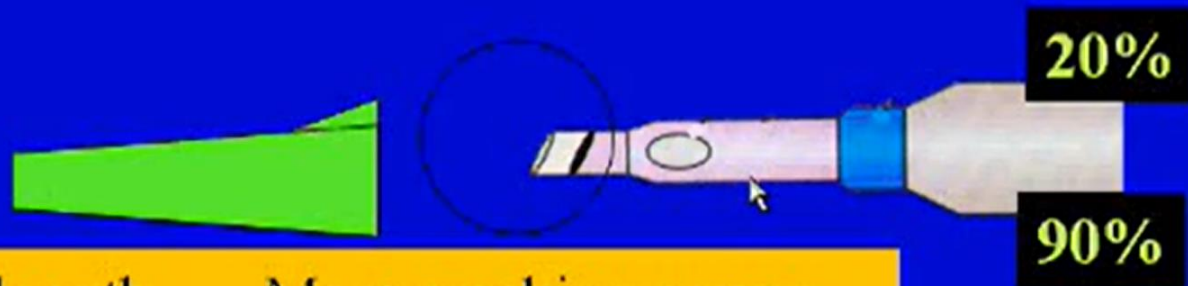
How fast things coming to tip

Vacuum



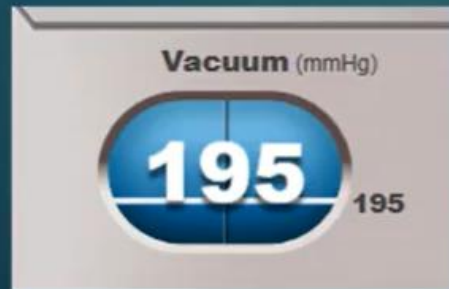
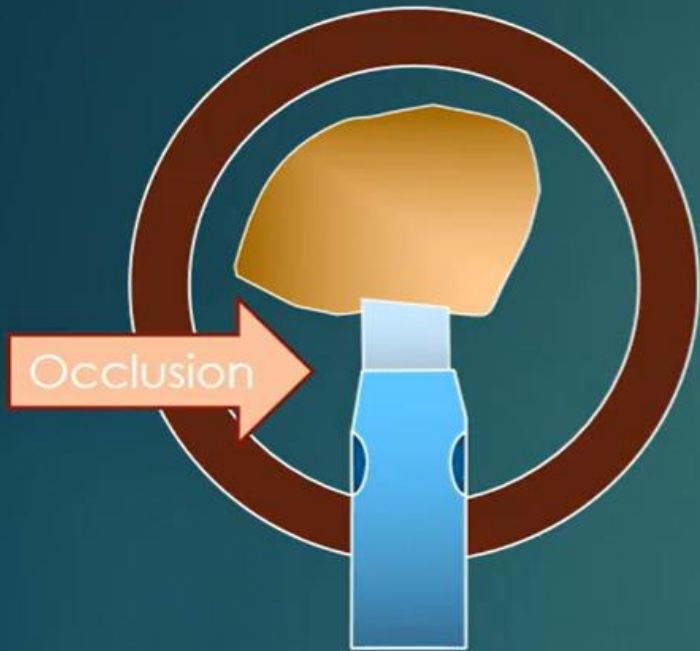
As tip is occluded Amount Holding power

Power

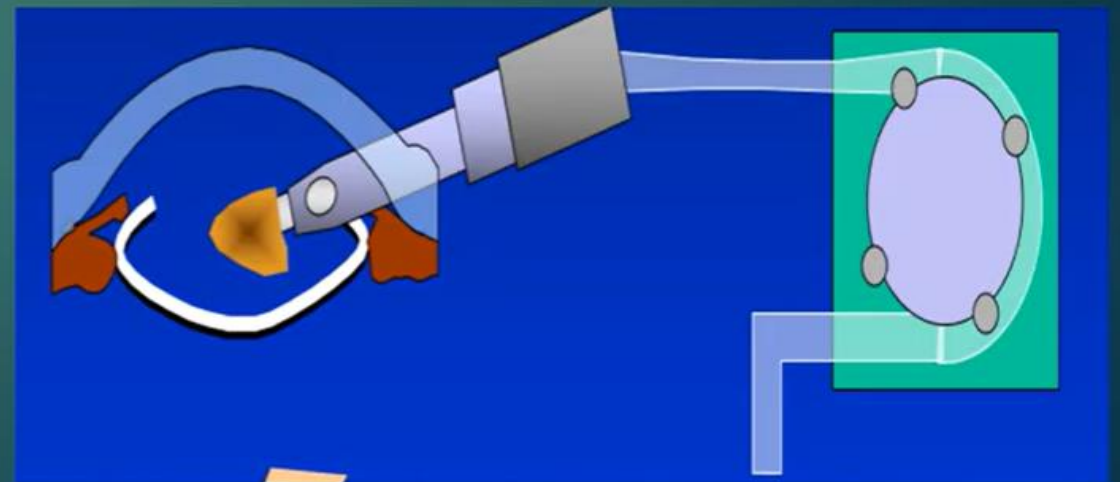


Change stroke length More cracking power

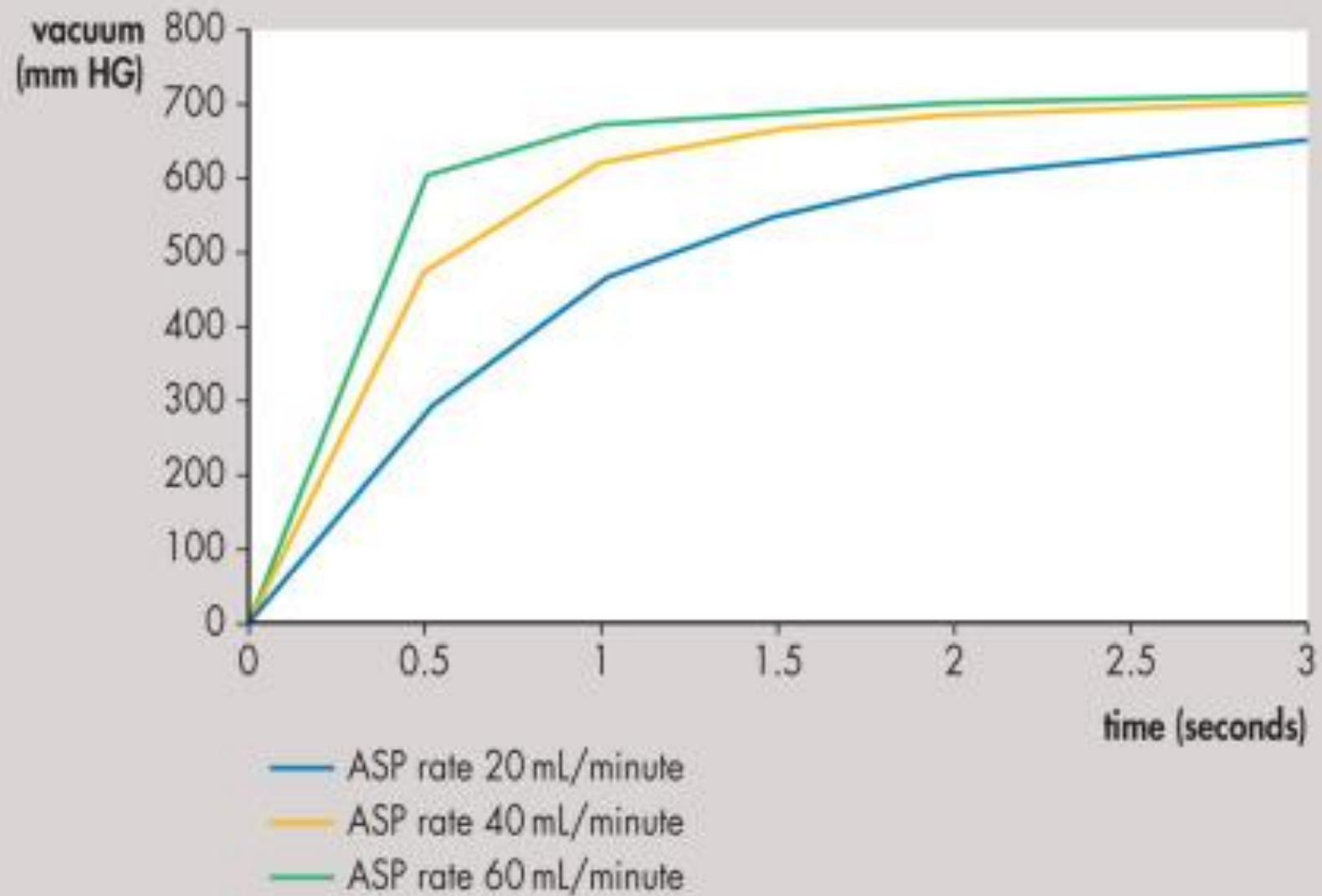


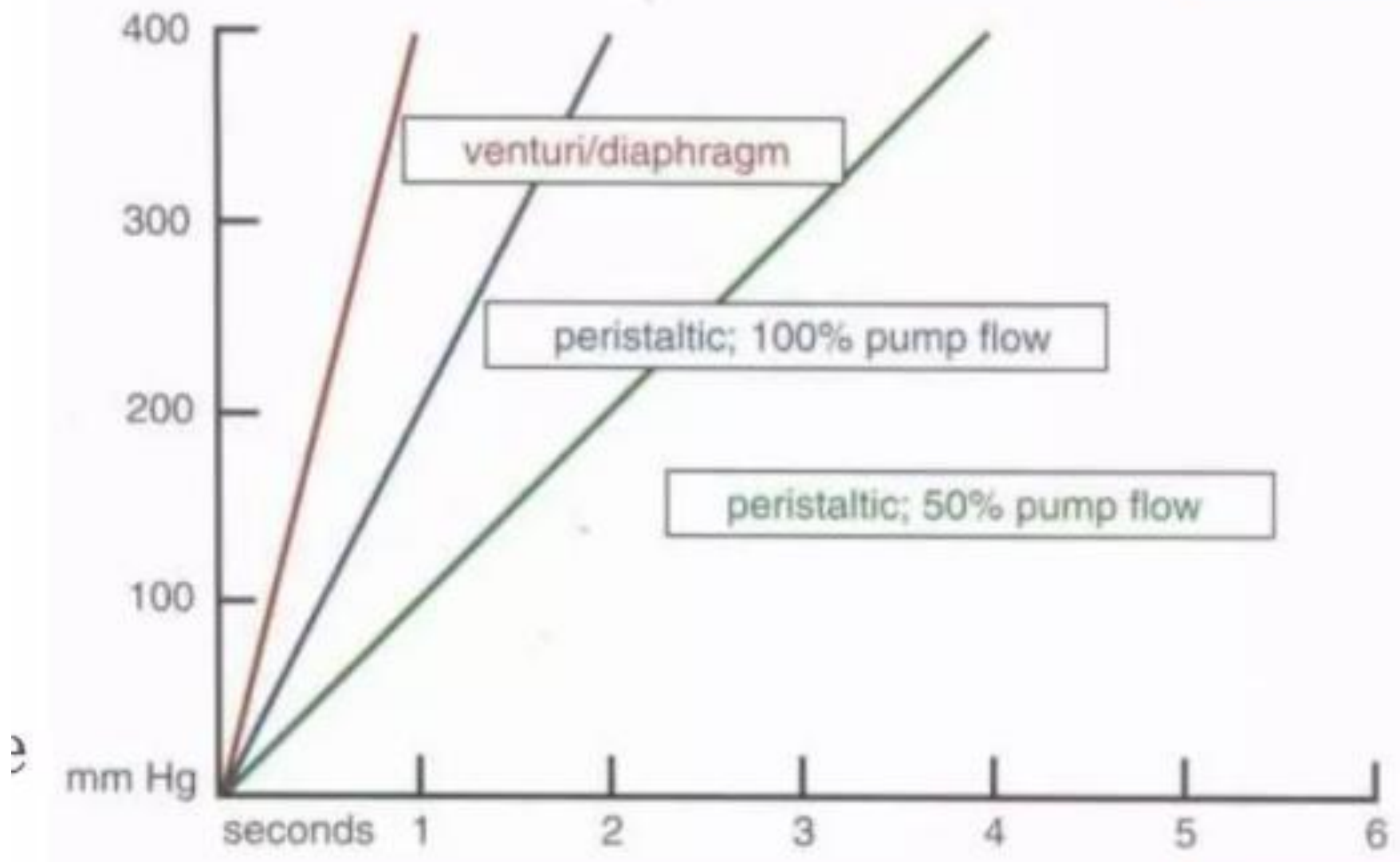


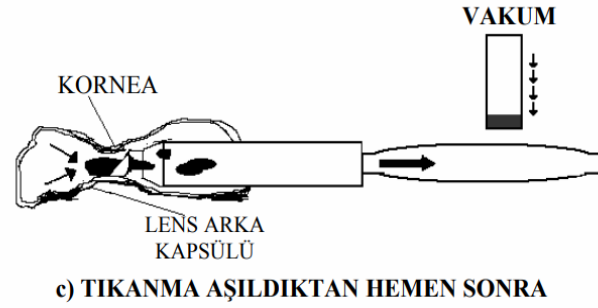
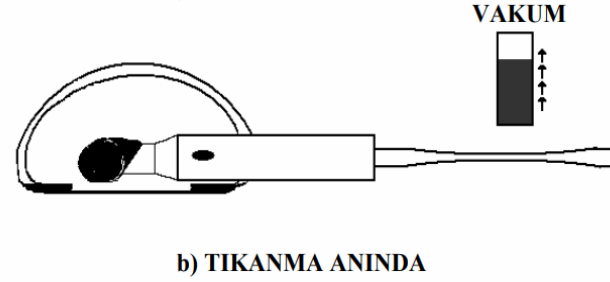
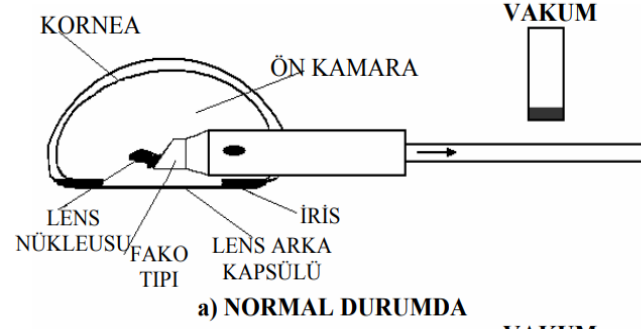
What happens to the pump on occlusion ?



VACUUM RISE-TIME







Şekil 8. Surge (çökme/dalgalanma) sırasında ön kamara değişiklikleri ve komplikasyonlar

Dalgalanma önlenmesi (Anti-Surge)

Post-Occlusion Surge and AC instability

Part 6: How to Adjust
Fluidic Parameters Intra-Op

Increase Inflow Pressure/Flow

Decrease Aspiration Outflow

Also decrease vacuum

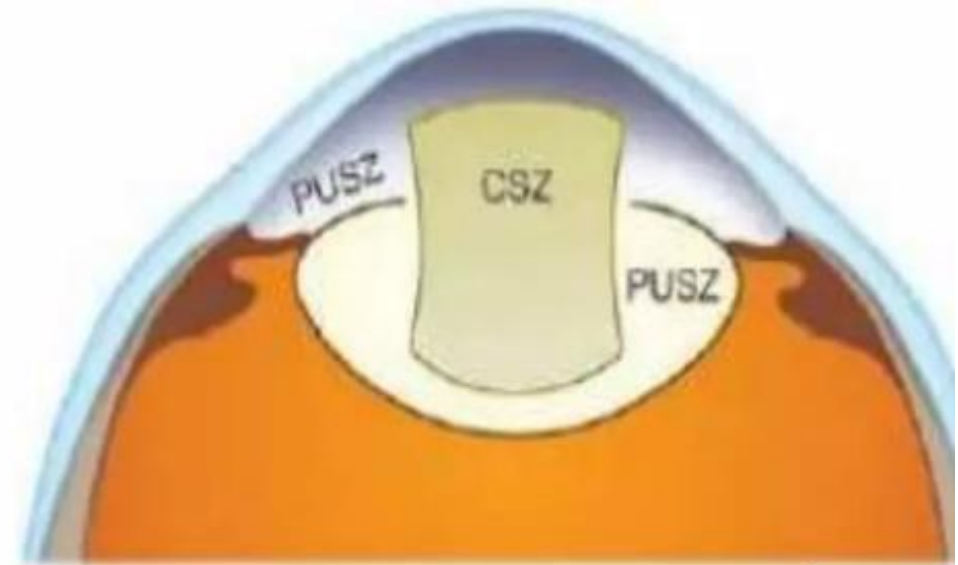


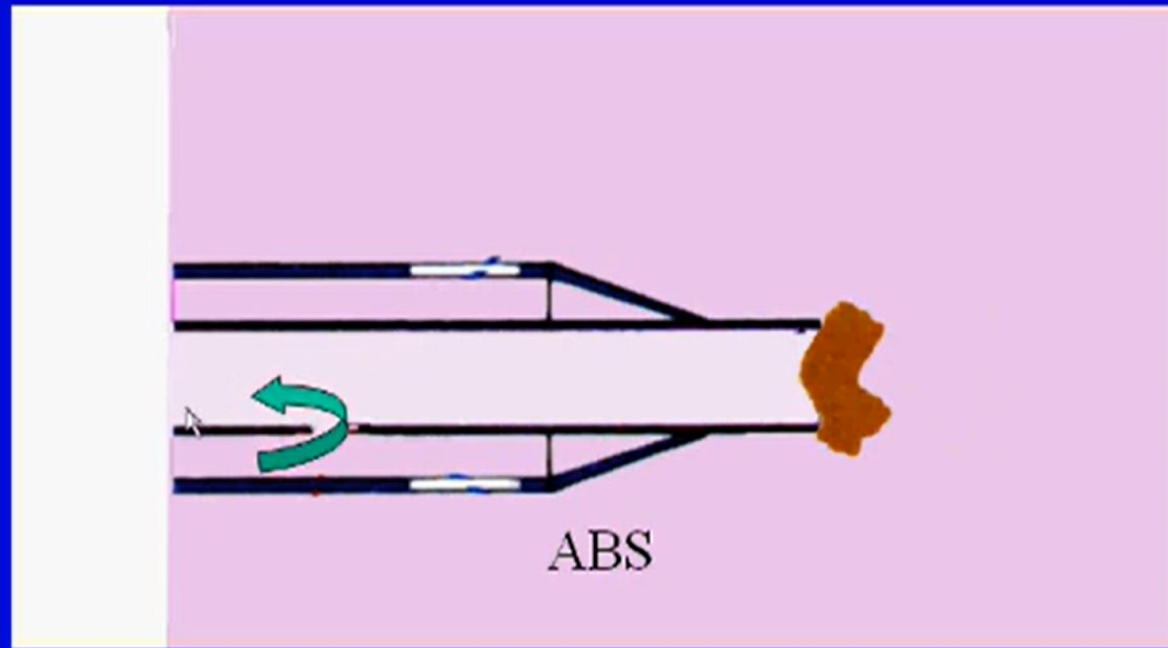
ZONES OF ASPIRATION

- Central safe zone (CSZ) - central area within the capsulorhexis margin

SMALLER CSZ	LARGER CSZ
Hypermetropia	Myopes
Narrow pupil	Zonular stress syndromes
Small capsulorrhexis	Vitrectomized eyes

- Peripheral unsafe zone (PUSZ) - capsular fornices and angle of anterior chamber





Some thermal protection
Less surge

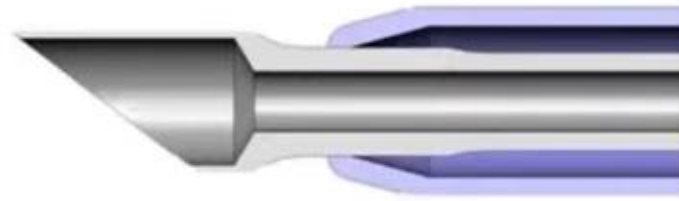
Occluded



Aspiration is reduced to near zero by nuclear fragment at tip.

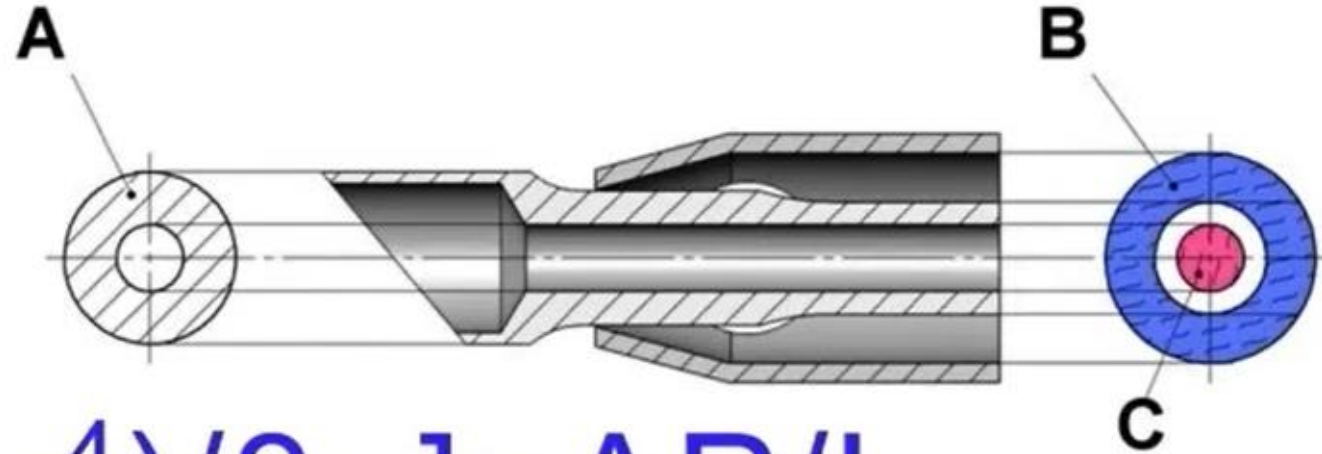
Flow is directed through ABS® port when tip is occluded. Flow rate can range from 4 to 15 cc/min., depending on tip, vacuum level and state of occlusion.

easyTip®CO-MICS
(1.4-1.6mm)



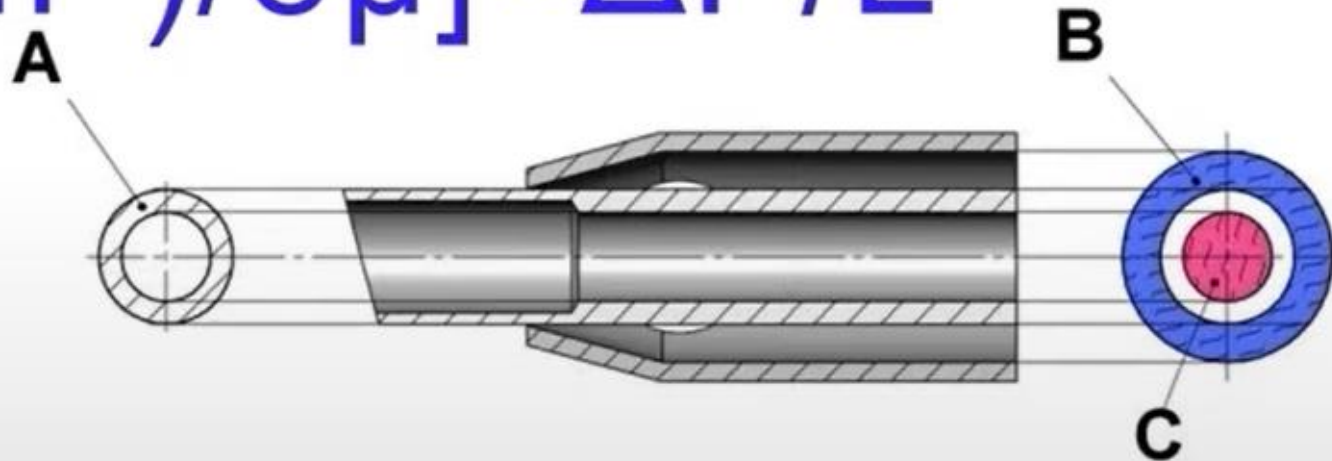
oerthli
SWITZERLAND

easyTip®2.2mm



$$Q = \left[\frac{\pi r^4}{8 \mu} \right] \times \Delta P / L$$

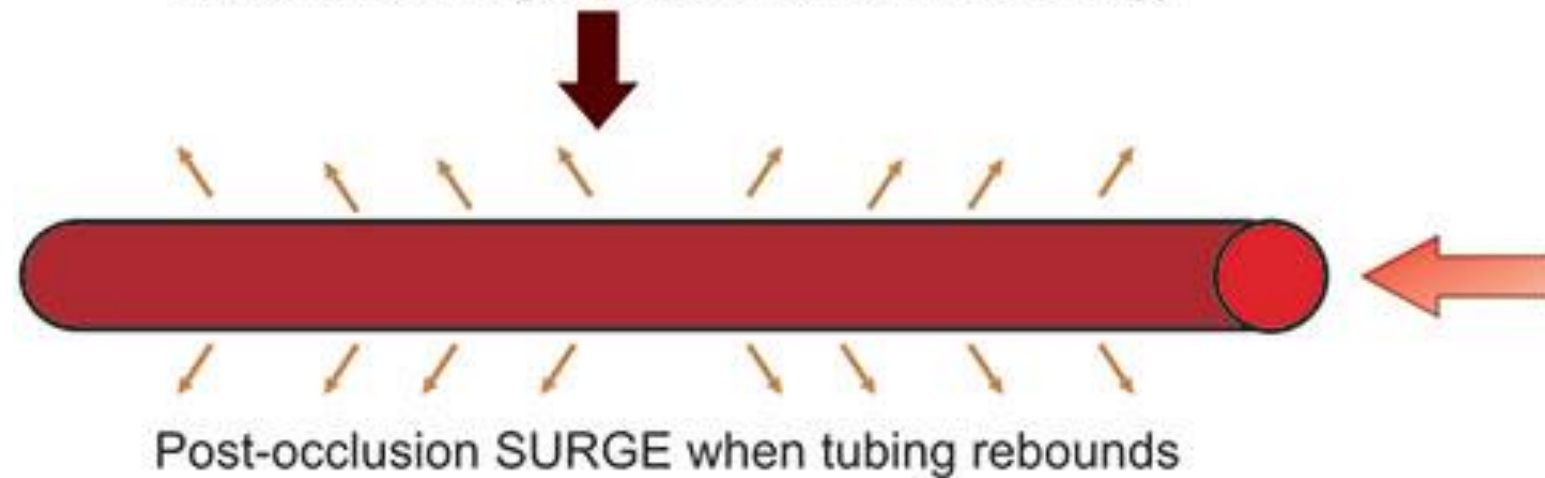
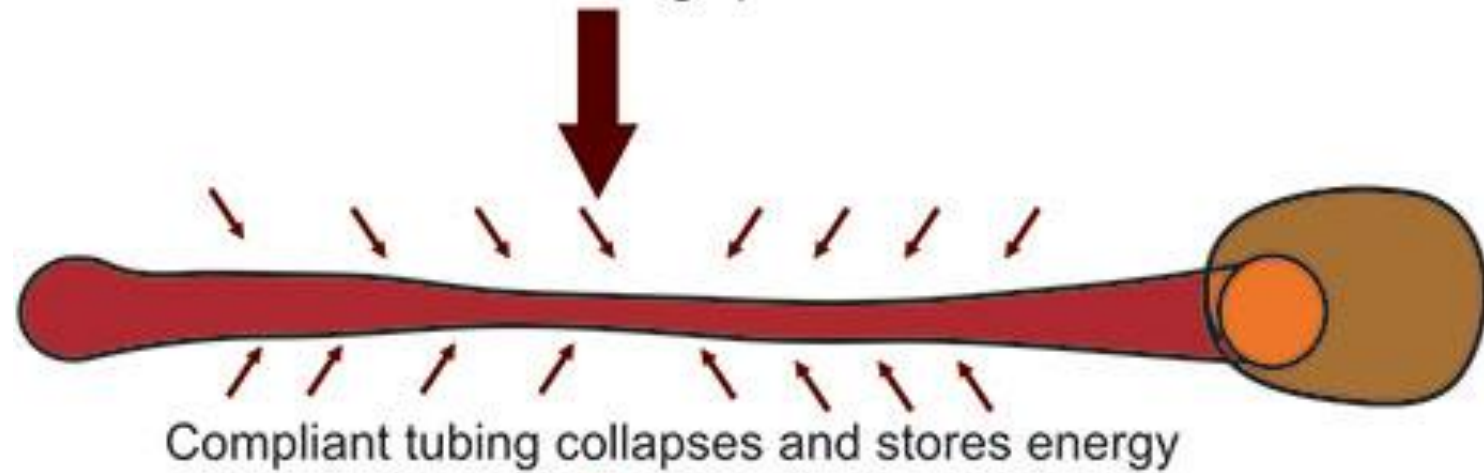
Standard Tip



B: Irrigationsfluss

C: Aspirationsleitung

Collapsed tubing stores energy





Small Bore Aspiration Tubing

• high resistance to flow



30-0031"
0.062" ID

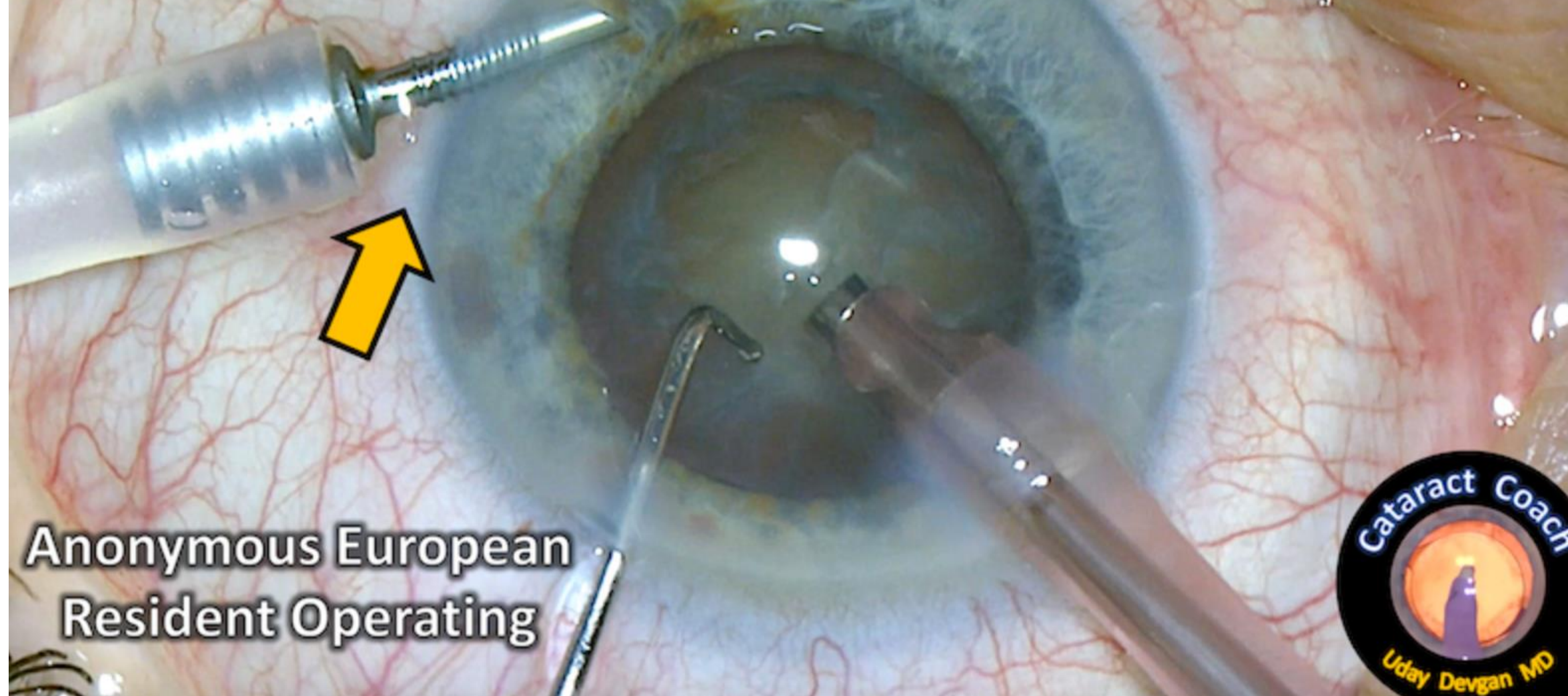


3010-100" PLUS PMS
0.057" ID



CONTURCON"
0.046" ID

Resident Case with an AC maintainer



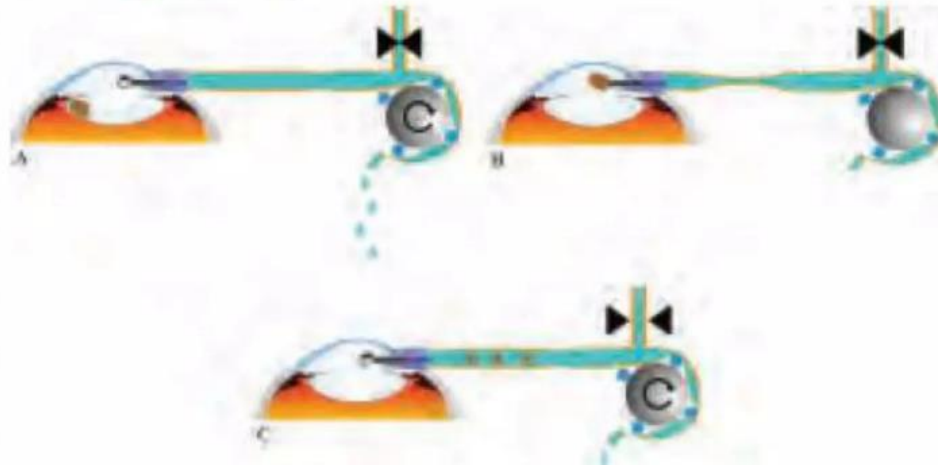
Anonymous European
Resident Operating



Venting

- The machine has a sensor which detects occlusion break and releases fluid into the system to fill the volume of the re-expanding tubing.
- This prevents fluid being drawn out of the AC.

1. Venting (Fig. 1.11)



Fako gücü



Fako el parçasının ultrason üreten mekanizması, ona bağlı tipin hızla ileri geri titreşmesine neden olur.



Hareket uzunluğu farklı makineler için değişir ve normalde 1,5-3,75 mili inç arasındadır.



Fako yüzde olarak belirtilir. Fako gücü %100 olarak ayarlandığında, strok uzunluğu o makine için izin verilen maksimum değerdir. Güç belirli bir yüzde oranında azaltıldığında, strok uzunluğu da azalır.



Elciğin frekansı genellikle kilohertz (KHz) olarak belirtilir. En yaygın kullanılan frekans 40 KHz'dir.

Phaco Power or Energy -
Stroke Length + Frequency

Stroke Length

- How far the phaco tip travels

Frequency

- How many times the phaco tip travels in a second



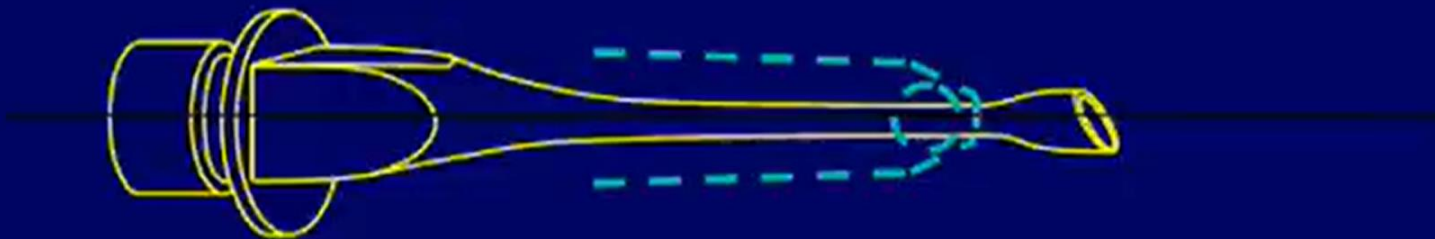
Stroke length



- 40000 - 45000 / second
(fixed rate)
- Phaco power :10% 70%

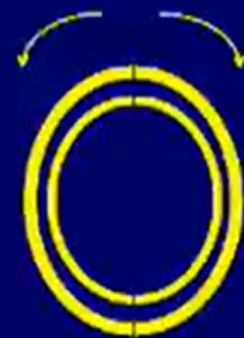
Ultrasound power

40000 Hhz



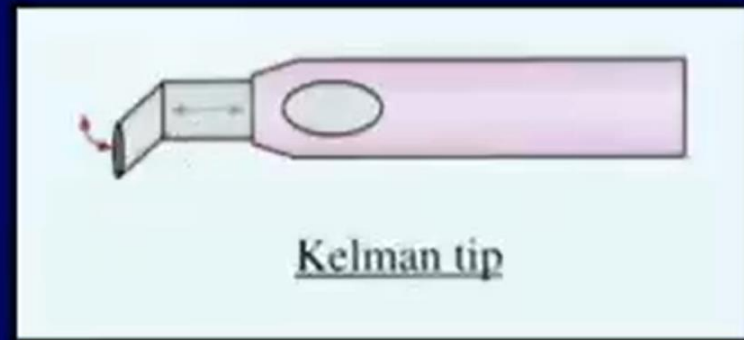
Sonic power

2°



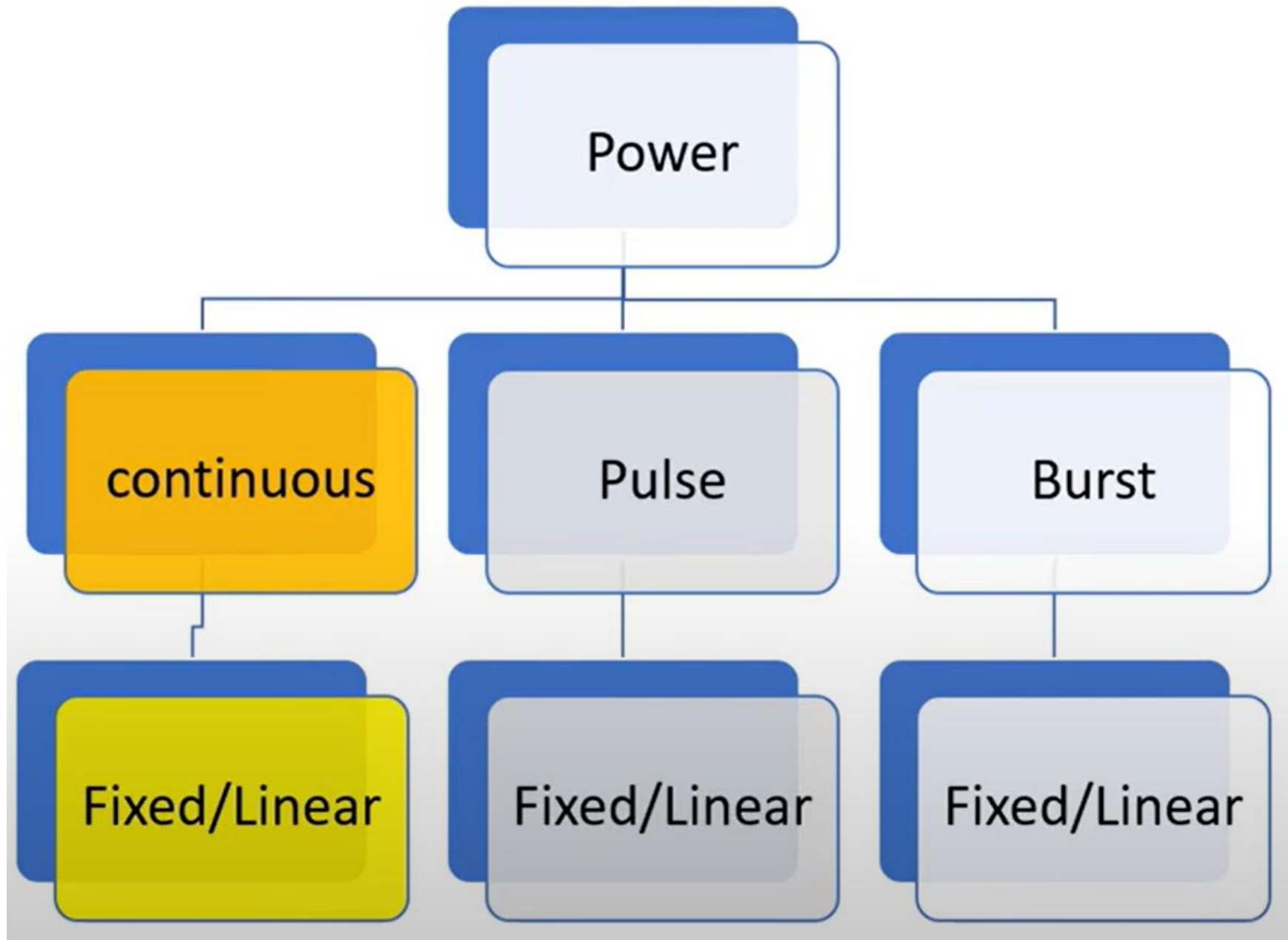
2°

100 Hz

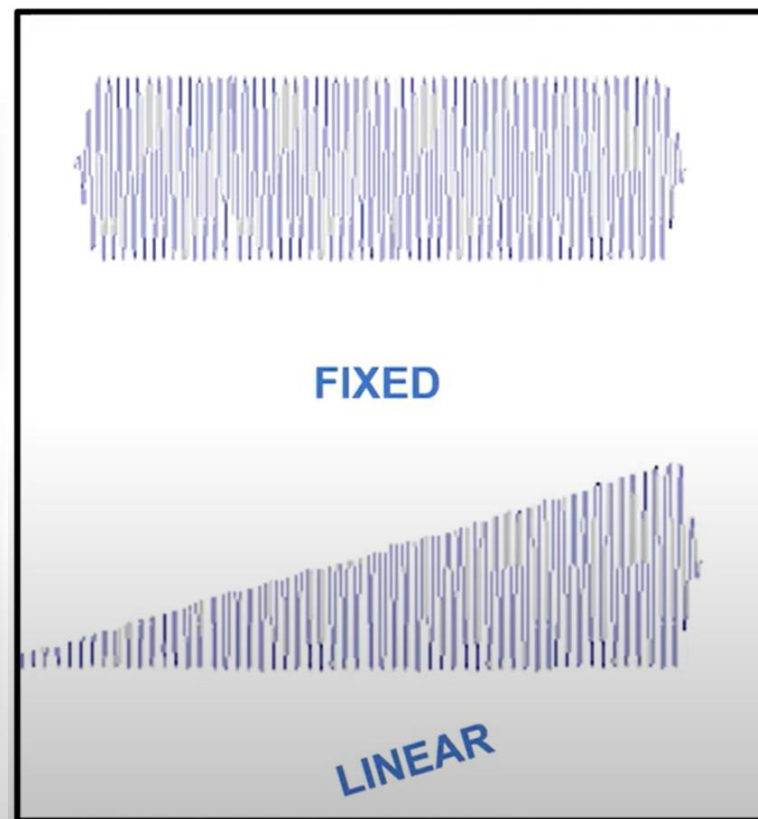


Kelman tip



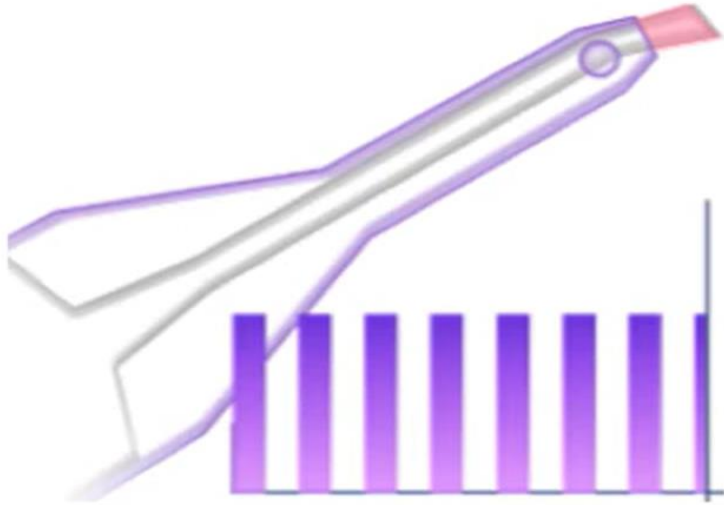


Continuous Energy



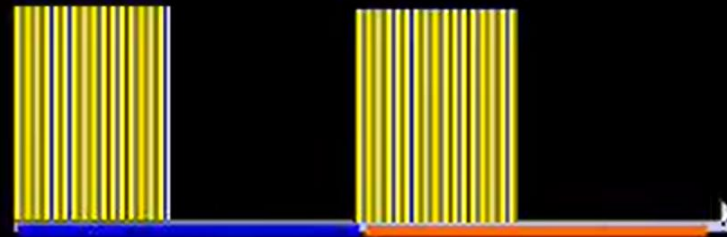
Pulse

- ❖ Pulse is an energy modulation with a pre-determined On- and OFF-time
- ❖ The handpiece delivers power in little pulses or packets of energy



Pulse Mode :

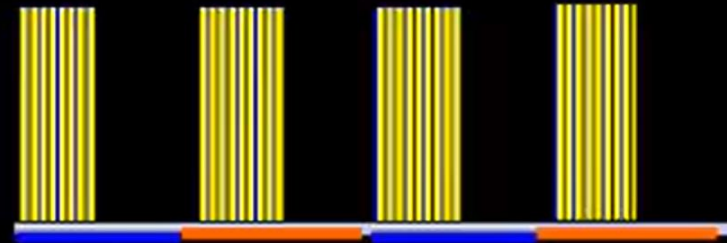
2 pulse / sec



1000

4

4 pulses /sec



10 pulses / sec



*Increasing the PPS does not change
Absolute phaco time :*



2 PPS



4 PPS



10 PPS

*Increasing the PPS does not change
Absolute phaco time :*



2 PPS



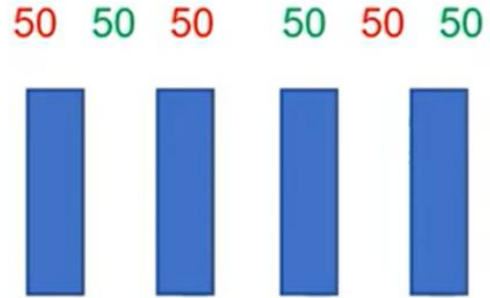
4 PPS



10 PPS



1 second has 1000ms



1 pulse – 50 % On Time

1 pulse = 1000ms

That is 1 on time + 1 off time for 1000ms
Or 1 on time will be 50% of 1000ms or 500ms



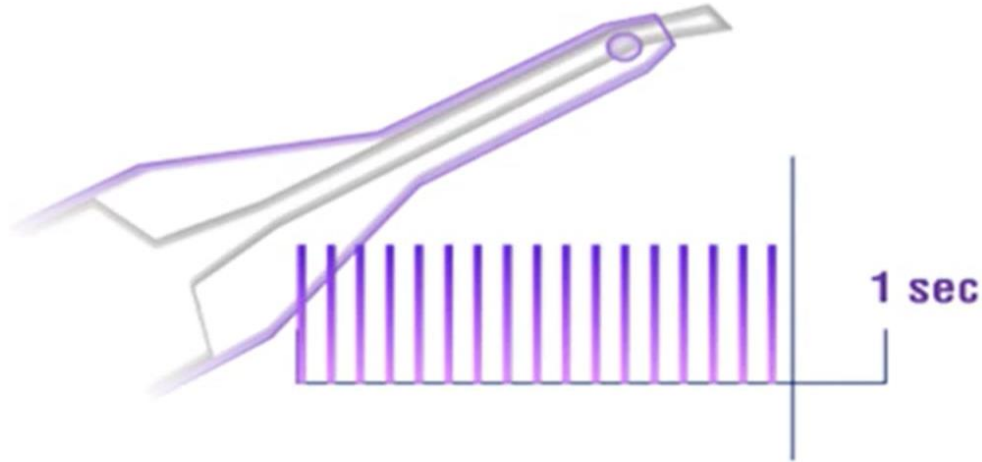
1 pulse – 30% On Time

1 pulse = 1000 ms

Or 1 on time + 1 Off time for 1000ms

1 on time will be for 30% of time or
 $30/100 \times 1000\text{ms} = 300\text{ ms}$ on time and
700 ms off time

Understanding Pulse



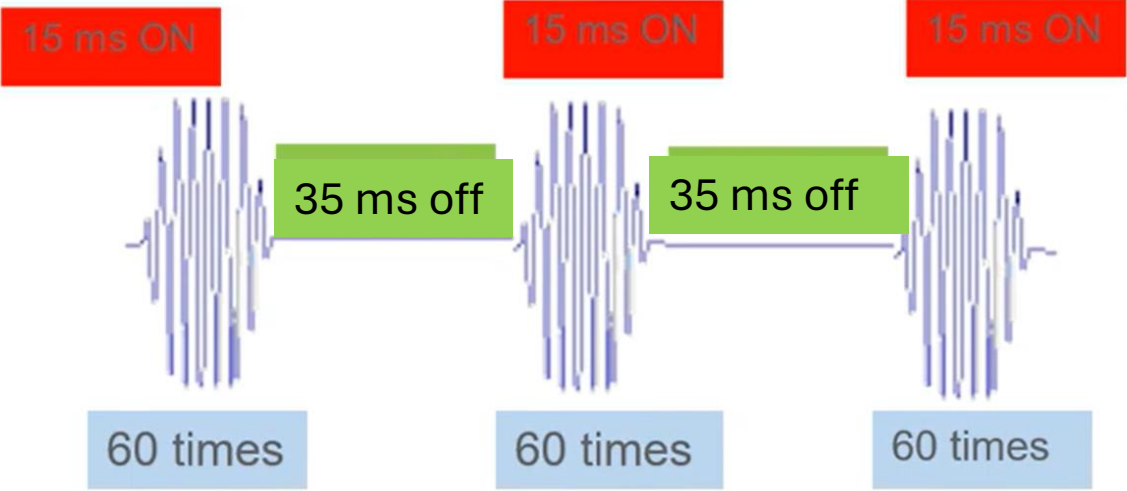
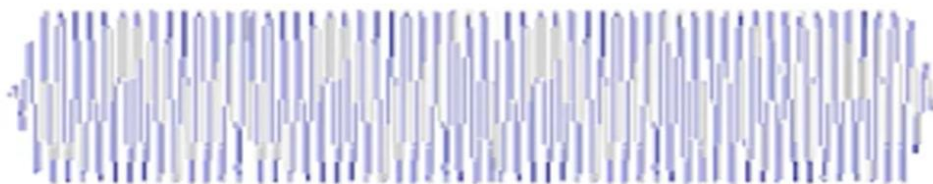
1 sec = 1000 ms

20 pulses per 1000ms
Hence, 1 pulse in $1000/20 = 50\text{ms}$

That is 1on+1off will be done in 50ms

We know 30% on time,
therefore $30/100 \times 50\text{ms} = 15\text{ms on time}$ for one pulse
 $50 - 15 = 35\text{ms off time}$ for 1 pulse

Relating Pulse energy with Frequency of handpiece



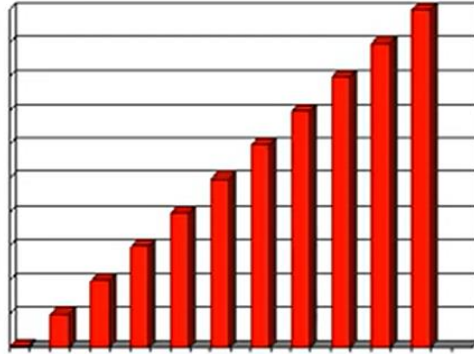
Part II we covered frequency of h/p
40Khz h/p vibrates 40,000 cycles per second.

15ms on 45 ms off time

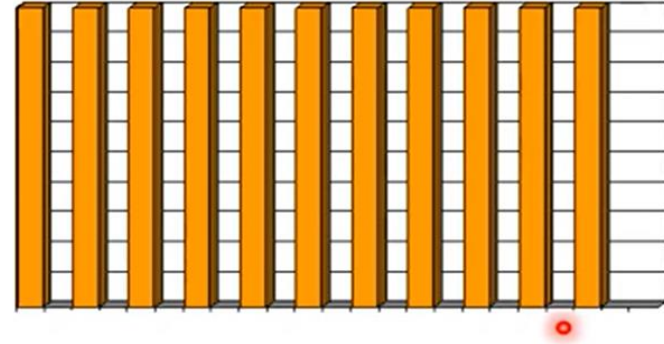
So in 15ms the phaco h/p will vibrate :

$40,000/1000 \times 15 = 60 \text{ times}$
or 60 hz

PULSED OPTION LINEAR



**START
FOOTSWITCH
POSITION 3**



**FINISH
FOOTSWITCH
POSITION 3**

Fixed Duty Cycle with Pulse



Pulse mode



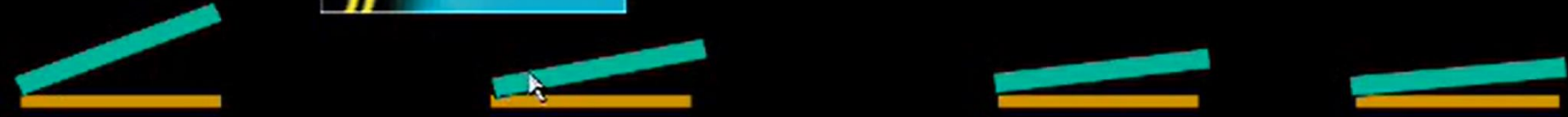
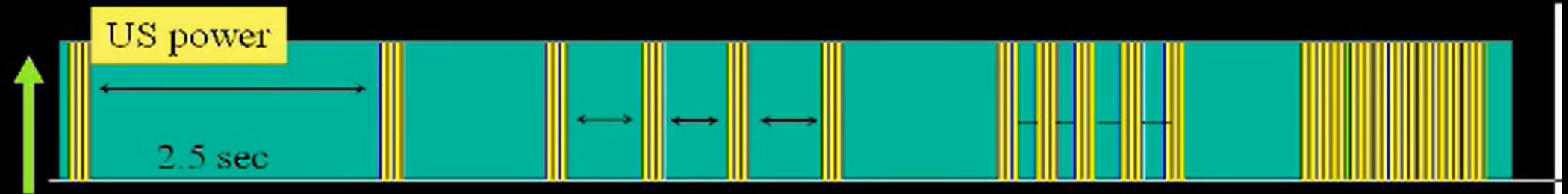
Hyper-pulse



Pulses/Sec increased to create a type of hyperpulse

Burst Mode

Burst width 30 – 500 msec

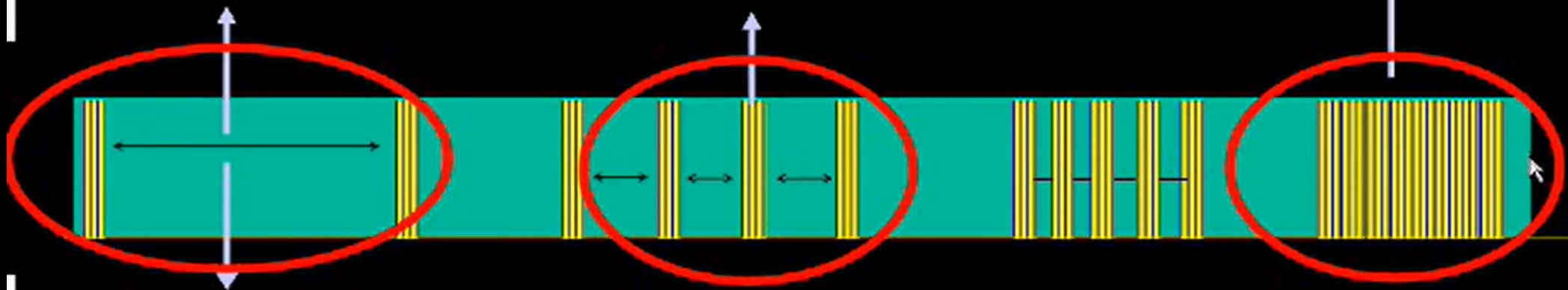


Burst Mode

for
epinucleus
removal

to remove
the
quadrants

sculpting



To hold lens
e.g. Chopping or
Bringing material
to central area





Data source: [illegible]

Continuous



Pulse



Burst

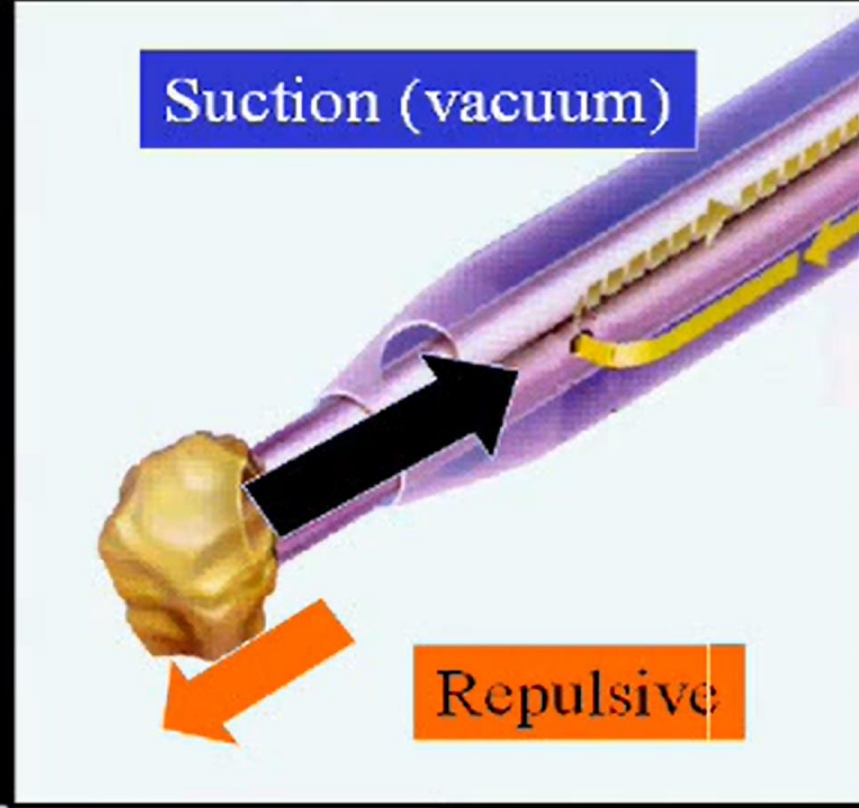
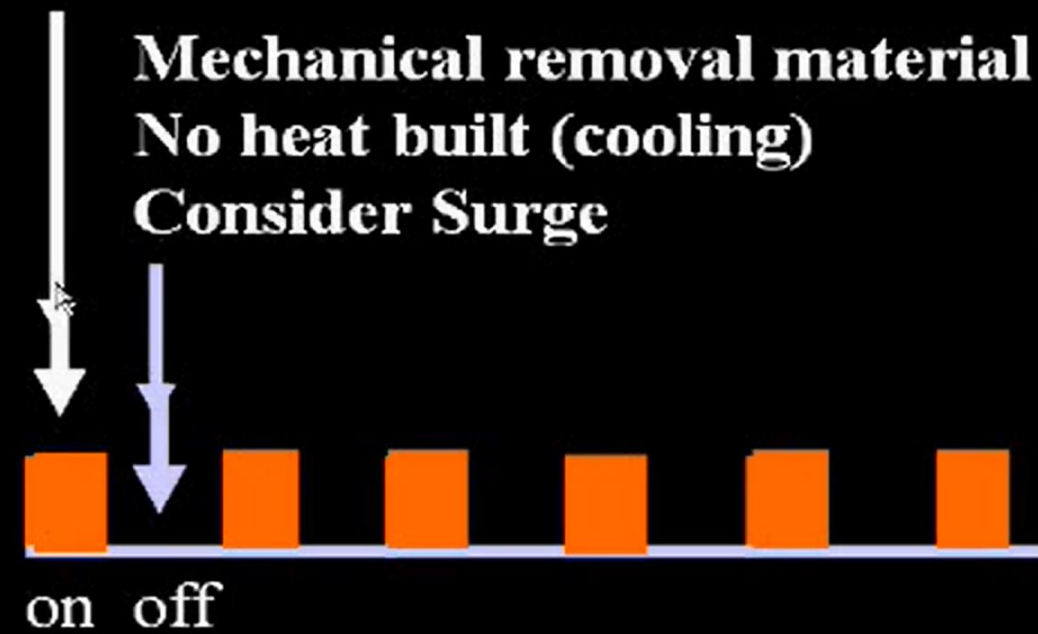


7:24 / 12:20



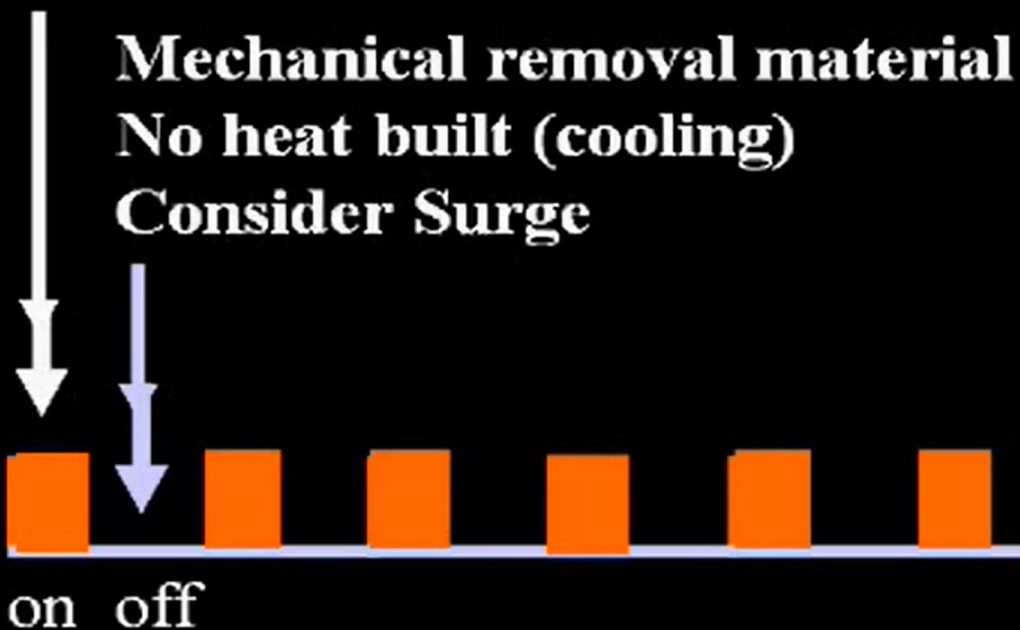
Two forces : repulsive vs. attractive

Emulsification
Heat production



Two forces : repulsive vs. attractive

Emulsification
Heat production



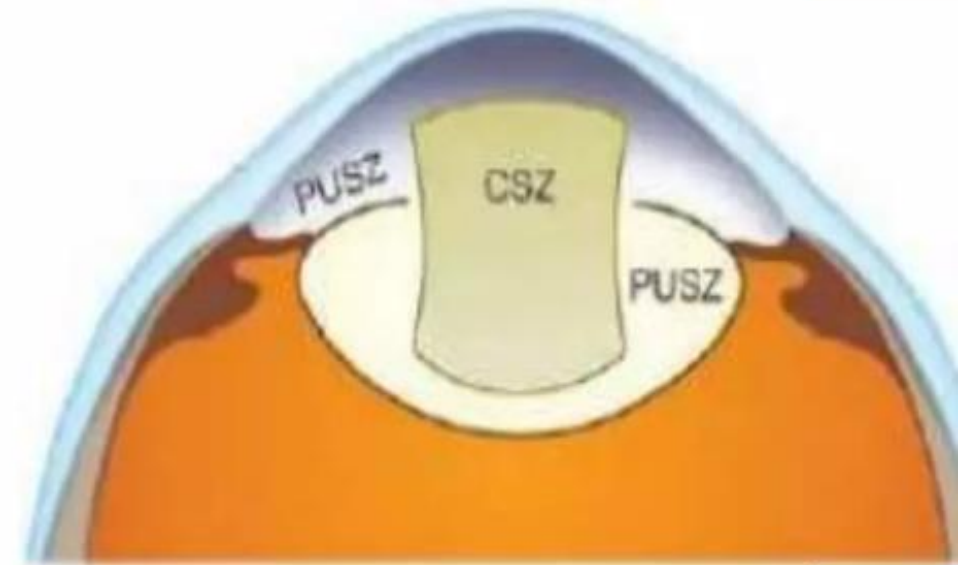
Vacuum	Bottle height
150	65
200-250	85
250-300	110 ³

ZONES OF ASPIRATION

- Central safe zone (CSZ) - central area within the capsulorhexis margin

SMALLER CSZ	LARGER CSZ
Hypermetropia	Myopes
Narrow pupil	Zonular stress syndromes
Small capsulorhexis	Vitrectomized eyes

- Peripheral unsafe zone (PUSZ) - capsular fornices and angle of anterior chamber



Fako tipleri (iğneleri)

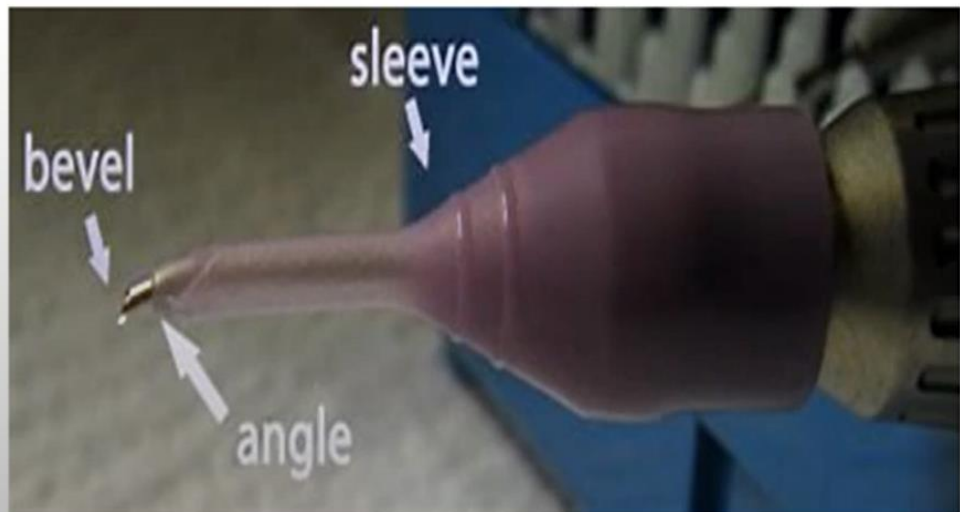
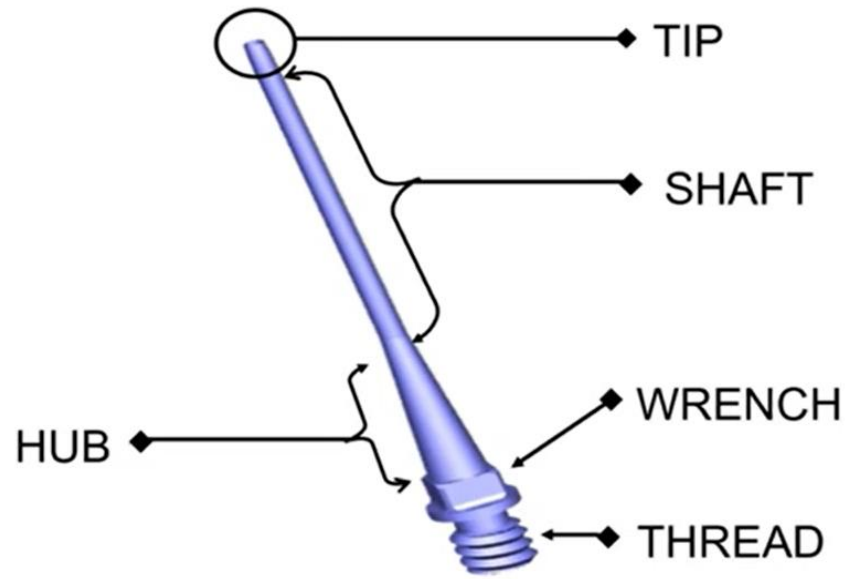
İğnenin şekli ve boyutu, aspirasyonu ve katarakta iletilen ultrasonun gücünü etkileyecektir.

Uygun iğnenin seçimi lens çıkarma tekniğine bağlıdır.

Standart uçların ucundaki eğim 0-60 derece arasında değişebilir.

Daha karmaşık uçlar bileşik açılara sahip olabilir. Uç yapılandırmaları yuvarlak veya elipsoid, bükülmüş veya genişletilmiş olabilir.

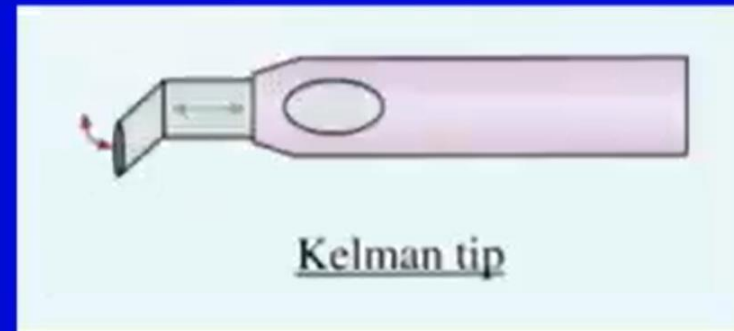
BASIC TIP ANATOMY



Shape of phaco tip



Kelman tip

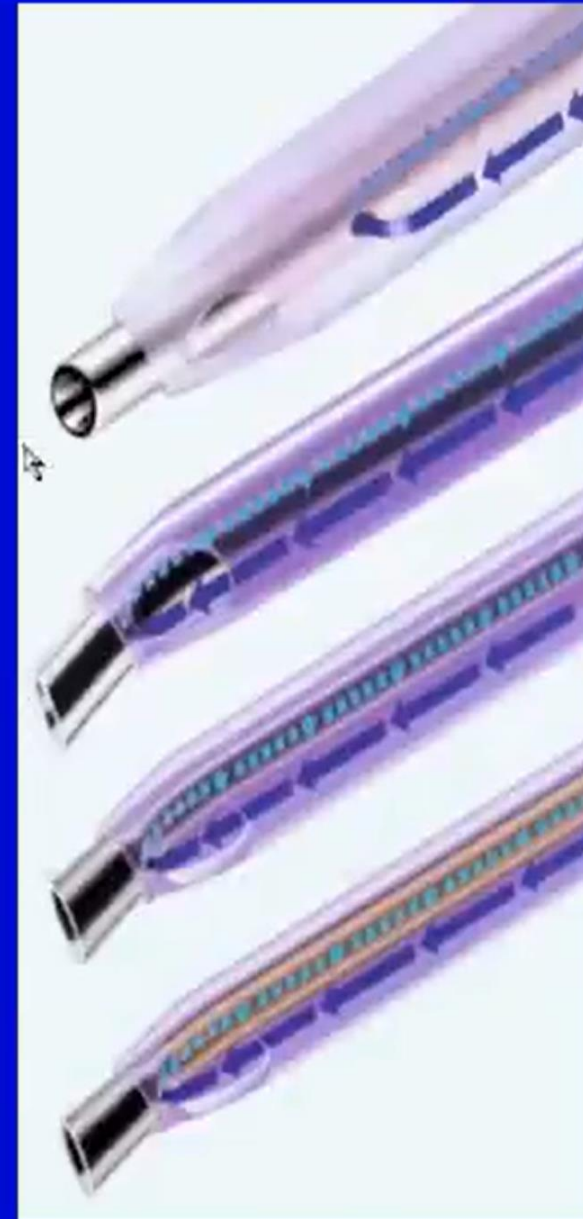


ABS Standard

ABS Kelman

Flared ABS

Mackool Flared ABS



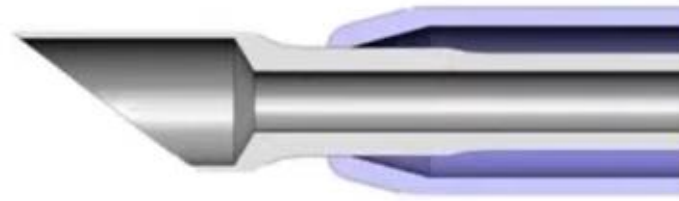


Kelman 45-degree ABS phaco tip
Max. amplitude 130 μm



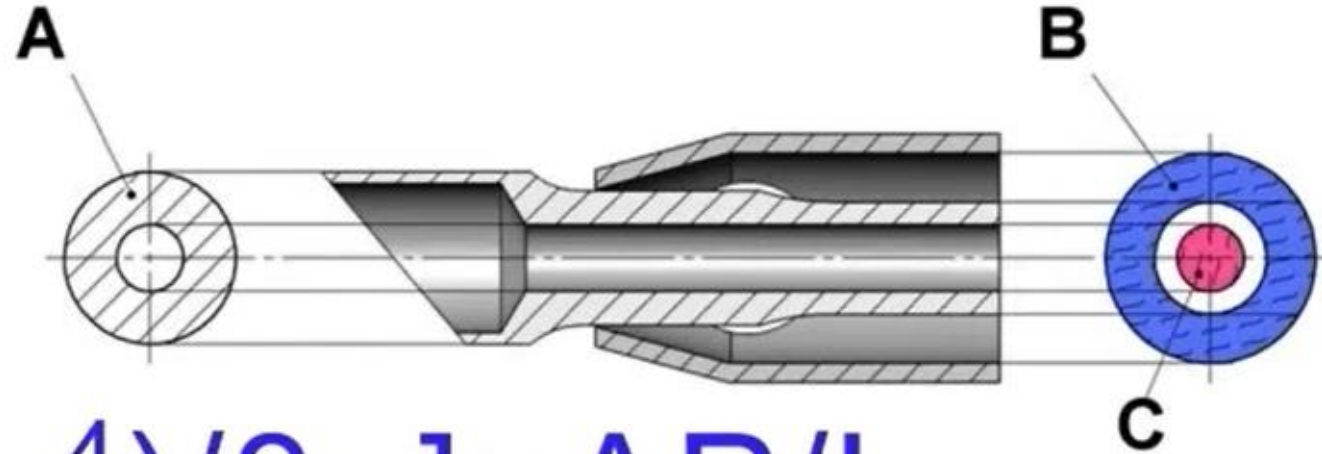
Balanced 45-degree ABS phaco tip
Max. amplitude 192 μm

easyTip®CO-MICS
(1.4-1.6mm)



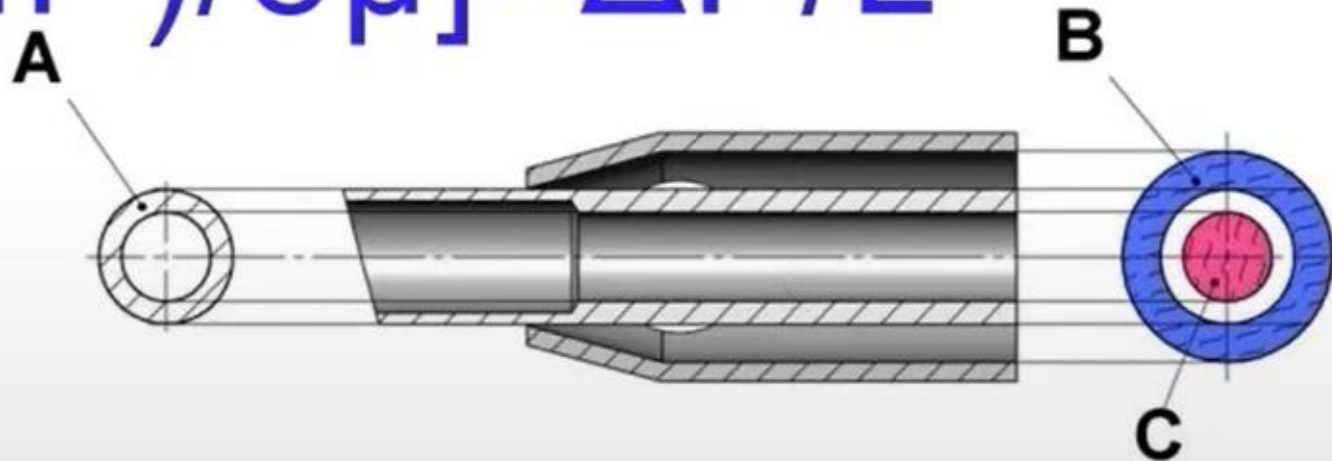
oertli
SWITZERLAND

easyTip®2.2mm



$$Q = \left[\frac{\pi r^4}{8 \mu} \right] \times \Delta P / L$$

Standard Tip

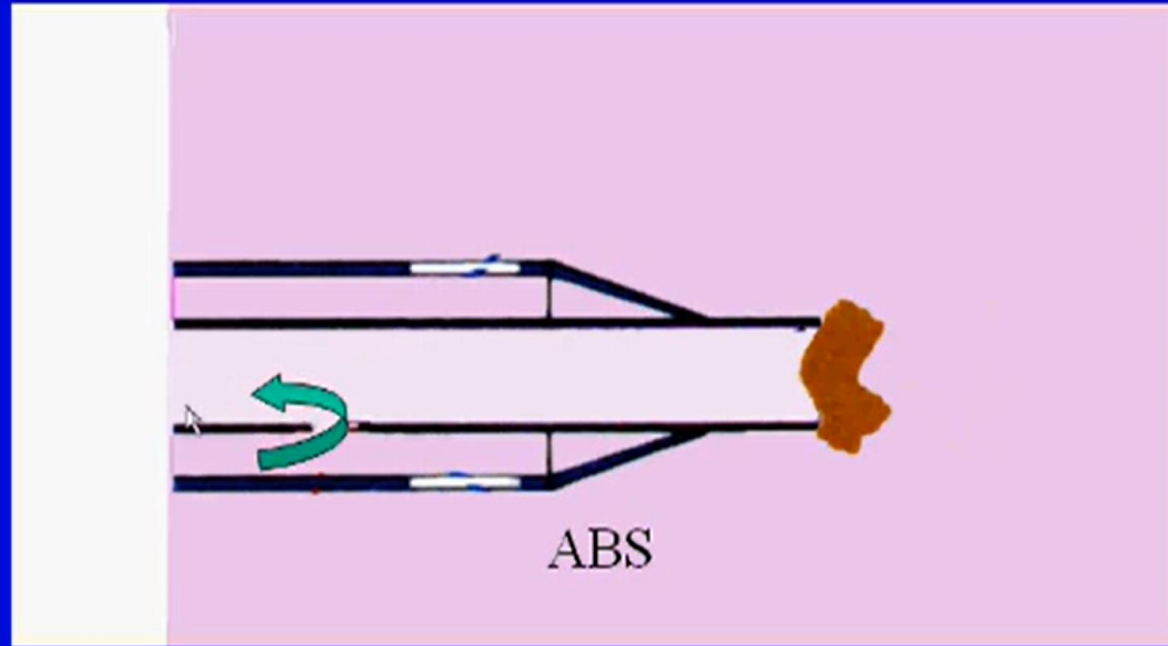


B: Irrigationsfluss

C: Aspirationsleitung

ABS tip Aspiration bypass





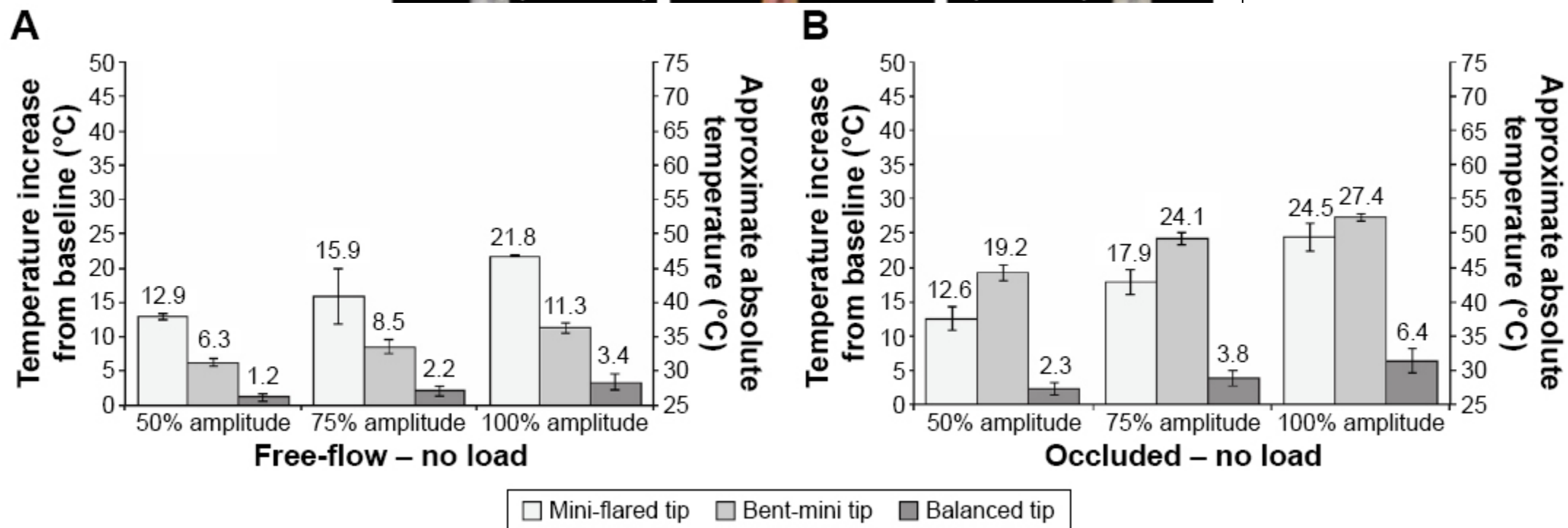
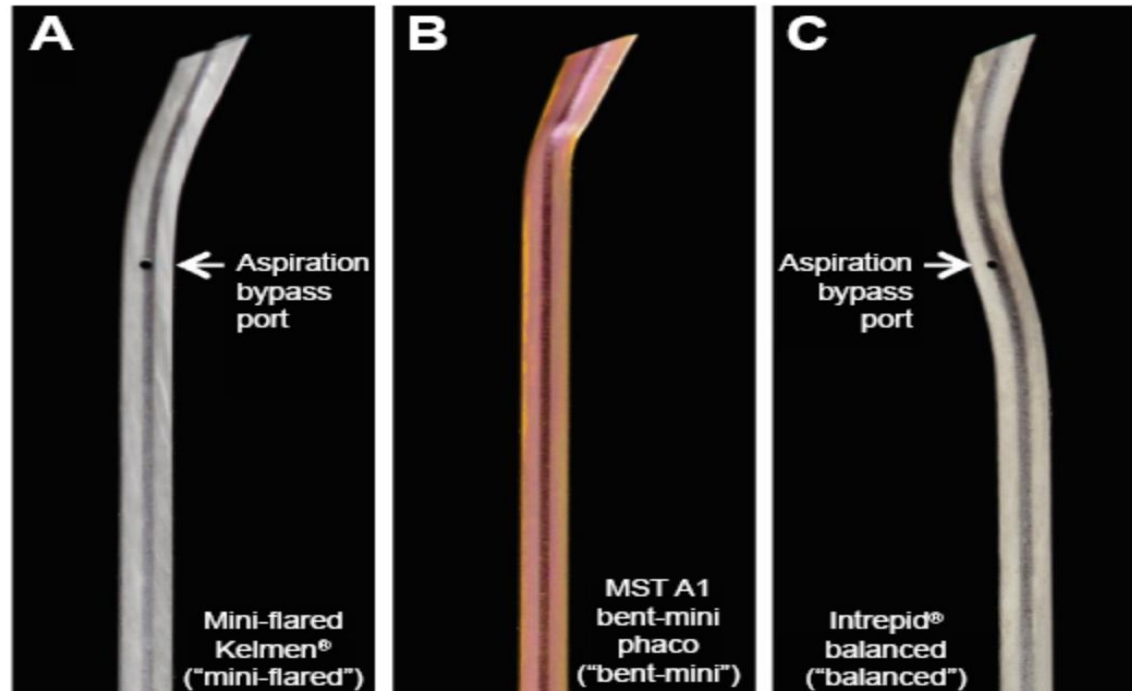
Some thermal protection
Less surge

Occluded

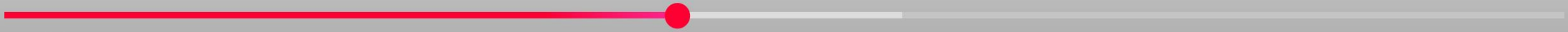
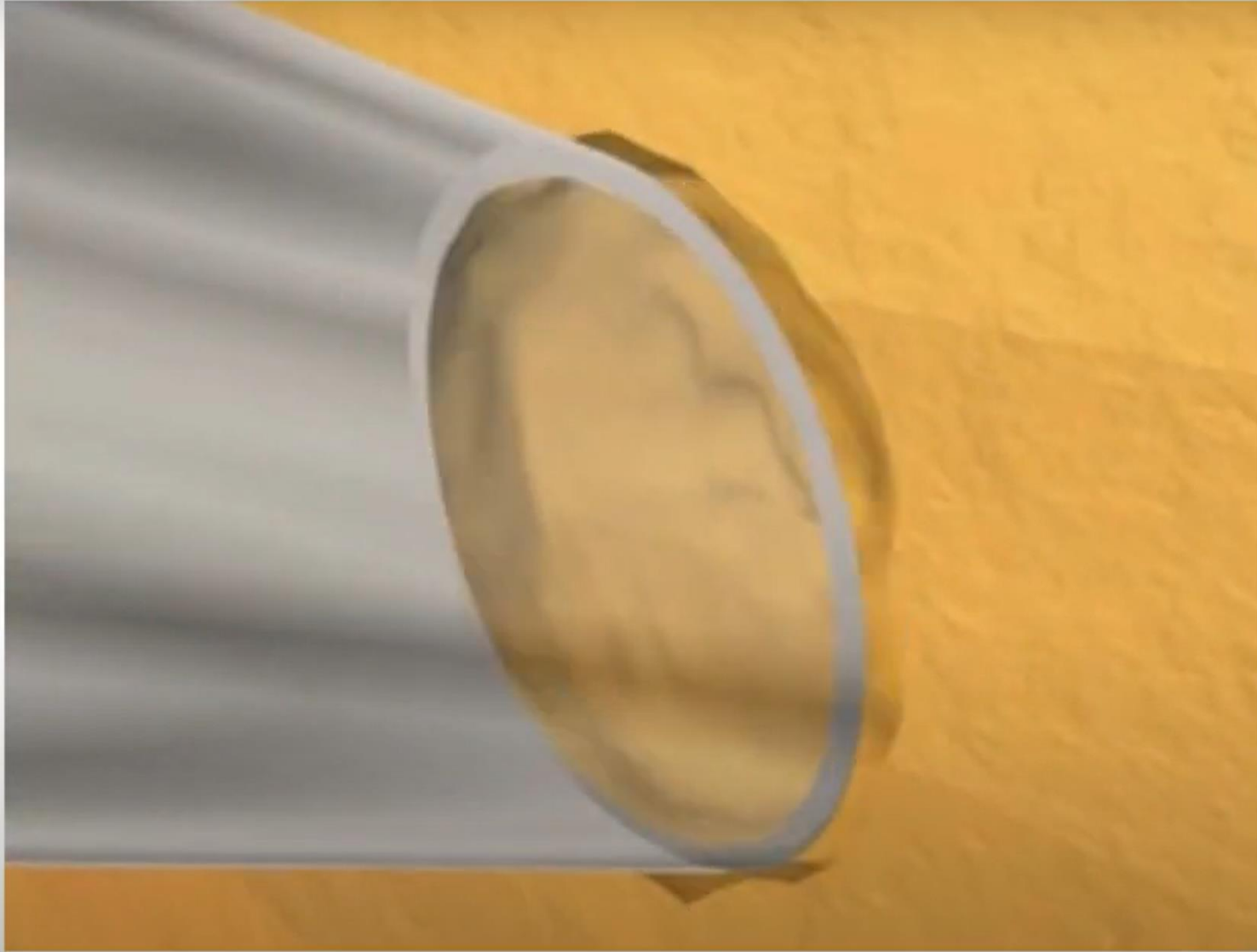


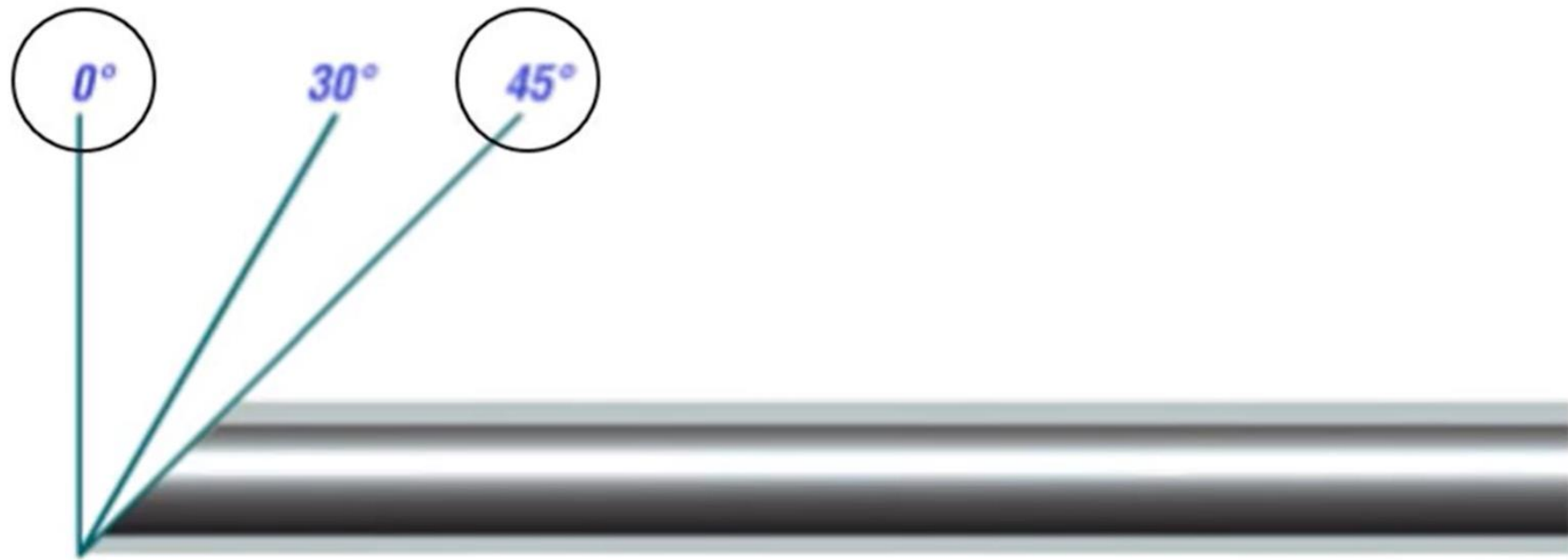
Aspiration is reduced to near zero by nuclear fragment at tip.

Flow is directed through ABS® port when tip is occluded. Flow rate can range from 4 to 15 cc/min., depending on tip, vacuum level and state of occlusion.



Basics of Phaco - Part II (follow quickguide.org) for Part III the link is given in description box.





Larger Bevel = Higher Holding Force

Larger Bevel = Cut Better “Sharper Edges”

Larger Bevel = Easier Visualization

Smaller Bevel = Easier to Occlude



Teşekkürler