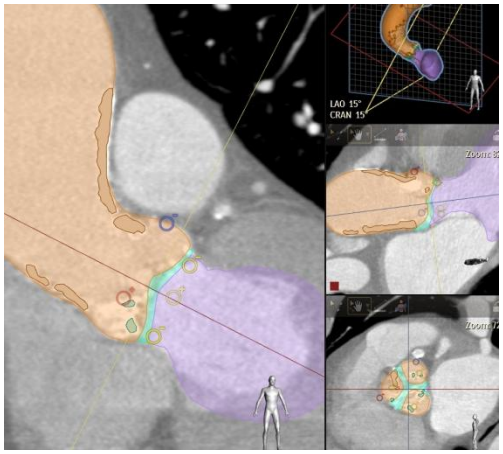
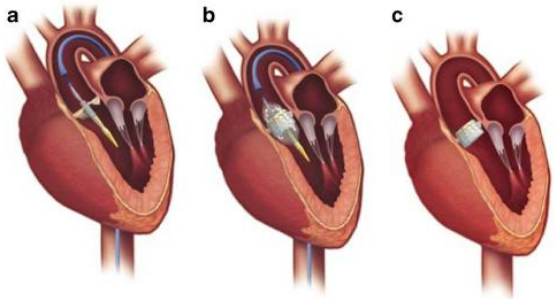
ISMETT Istituto di Ricovero e Cura a Carattere Scientifico

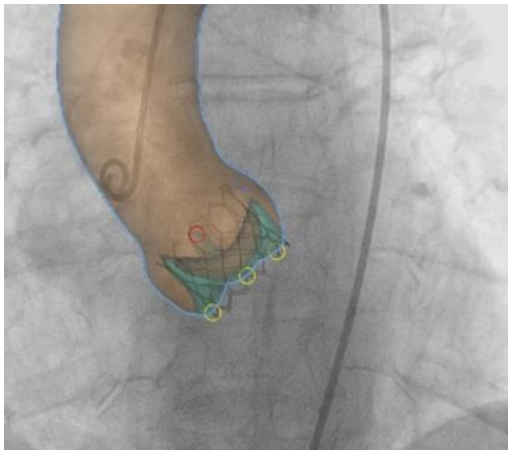
UPMC LIFE CHANGING MEDICINE

Airt PALERMO 25 - 26 MAGGIO 2018 SAVE THE DATE

Utilizzo di un software specifico per la pianificazione di procedure TAVI in cardiologia interventistica







Antonino Cucchiara

acucchiara@ismett.edu

Diagnostic and Therapeutic Services,

IRCCS Mediterranean Institute for Transplantation and Advanced Specialized Therapies (ISMETT), Palermo, Italy

Obiettivi

- ***Anatomia Anulus Aortico***

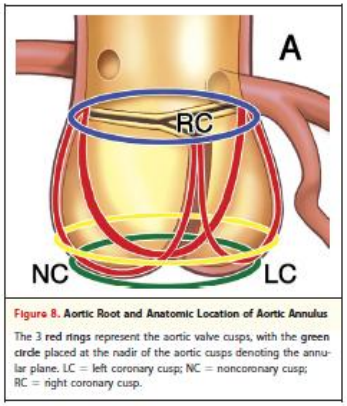
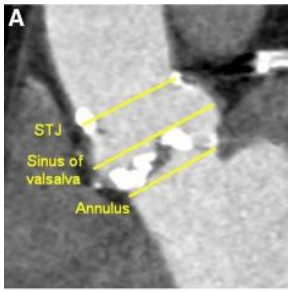
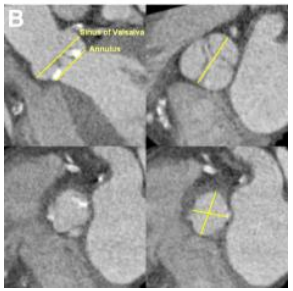


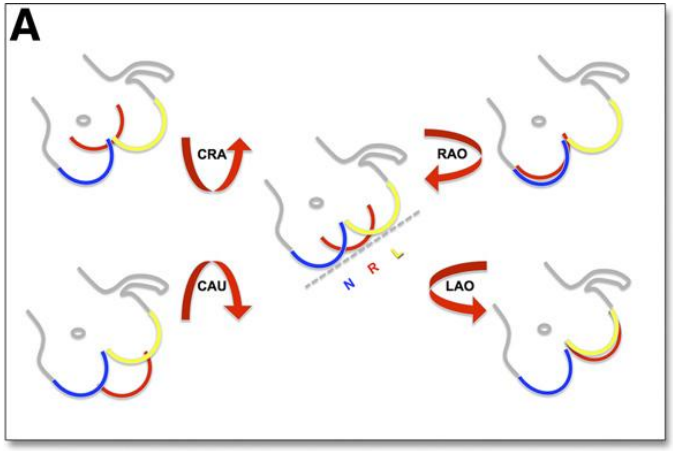
Figure 8. Aortic Root and Anatomic Location of Aortic Annulus

The 3 **red rings** represent the aortic valve cusps, with the **green circle** placed at the nadir of the aortic cusps denoting the annular plane. LC = left coronary cusp; NC = noncoronary cusp; RC = right coronary cusp.





- ***Tecnica Follow the Right Cusp***



- ***Analisi dati di un software dedicato per il planning della procedura TAVI***

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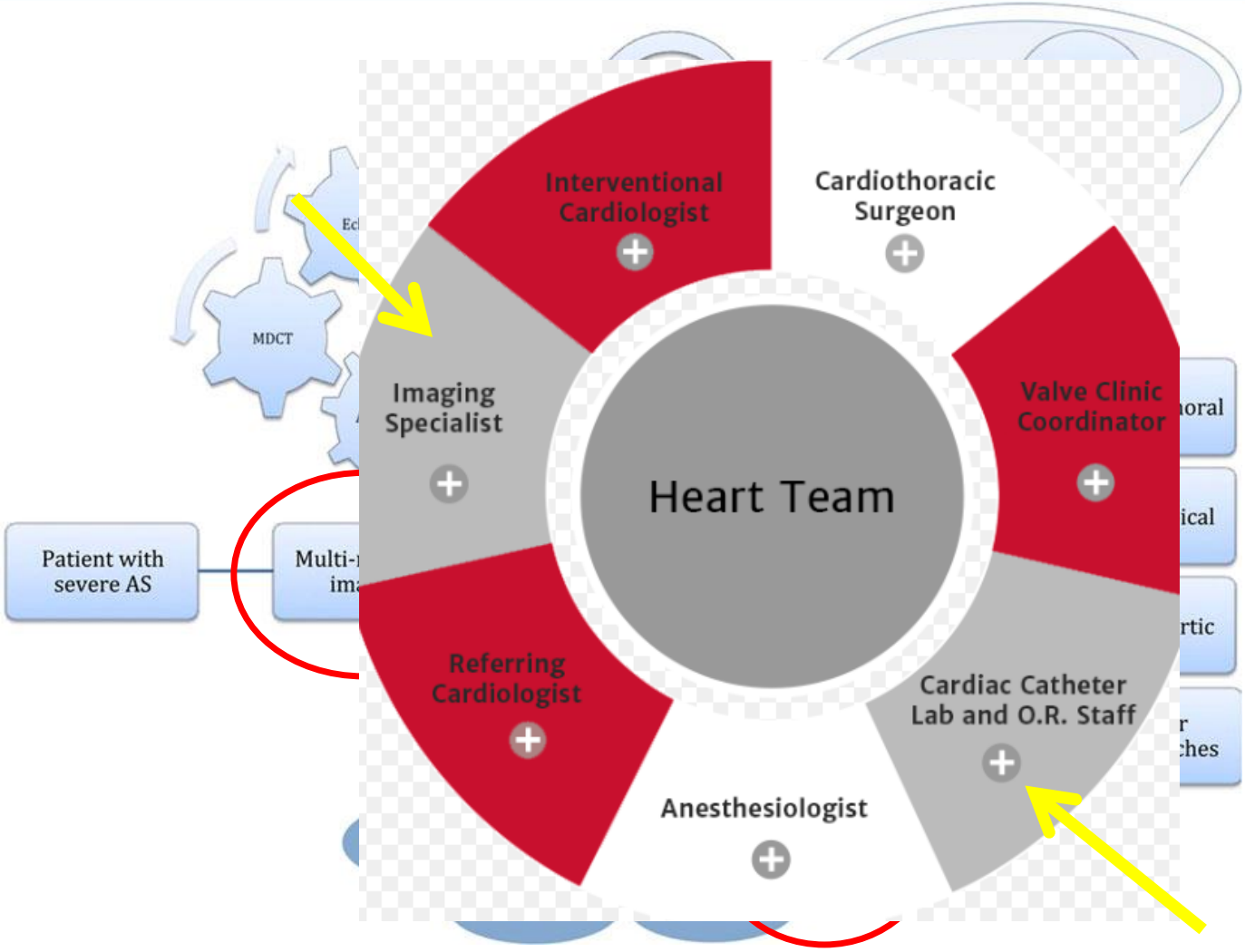
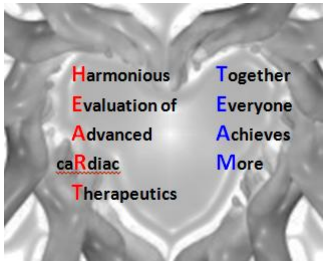
TSRM prima-durante-dopo procedura TAVI





101. Agarwal S, Tuzcu EM, Krishnaswamy A, Schoenhagen P, Stewart WJ, Svensson LG, Kapadia SR. Transcatheter aortic valve replacement: current perspectives and future implications. *Heart* 2015;**101**:169–177.

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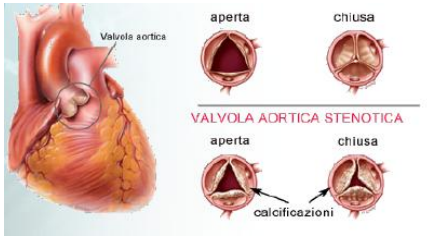
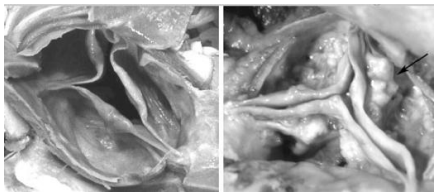
TAVI or TAVR

TAVI Transcatheter Aortic Valve Implantation

TAVR Transcatheter Aortic Valve Replacement





Trattamento della stenosi aortica severa in pazienti ad elevato o intermedio rischio per la cardiochirurgia SAVR

STENOSI AORTICA patologia valvolare

5% della popolazione con età maggiore a 75 anni
mortalità 50% a 2 anni dall'insorgenza

2002, prima TAVI effettuata nell'essere umano da A.Cribier

Incremento esponenziale delle procedure

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UPMC LIFE CHANGING MEDICINE

Incremento procedure

INTRODUZIONE

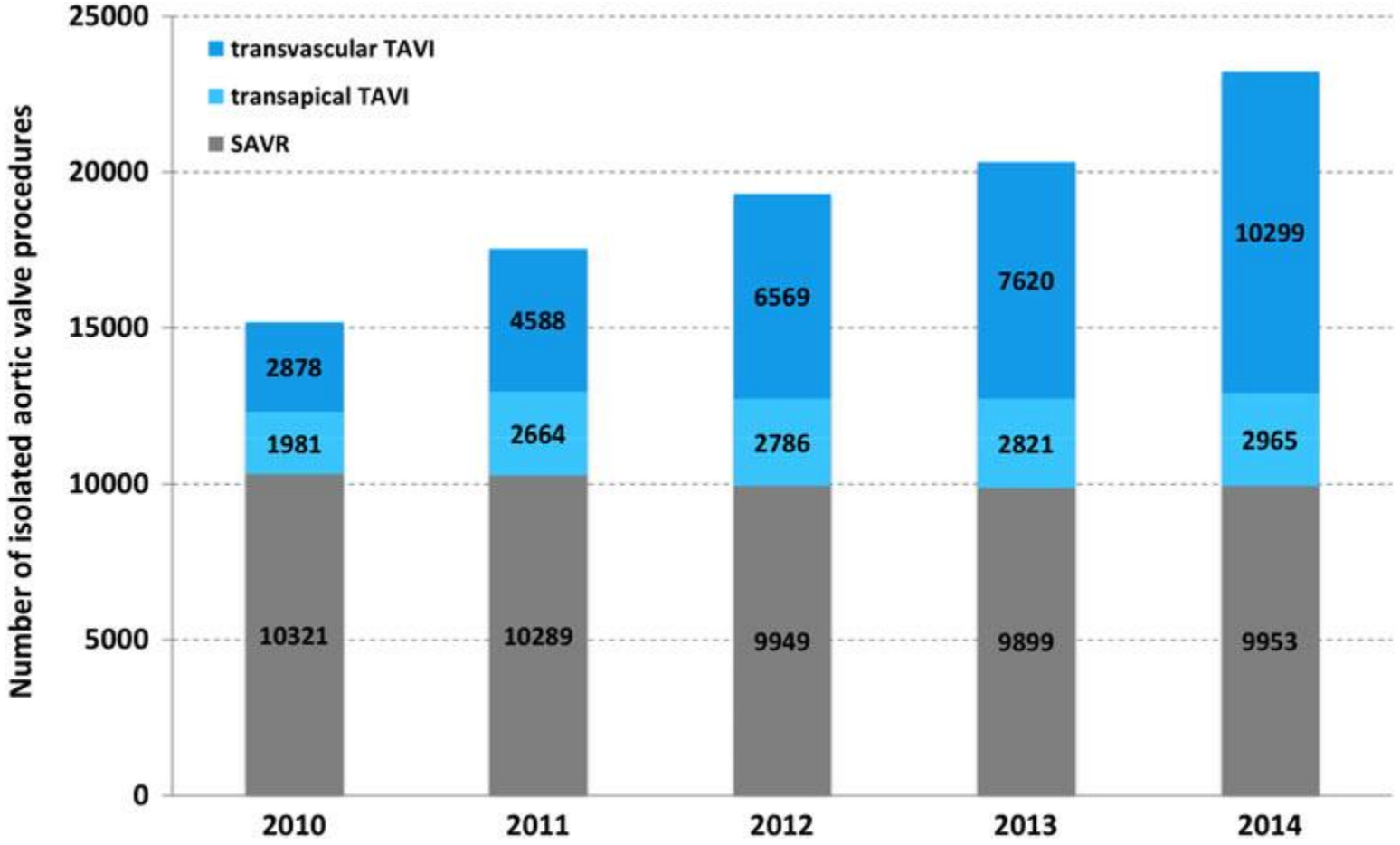
TAVI or TAVR

Numero procedure

Numero procedure IRCCS ISMETT

Valvole protesiche

Caratteristiche dimensionali e scelta valvole protesiche



9. AQUA Qualitätsreport 2014 p69–74. http://www.aqua-institut.de.

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Un po' di numeri IRCCS ISMETT

204 pazienti da Gennaio 2016 a Marzo 2018

- 80 pazienti nel 2016
- 103 pazienti nel 2017
- previsione circa 120 pazienti nel 2018 (30 pazienti ad aprile 2018)

Device success	202 (99)
Intra procedural death	0
Intra hospital death	2 (0,9)
Major vascular complication	3 (1,4)
Major stroke	2 (0,9)
New Peacemaker	23 (11,2)
Tamponade	2 (0,9)
Acute kidney injury	1 (0,4)

Valvole protesiche

INTRODUZIONE

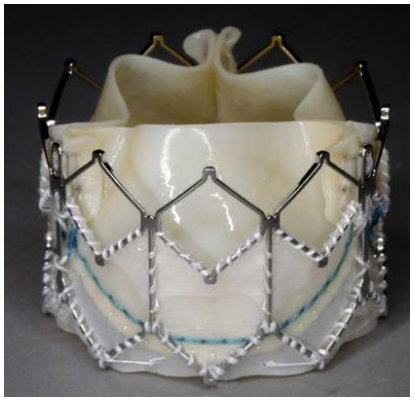
TAVI or TAVR

Numero procedure

Numero procedure IRCCS ISMETT

Valvole protesiche

Caratteristiche dimensionali e scelta valvole protesiche



Parameter	Edwards Sapien 3	Medtronic Core Valve Evolut
Deployment	Balloon expandable	Self expandable
Frame	Cobalt-chromium	Nitiol
Pericardial leaflets	Bovine	Porcine
Valve function	Intraanular	Supraanular
Sheath size Fr	14,16	14
Repositionable	NO	SI
Rapid ventricular pacing	SI	NO

Caratteristiche dimensionali e scelta valvole protesiche

INTRODUZIONE

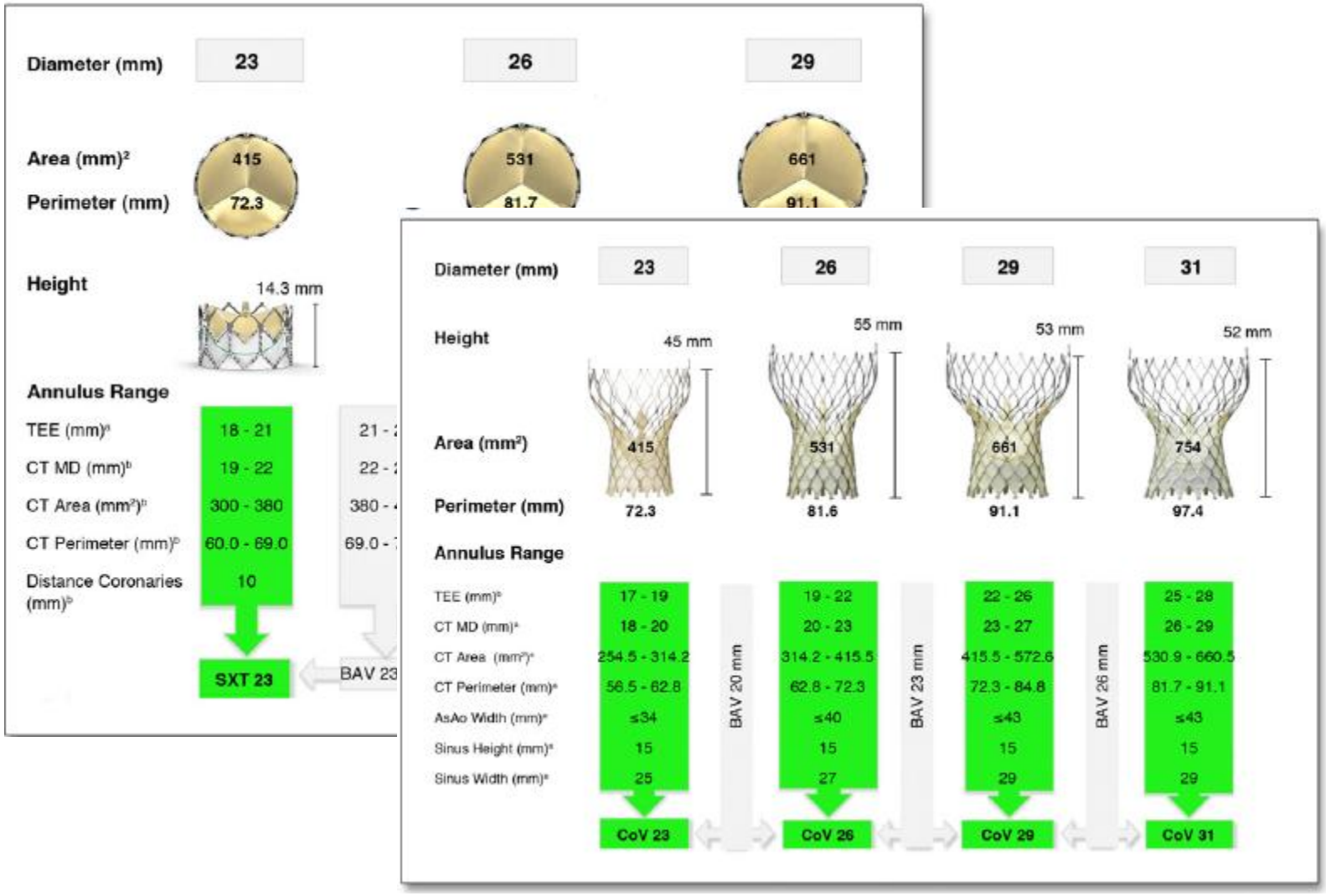
TAVI or TAVR

Numero procedure

Numero procedure IRCCS ISMETT

Valvole protesiche

Caratteristiche dimensionali e scelta valvole protesiche



Background

I software dedicati per la simulazione provvedono ad elaborare le immagini in maniera ottimale per lo specifico campo di interesse (TAVI)

Provvedono a fornire un set di dati inerenti la procedura secondo le linee guida:

- Distanza coronaria SN rispetto al piano valvolare
- Distanza coronaria DX rispetto al piano valvolare
- Misure in termini di area, perimetro e diametri di GST, LVOT, bulbo aortico, etc.
- Previsione della proiezione di lavoro
- Simulazione delle diverse valvole protesiche in commercio.

Time consuming

efficacia e sicurezza della procedura

Radiologo impiega 20 minuti elaborazione
Software 5 minuti (con sistemazione da parte di operatore della segmentazione effettuata in automatico)

CT Imaging

BACKGROUND

CT imaging

Report e misure pre TAVI

Anatomia

Anatomia radice aortica

Anatomia anulus Aortico

Misura anulus aortico e scelta Protesi valvolare

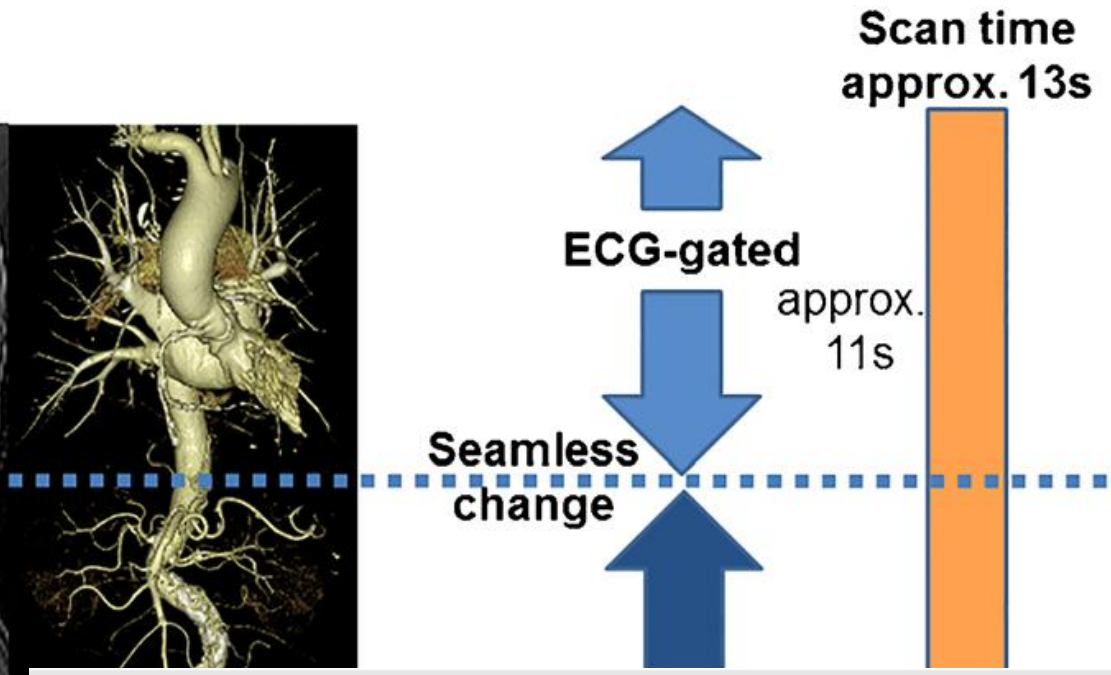


Table 2 Recommendations for CT image acquisition before TAVI/TAVR

Imaging of the aortic root must use ECG-synchronization.
Motion artifacts should be minimized.
Slice thickness should be ≤1.0 mm.
Multiphase ("cine") imaging is in general not necessary.
Imaging of the aorta and peripheral vessels should extend from aortic arch (and potentially subclavian artery) to below the groin.
Imaging of the abdominal aorta and peripheral vessels does not need to be ECG gated.
Contrast agent exposure may be an issue in the patients who are often of advanced age and may have renal impairment. Contrast reduction and adherence to protocols for prevention of contrast-induced nephropathy is recommended.
Two separate acquisitions (ECG-synchronized for the aortic root and nongated for the aorta and peripheral vessels) may be preferable over an ECG-synchronized acquisition of the entire volume to reduce the amount of contrast agent. If ECG-triggered high-pitch spiral acquisition is available, its use may be advantageous.

ECG, electrocardiogram; TAVI, transcatheter aortic valve implantation; TAVR, transcatheter aortic valve replacement.

Eur Radiol (2017) 27:1963–1970
DOI 10.1007/s00330-016-4547-4

Journal of Cardiovascular Computed Tomography (2012) 6, 366–380

Report e misure pre TAVI

Table 12 Data elements included in the report

Data acquisition mode
Timing of images in the cardiac cycle (systolic vs diastolic)
Contrast volume
Image quality
Aorta
Presence of kinking
Presence of intraluminal obstruction
Presence of intraluminal thrombi
Ascending aorta
Width at 40 mm from annulus
Position relative to sternum
Aortic arch
Width
Branch anatomy (for embolic protection device purposes)
Descending aorta
Width
Iliofemoral arteries
Minimal width on both sides
Tortuosity
Calcification
Aortic root
Sinotubular junction aortic diameter*
Sinus of Valsalva width*
Sinus of Valsalva height*
Distance of coronary ostia from aortic annular plane
Aortic valve
Cuspidity
Qualitative extent of aortic valve calcification, separately for commissures and annulus
Presence of a severely calcified cusp which may obstruct a coronary ostium
Aortic Annulus
Aortic annulus short diameter
Aortic annulus long diameter
Aortic annulus area and area-derived diameter
Aortic annulus circumference and circumference-derived diameter
Appropriate fluoroscopic projection angle to obtain an orthogonal view onto the aortic valve plane (if the reader feels competent to report this)
Left Ventricle
Presence of thrombi

*For self-expanding valves.

SCCT expert consensus document on computed tomography imaging before transcatheter aortic valve implantation (TAVI)/transcatheter aortic valve replacement (TAVR)

Stephan Achenbach, MD, FSCCT[a,*], Victoria Delgado, MD[b], Jörg Hausleiter, MD[c], Paul Schoenhagen, MD[d], James K. Min, FSCCT[e], Jonathon A. Leipsic, MD, FSCCT[f]

Journal of Cardiovascular Computed Tomography (2012) 6, 366–380

Table 1
CT parameters – measurements in pre-TAVI screening.

Aortic annulus (AA)
- AA short and long diameters
- AA perimeter and perimeter-based effective diameter
- AA area and area-based effective diameter
- Ideal fluoroscopic projection angle

Aortic valve
- Pattern and extent of calcifications
- Presence of calcified cusps
- Cuspidity

Aortic root
- Height and width of sinus of Valsalva
- Distance from the AA plane to the coronary artery ostia
- Sinotubular junction diameter

Aorta
- Anatomy
- Tortuosity and elongation
- Intraluminal calcification, thrombi, and dissections
- Ascending aorta, aortic arch, and descending aorta diameters

Iliofemoral arteries
- Minimal luminal diameters bilaterally
- Tortuosity and angulation
- Calcifications

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UPMC LIFE CHANGING MEDICINE

Anatomia

BACKGROUND

CT imaging

Report e misure pre TAVI

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Anatomia radice aortica

Anatomia anulus Aortico

Misura anulus aortico e scelta Protesi valvolare

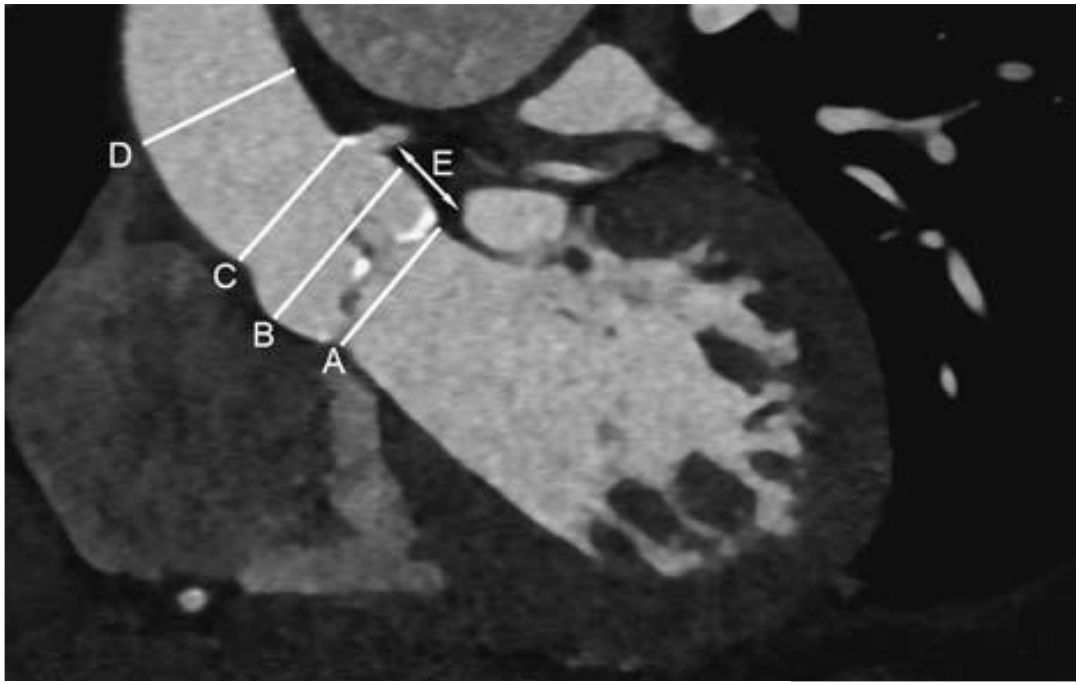


FIGURE 1. Overview of standard measurements on cardiac CT for TAVR assessment on coronal-oblique multiplanar reformations along the axis of the aortic root. A, Diameter of the AA. B, Sinus of Valsalva. C, Sinotubular junction. D, Ascending aorta. E, Distance between AA and left coronary artery ostium.

(*J Thorac Imaging* 2015;30:349–358)

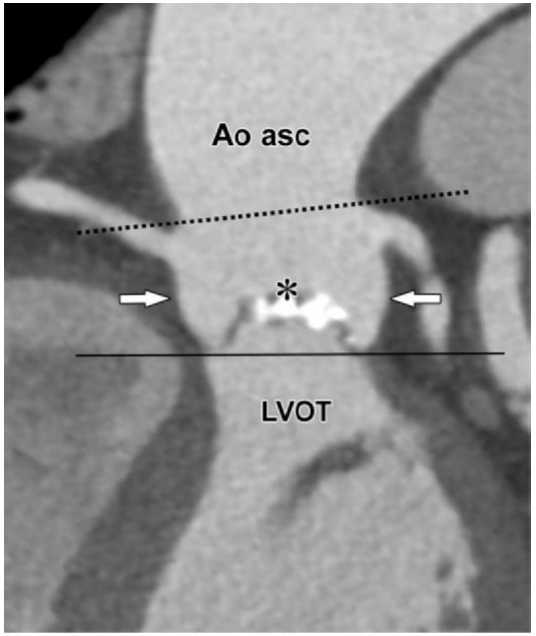


Figure 7. Coronal contrast-enhanced CT image shows the aortic root extending between the LVOT and the ascending aorta *(Ao asc)*, with its borders formed by the sinotubular junction (dashed line) and the basal attachments of the aortic valve leaflets, which define the level of the annular plane (solid line). The aortic root contains the sinus of Valsalva (arrows) and aortic valve leaflets (*).

RadioGraphics 2014; 34:1491–1514

Anatomia Radice Aortica

BACKGROUND

CT imaging

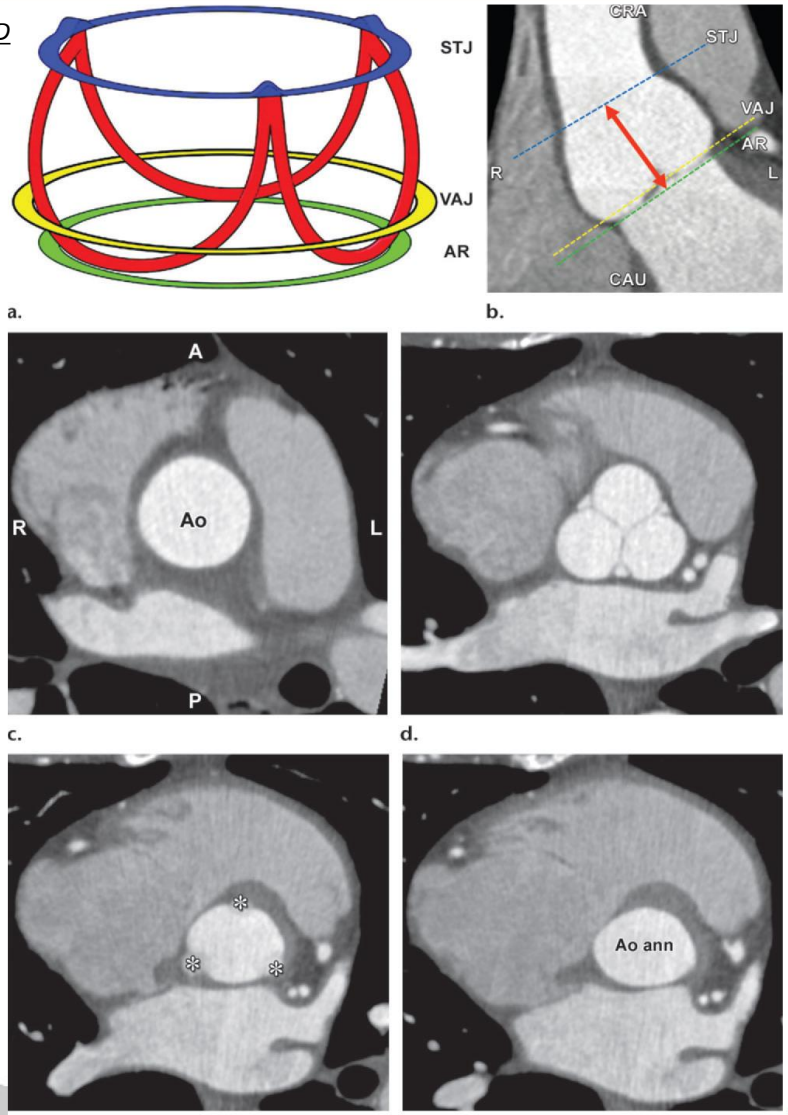
Report e misure pre TAVI

Anatomia

Anatomia radice aortica

Anatomia anulus Aortico

Misura anulus aortico e scelta Protesi valvolare



Gli anelli aortici sono 4:

1. virtual basal ring,
2. anello aorto-ventricolare ,
3. crown-like ring,
4. anello della giunzione sino tubulare.

Figure 9. **(a)** Drawing illustrates the crownlike suspension of the aortic valve leaflets within the aortic root extending across the length of the aortic sinus. *AR* = virtual annular ring (green), formed by joining the basal attachments of the aortic valve leaflets; *STJ* = sinotubular junction (blue); *VAJ* = ventriculoarterial junction (yellow). Red = aortic leaflet insertion sites in the sinus of Valsalva forming a crownlike ring. (Reprinted, with permission, from reference 39.) **(b)** Coronal contrast-enhanced CT image demonstrates the levels of the sinotubular junction *(STJ)* (blue line), ventriculoarterial junction *(VAJ)* (yellow line), and annular ring *(AR)* (green line). Double-headed arrow = anatomic range of the sinuses of Valsalva. *CAU* = caudal, *CRA* = cranial. **(c–f)** Double-oblique reformatted images further clarify the changing shape of the aortic root contour. **(c)** The sinotubular junction forms the top of the crown, where the outlet of the aortic root in the ascending aorta *(Ao)* is a true circle. *A* = anterior, *P* = posterior. **(d)** The aortic root gradually becomes less circular, with a more cloverleaf shape at its midportion (ie, at the sinuses of Valsalva). At this level, the aortic valve leaflets are clearly seen. **(e)** The aortic valve leaflets (*) are just barely visible at the level of the ventriculoarterial junction, where the left ventricular structures give rise to the fibroelastic walls of the aortic valvar sinuses. Note that the aortic root contour is now becoming increasingly ellipsoid. **(f)** The bottom of the aortic root is formed by the virtual ring, or aortic annulus *(Ao ann)*, which has an oval shape in most patients.

RadioGraphics 2014; 34:1491–1514

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Anatomia Anulus Aortico

BACKGROUND

CT imaging

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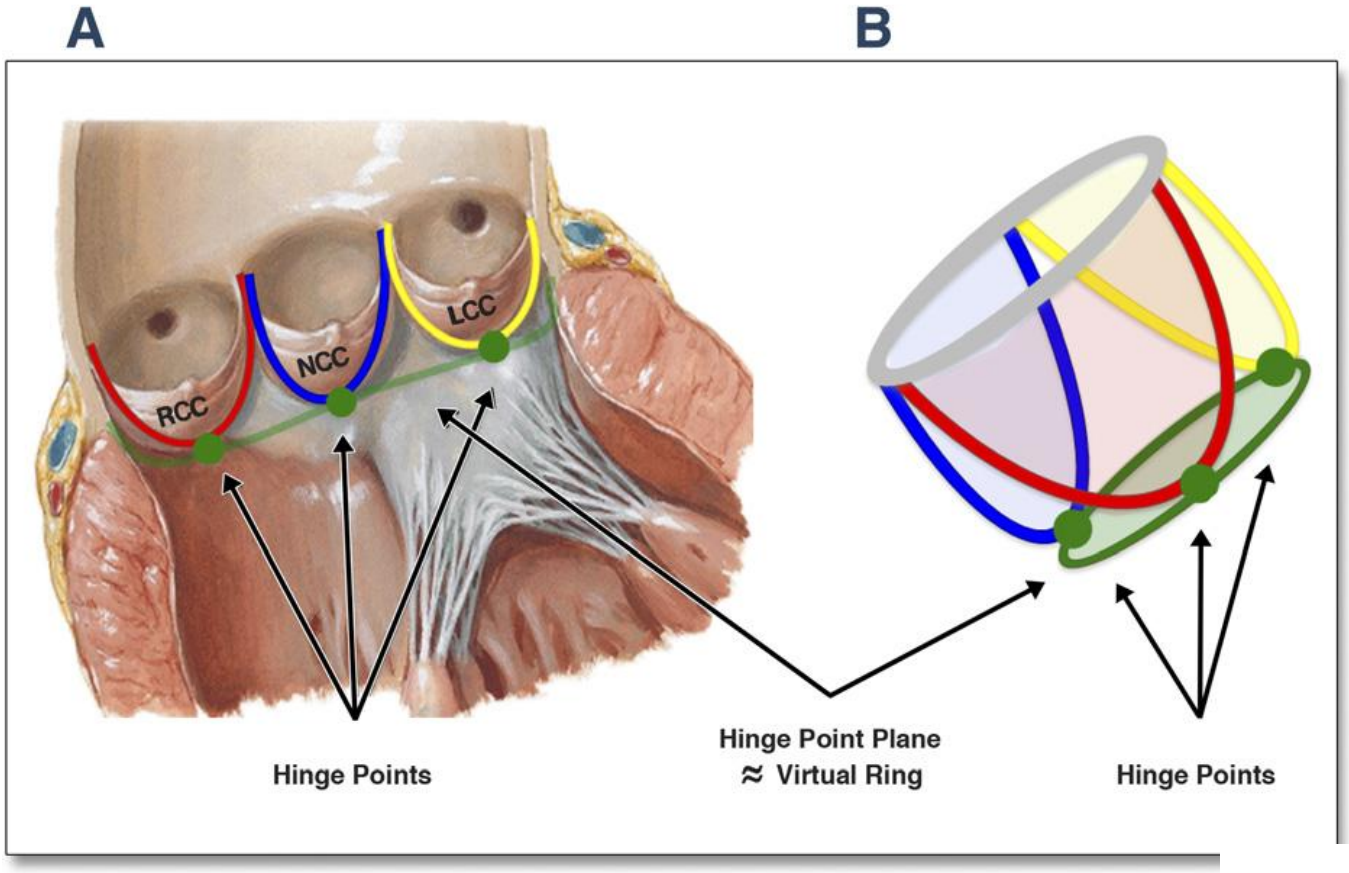
Anatomia radice aortica

Anatomia anulus Aortico

Misura anulus aortico e scelta Protesi valvolare



VOL. 6, NO. 2, 2013
ISSN 1936-878X/$36.00
http://dx.doi.org/10.1016/j.jcmg.2012.12.005

Figure 1. Normal Anatomy of the Aortic Annulus

The aortic annulus accounts for the tightest part of the aortic root (**A**) and is defined as a virtual ring (**green line**) with 3 anatomical anchor points at the nadir (**green points**) of each of the attachments of the 3 aortic leaflets (**B**). LCC = left coronary cusp; NCC = non-coronary cusp; RCC = right coronary cusp.

Misure anulus aortico e scelte protesi valvolare

Misure dell'anulus aortico è critico:

- Sottostima
  - Rischio embolizzazione
  - Rischio leak paraprotesici
- Sovrastima
  - Rischio rottura anulus
  - Disfunzione valvolare

prosthesis sizes between 26 and 29 mm). Undersizing, oversizing, or overexpansion in case of "borderline" annular dimensions, were decided based on balloon sizing and individualized anatomical considerations including the calcific burden of the native valve and annulus, as well as the risk of migration, significant paravalvular leak (PVL), or annular injury.

STRUCTURAL HEART
2017, VOL. 1, NOS. 3–4, 169–178
https://doi.org/10.1080/24748706.2017.1358832

Metodo

METODO

Funzionamento software

Segmentazioni strutture

Virtual Ring

Dal gennaio 2018 ad aprile 2018 30 pazienti

Età media 84 anni

Valvole protesiche	N° pazienti
Sapien 3	**27**
20	1
23	10
26	14
29	2
Evolut R	**3**
26	2
29	1

Software per la simulazione TAVI ***Philips Heart Navigator® (HN)***

Utilizzo dello stesso data set per elaborazione CT e HN

Funzionamento software

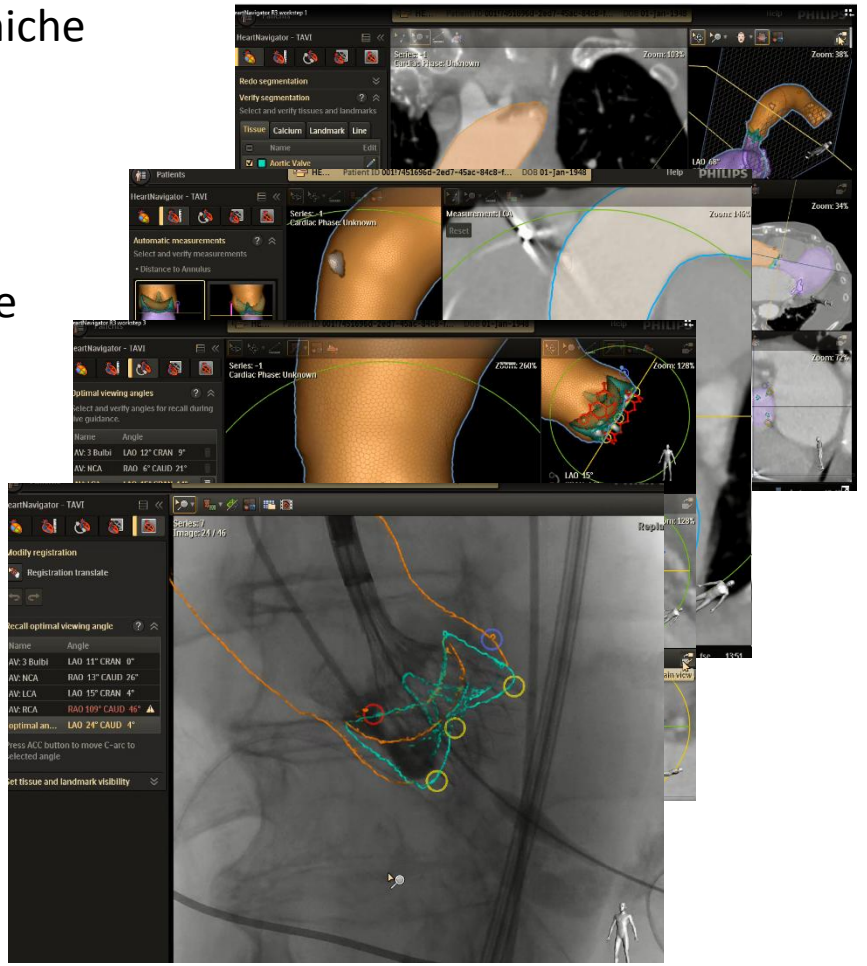
METODO

Funzionamento software

Segmentazioni strutture

Virtual Ring

- Segmentazione strutture anatomiche
- Misure
- Valutazione valvola da impiantare
- Proiezione angiografica di lavoro



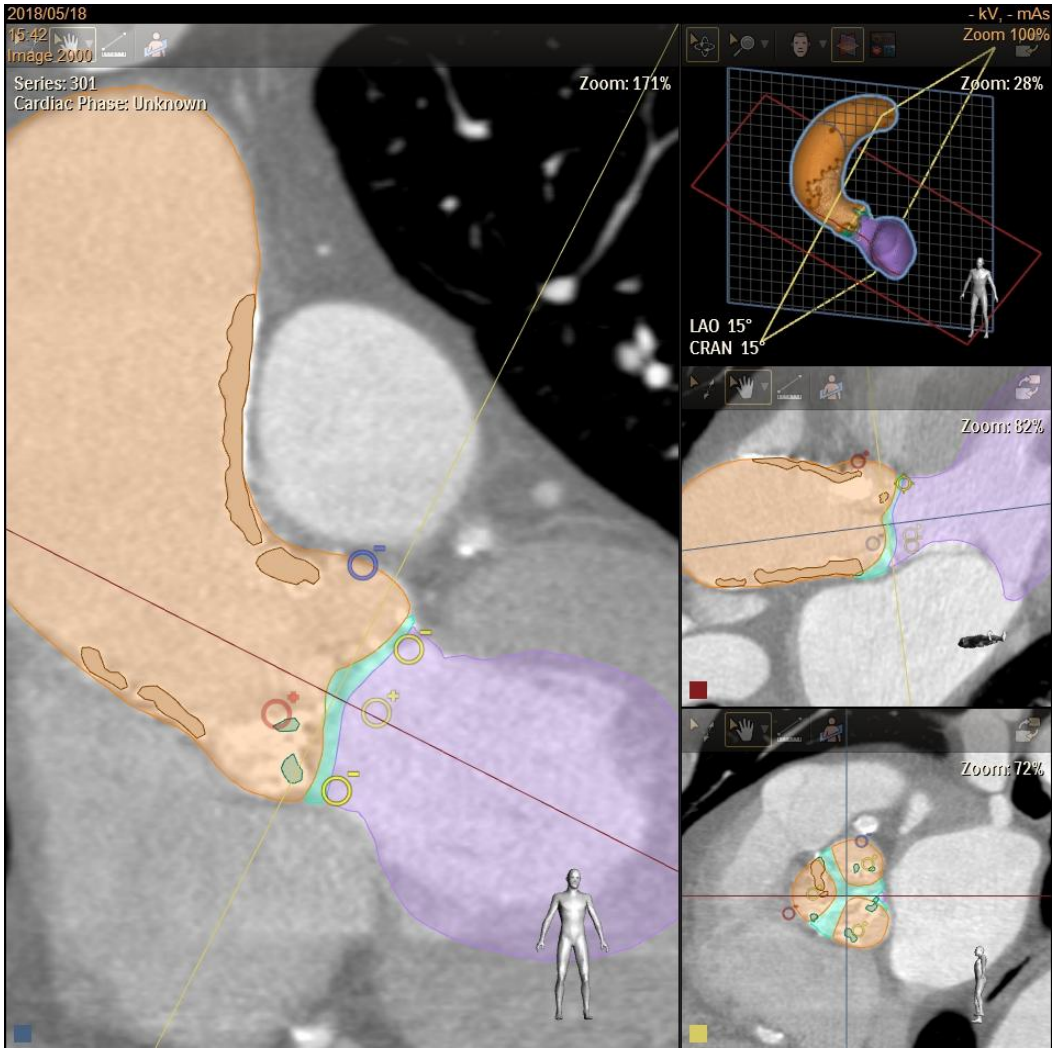
Segmentazione strutture

METODO

Funzionamento software

Segmentazioni strutture

Virtual Ring



Punti di riferimento:

- AV
  valvola aortica
- MV
  valvola mitralica
- Apex
  apice ventricolo SN

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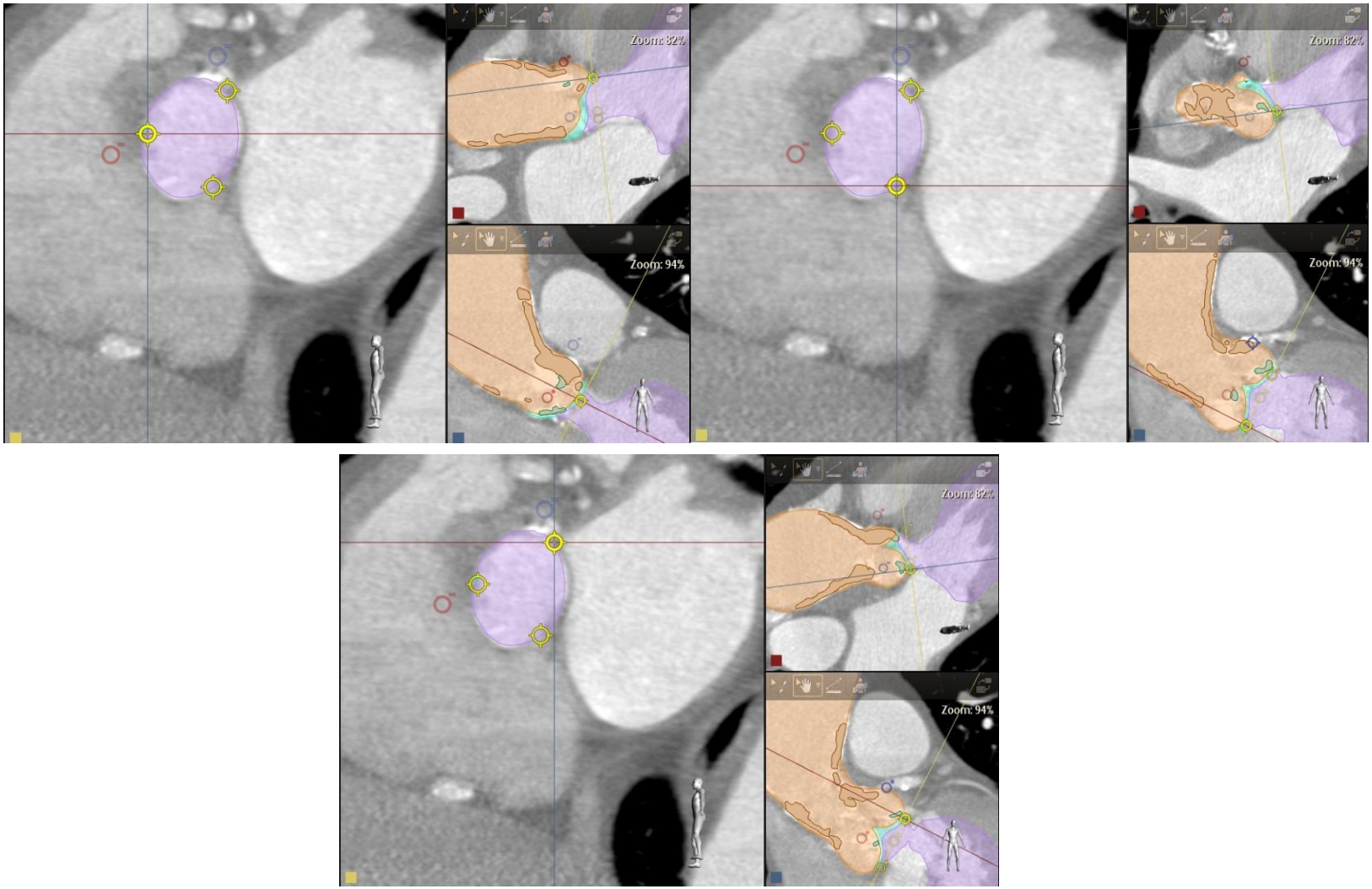
Virtual Ring

METODO

Funzionamento software

Segmentazioni strutture

Virtual Ring



Comparazione misure CT vs HN - anulus aortico

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

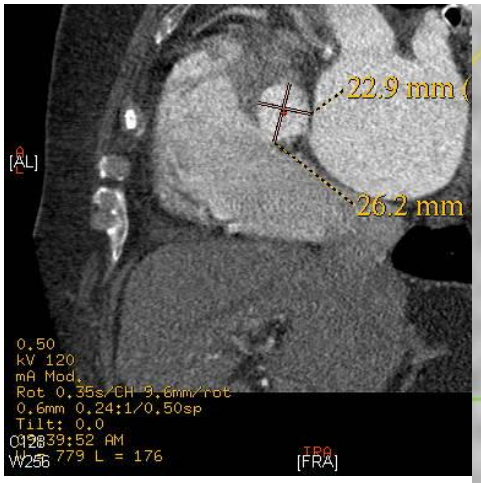
CT vs HN
Coro DX

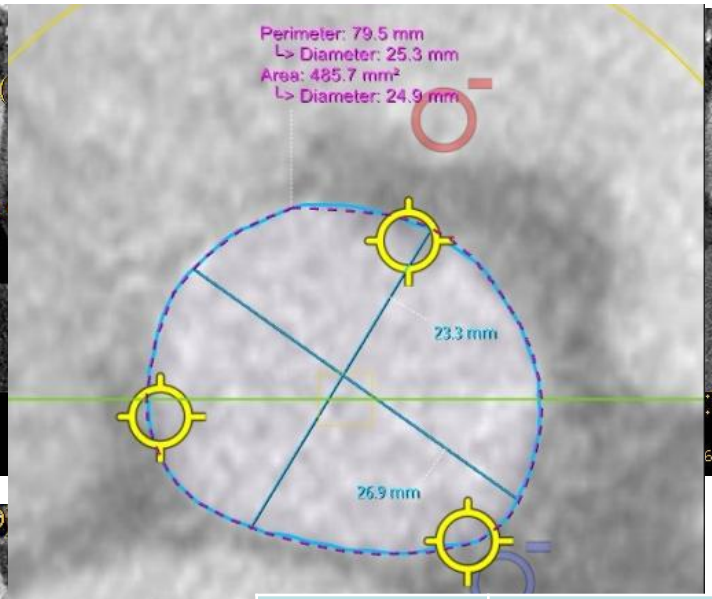
CT vs HN
Bulbo aortico

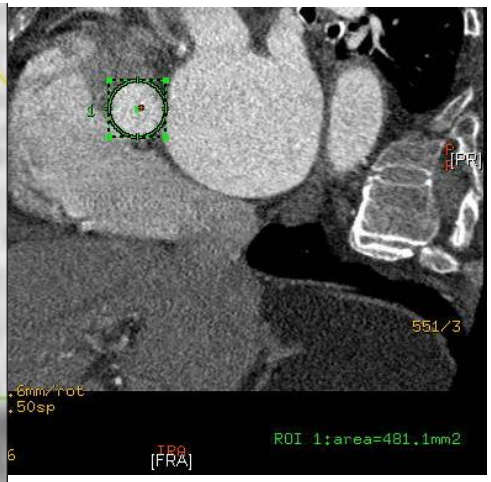
CT vs HN
LVOT & GST

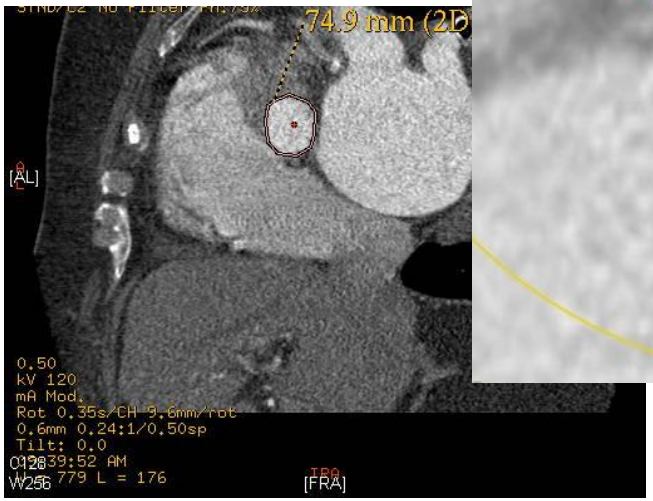
Diastolica o sistolica

Rimed HELP









anulus	CT	HN	P value
Perimetro mm	78,8 ± 9,7	77,5 ±6,9	< 0,01
Area mm^2	434 ± 99,5	458 ± 81,4	< 0,01
Diametro I mm	21,9 ± 3,0	22,9 ± 2,4	< 0,01
Diametro II mm	27 ± 3,5	25,8 ± 2,2	< 0,01

Comparazione misure CT vs HN – coro SN

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

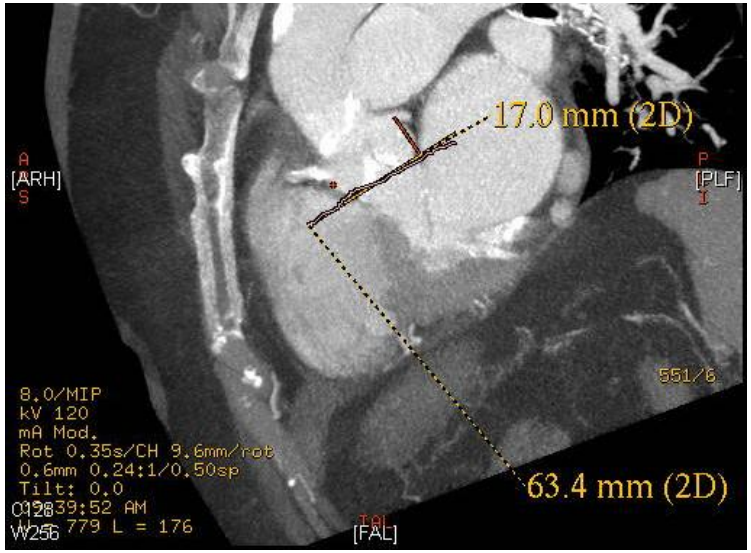
CT vs HN
Coro DX

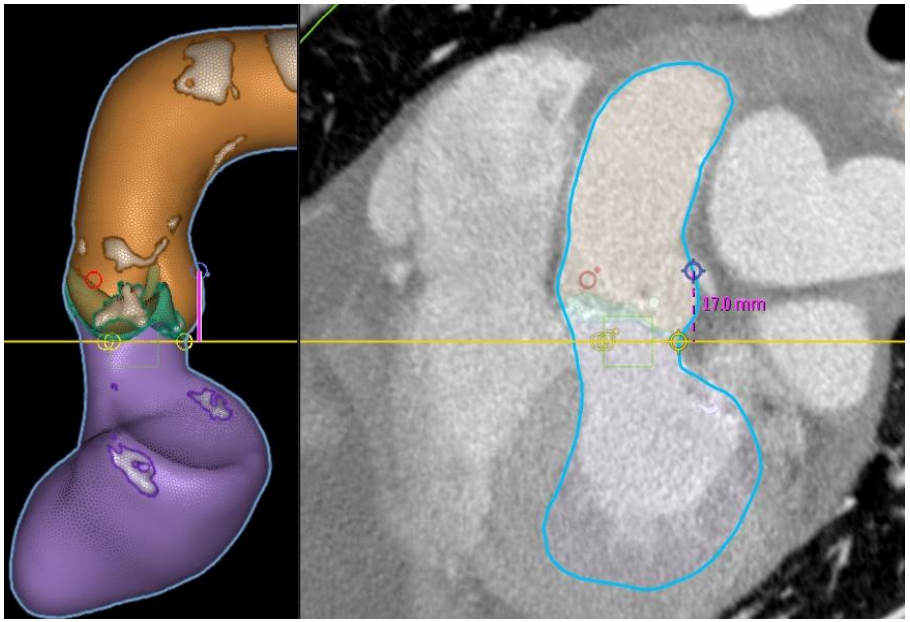
CT vs HN
Bulbo aortico

CT vs HN
LVOT & GST

Diastolica o sistolica

Rimed HELP





Distanza coro SN/ piano valvolare	CT	HN	P value
distanza mm	13,6 ± 3,2	13,8 ± 3	< 0,01

Comparazione misure CT vs HN – coro DX

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

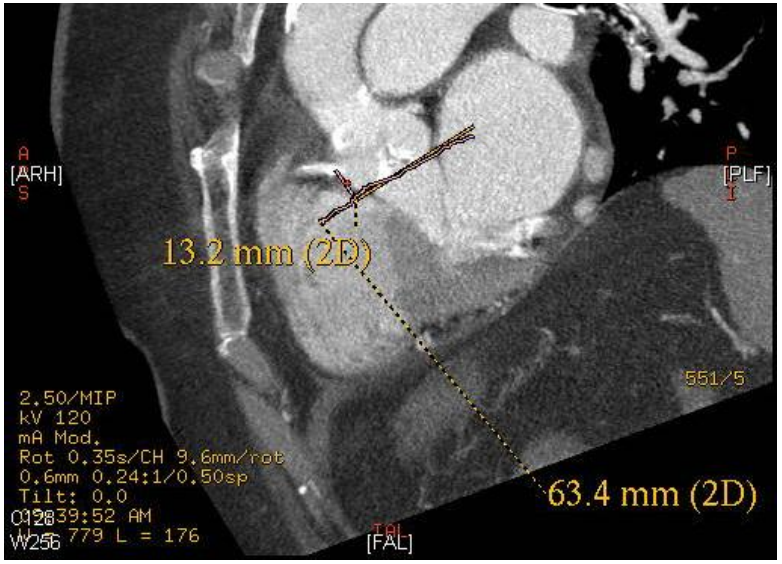
CT vs HN
Coro DX

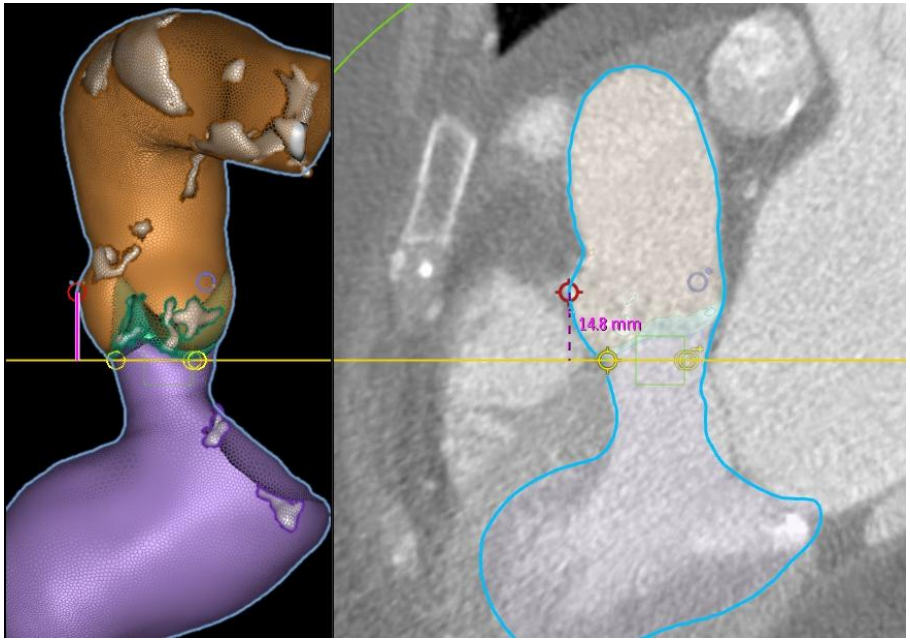
CT vs HN
Bulbo aortico

CT vs HN
LVOT & GST

Diastolica o sistolica

Rimed HELP





Distanza coro DX/ piano valvolare	CT	HN	P value
distanza mm	13,5 ± 3,3	14,4 ± 2,9	< 0,01

Comparazione misure CT vs HN – bulbo aortico

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

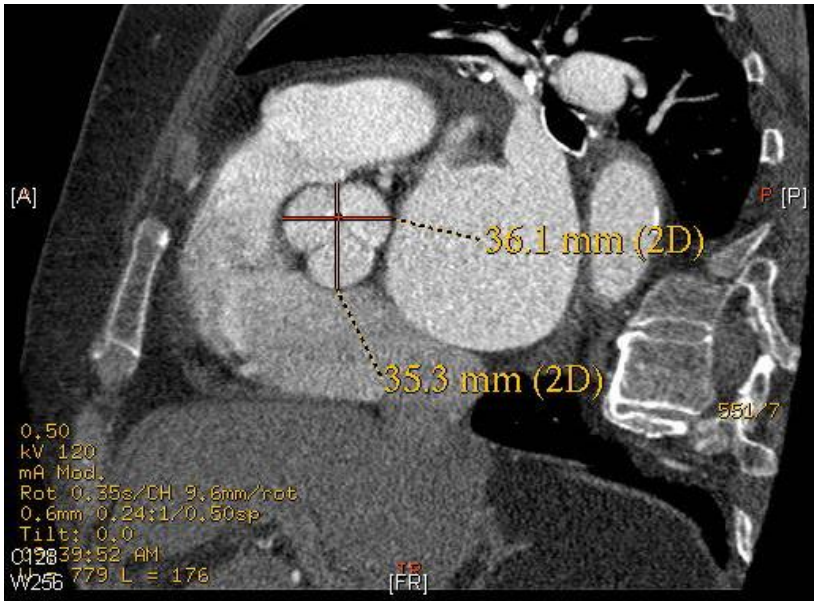
CT vs HN
Coro DX

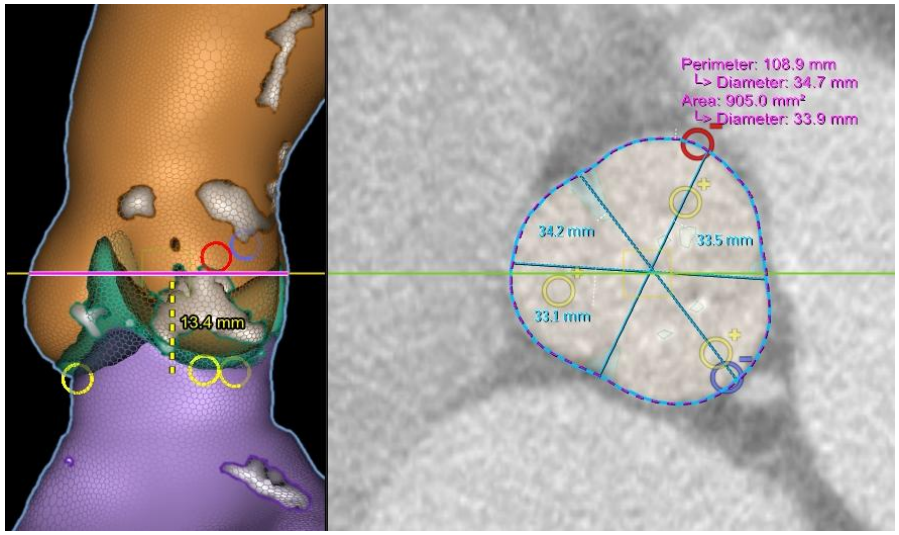
CT vs HN
Bulbo aortico

CT vs HN
LVOT & GST

Diastolica o sistolica

Rimed HELP





Diametri bulbo	CT	HN	P value
Diametro I mm	30,9 ± 3,7	31,2 ± 3,4	< 0,01
Diametro II mm	32,5 ± 4,3	32,9 ± 3,5	< 0,01

LVOT - GST

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

CT vs HN
Coro DX

CT vs HN
Bulbo aortico

CT vs HN
LVOT & GST

Diastolica o sistolica

Rimed HELP

Diametri LVOT	CT	HN	P value
Diametro I mm	20,8 ± 3	20,2 ± 2	< 0,01
Diametro II mm	27,7 ± 3,7	27,2 ± 2,6	< 0,01

Diametri GST	CT	HN	P value
Diametro I mm	28,3 ± 3,6	28,3 ± 3,4	< 0,01
Diametro II mm	29,5 ± 4	29,5 ± 3,5	< 0,01

diastolica o sistolica

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

CT vs HN
Coro DX

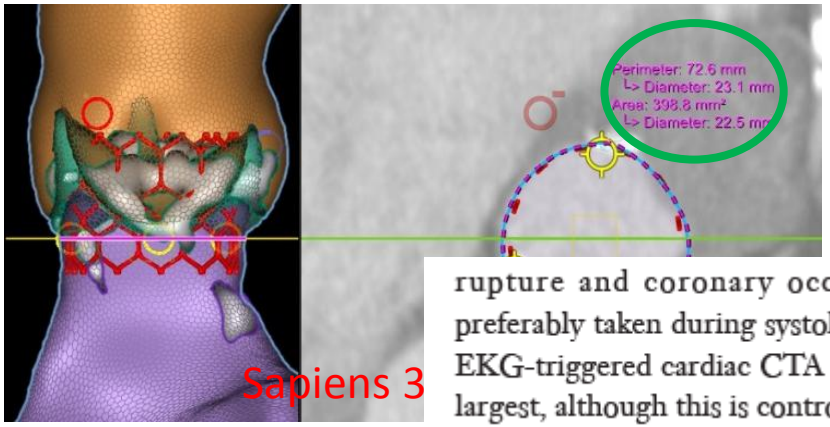
CT vs HN
Bulbo aortico

CT vs HN
LVOT & GST

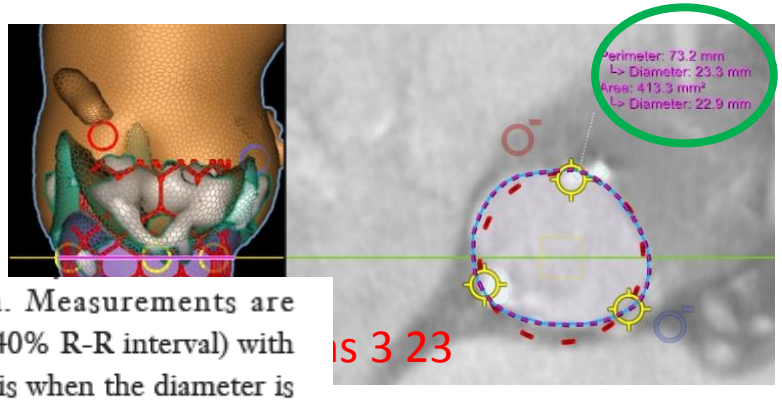
Diastolica o sistolica

Rimed HELP

diastolica

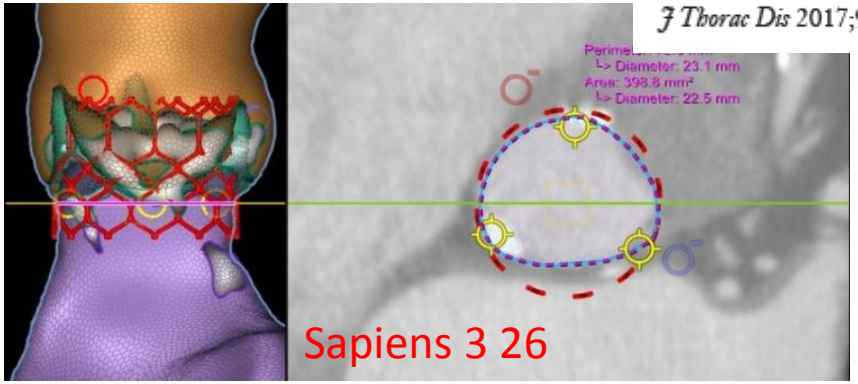


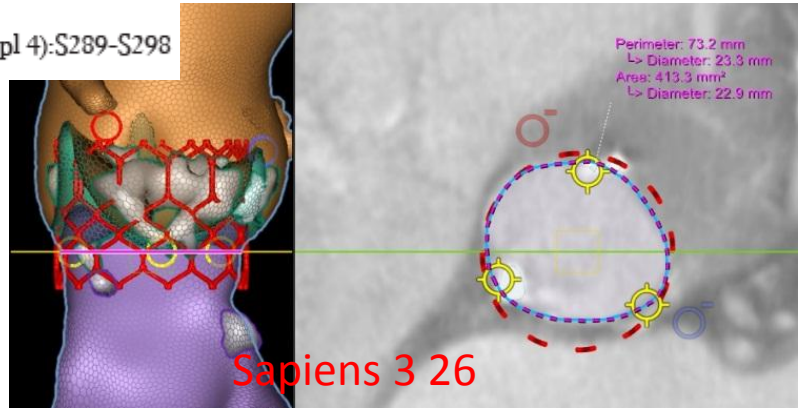
sistolica



rupture and coronary occlusion. Measurements are preferably taken during systole (20–40% R-R interval) with EKG-triggered cardiac CTA as this is when the diameter is largest, although this is controversial (5,15,16).

J Thorac Dis 2017;9(Suppl 4):S289-S298





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Rimed HELP

RISULTATI

CT vs HN
Anulus aortico

CT vs HN
Coro SN

CT vs HN
Coro DX

CT vs HN
Bulbo aortico

CT vs HN
LVOT & GST

Diastolica o
sistolica

Rimed HELP

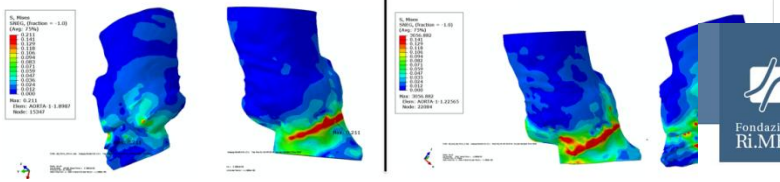
Result : 23mm vs 26mm

Scenario #1: 23mm

PVL
(27+20mm²)

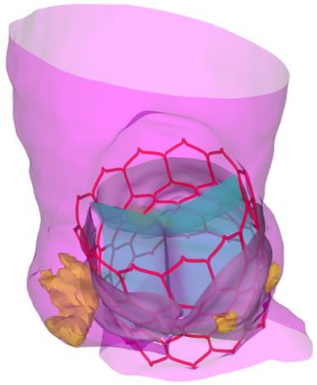
Scenario #2: 26mm

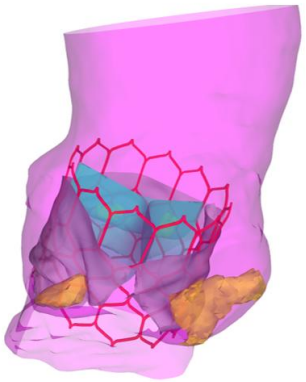
PVL
(18mm²)



Fondazione Ri.MED

Best strategy leads to 26 mm SAPIEN 3





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Aortografia

AORTOGRAFIA

Proiezione di lavoro

Valvola Edwards Sapien 3

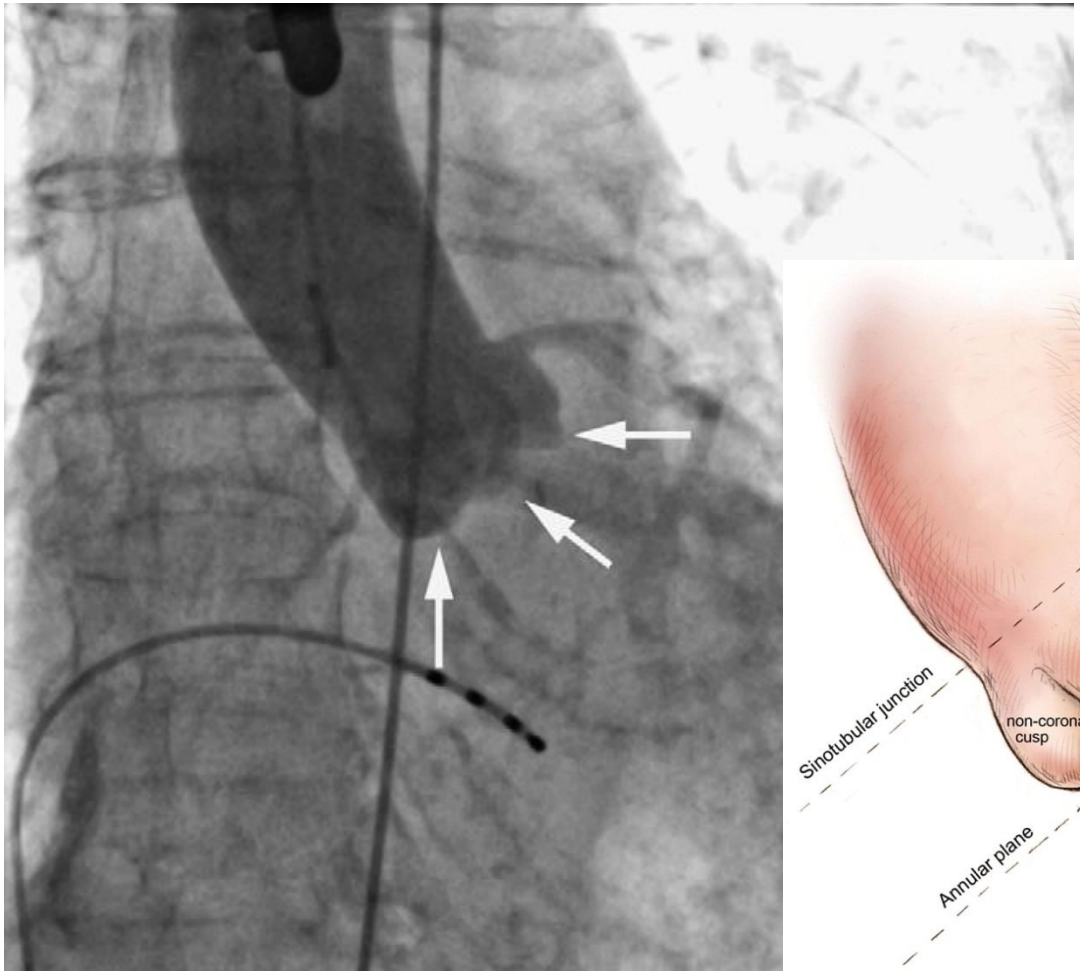
Valvola Medtronic CoreValve

Proiezione di lavoro mediante HN

Tecniche innovative ?

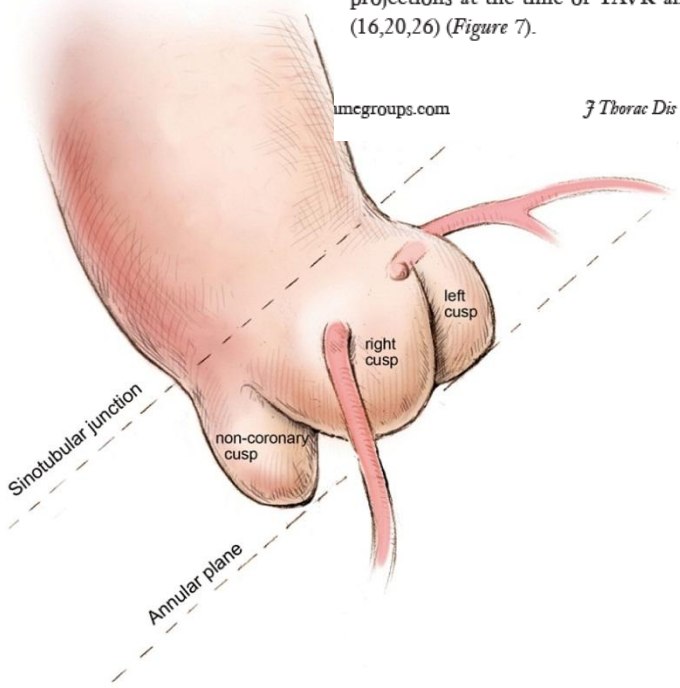
Tecnica follow the right cusp

Giochiamo insieme



At the time of valve deployment during TAVR, the correct fluoroscopic view in which all three cusps are seen in line is obtained. This deployment angle requires multiple "trial-and-error" aortograms with repositioning of the fluoroscopy arm until an adequate 3-cusp view is seen, but can be predicted with cardiac CTA. Cardiac CTA guided determination of the deployment angle may reduce procedure time, contrast volume, and radiation exposure, with improvements in the rate of correct fluoroscopic projections at the time of TAVR and improved outcomes (16,20,26) (*Figure* 7).

amegroups.com *J Thorac Dis* 2017;9(Suppl 4):S289-S298



Proiezione di lavoro

AORTOGRAFIA

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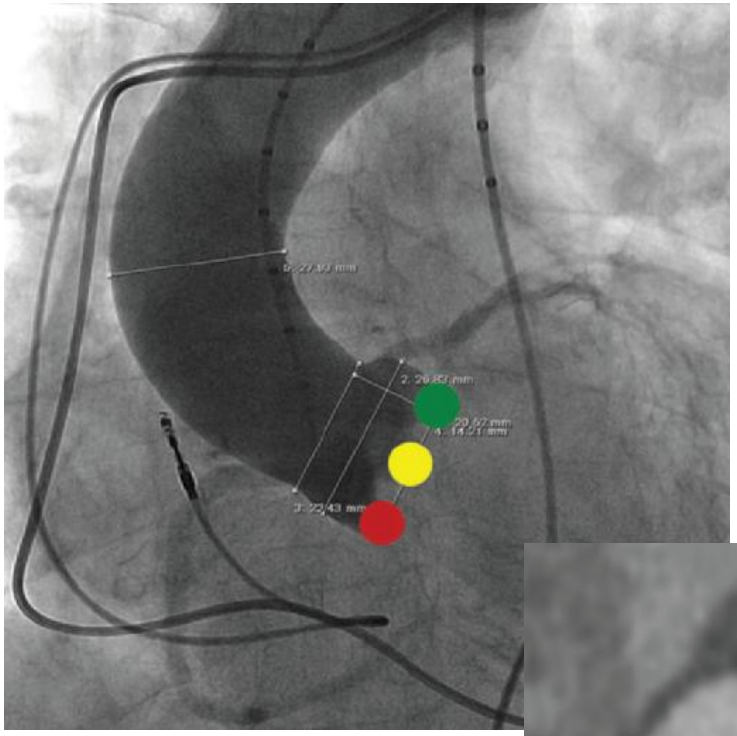


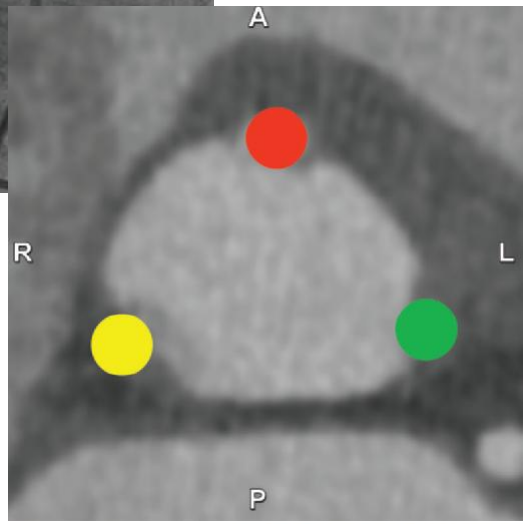
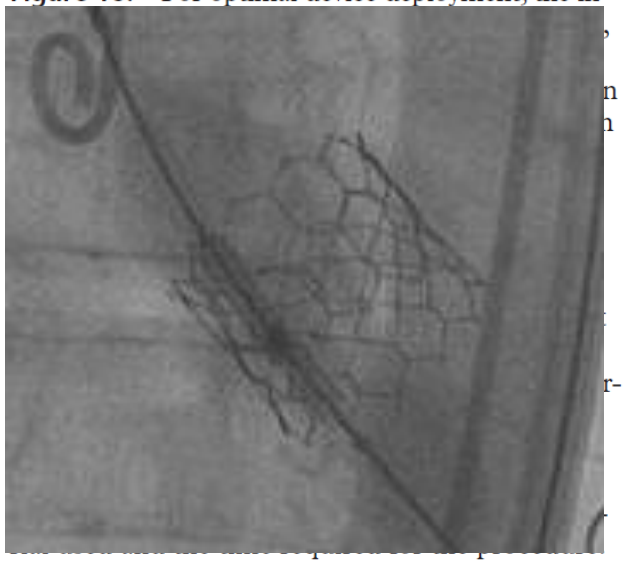


Figure 16. For optimal device deployment, the in-



A = anterior, *P* = posterior.

RadioGraphics 2014; 34:1491–1514

Errore di parallasse = non corretto allineamento su stesso piano della parte distale e prossimale della protesi

\+ aortografie
=
\+ MdC

Valvola Edwards Sapien 3

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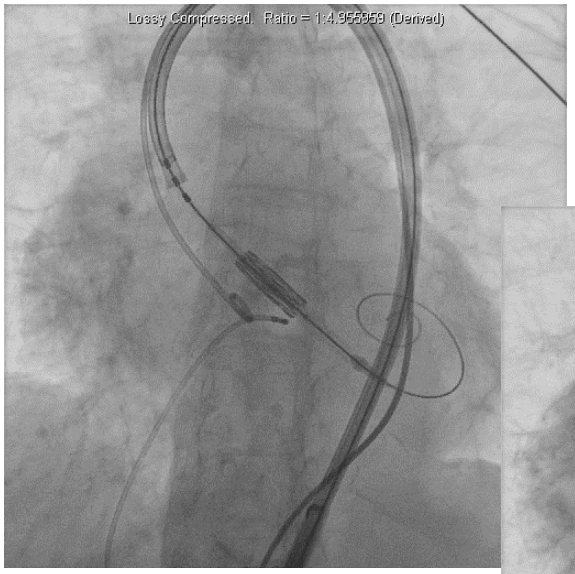

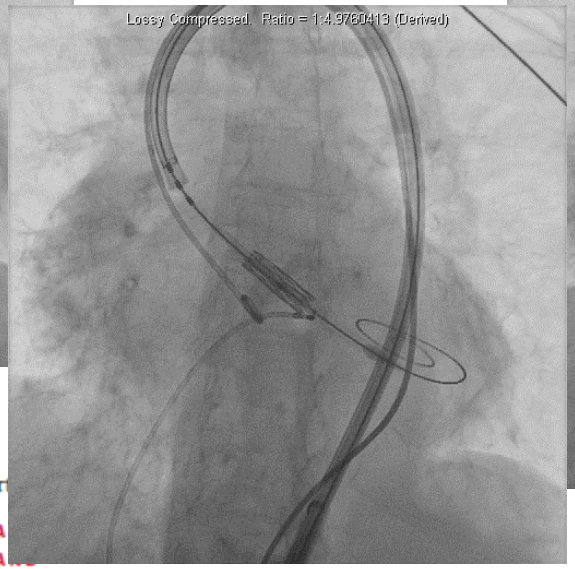

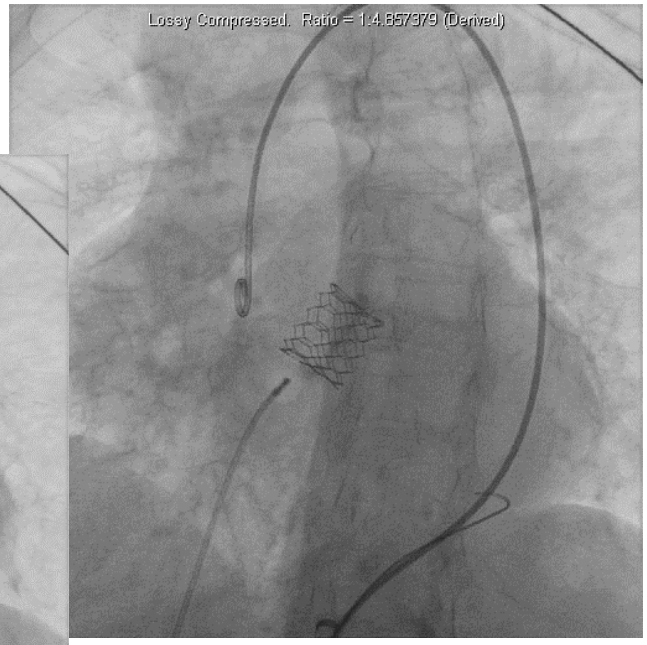

Optimal positioning of the transcatheter aort
prosthesis is paramount to procedural success, as the goal is to displace the native valve leaflets and deploy within the native valve annulus. If valve deployment is too high, there is increased risk of aortic injury, paravalvular regurgitation, or embolization into the aorta (13). Conversely, if deployment is too low, there is increased risk of mitral valve dysfunction, heart block, paravalvular regurgitation, or embolization into the left ventricular cavity (14).

A
A
CT – c
ECG –
LAO –
MDCT
comput
RAO –
TAVI –
valve in

the coronary and access vessels if there is any question.

The Edwards Sapien III valve is ideally deployed with approximately 20–30% of the stent frame on the ventricular side, and 70–80% on the aortic side (*Figure 11*). This prosthesis is thus placed in an intra-annular position. The

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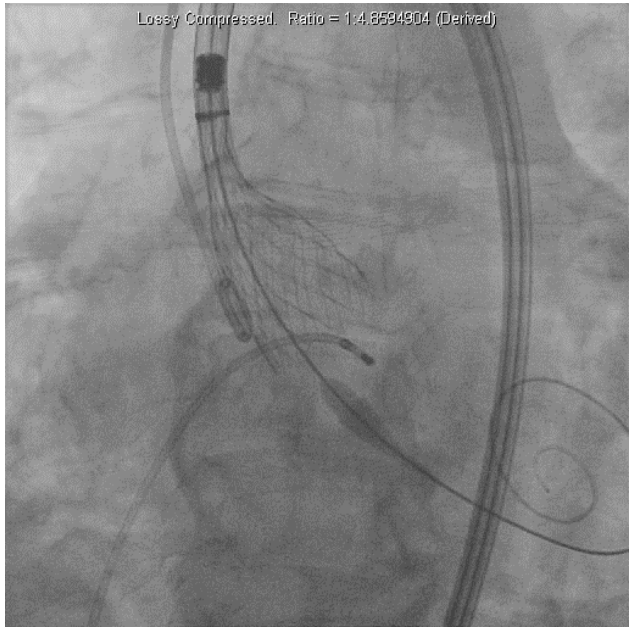

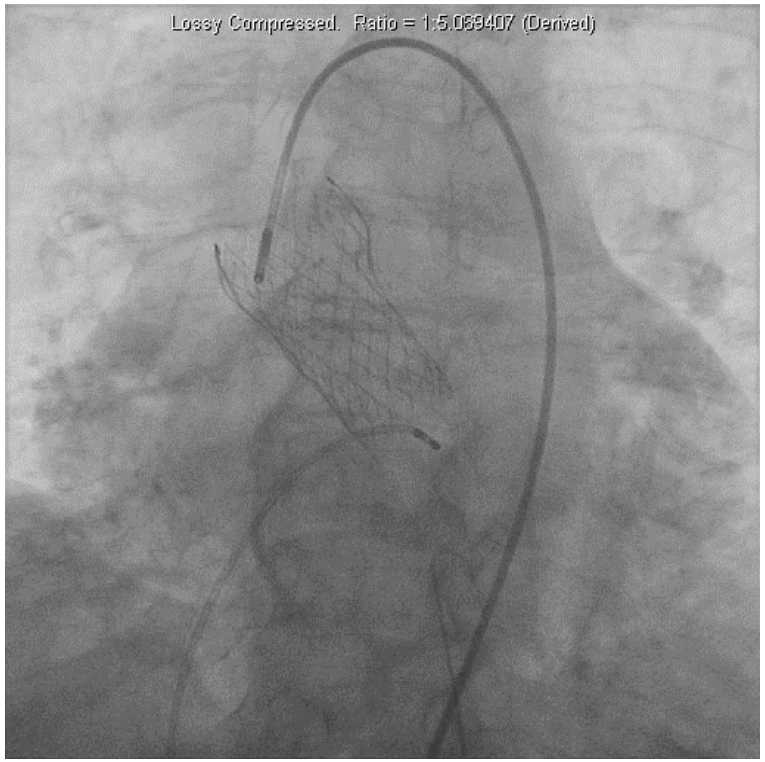

Medtronic CoreValve, when collapsed in its sheath, displays a series of lines on fluoroscopy that correspond to the intersections of the nitinol lattice (*Figure 12*). These markers are used to deploy the valve ideally with only 4–6 mm of the stent frame on the ventricular side (*Figure 13A*). The valve leaflets are thus on a supra-annular place (*Figure 13B*), which is beneficial with regards to a larger effective orifice area, especially in the setting of valve-in-valve procedures (*Figure 14*).

J Thorac Dis 2017;9(Suppl 4):S289-S298

Proiezione di lavoro mediante HN

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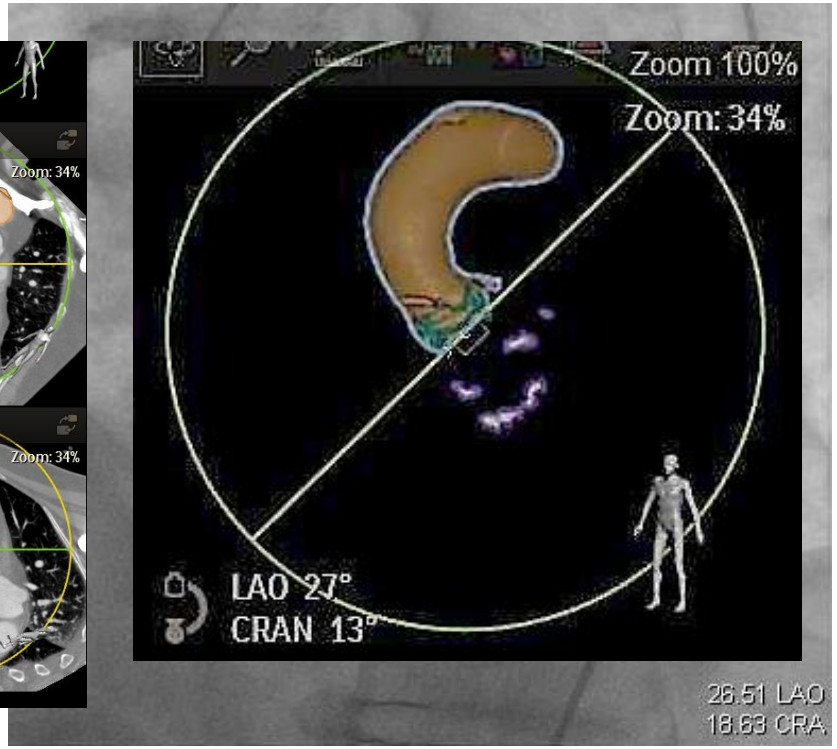

14 LAO – 17 CRA

26 LAO – 19 CRA

Tecniche innovative ???

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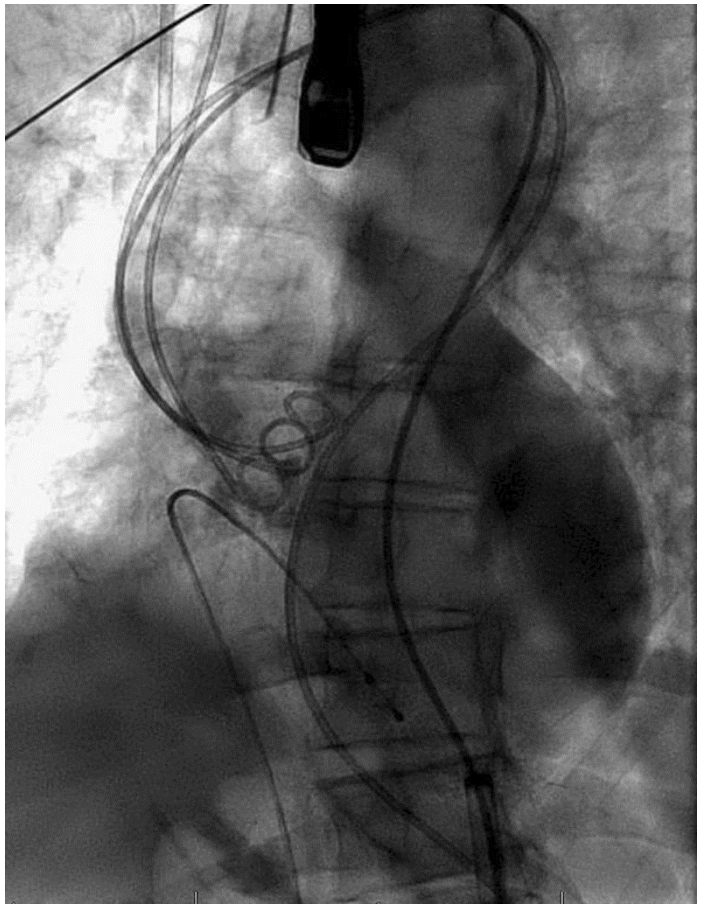

Triple pigtail technique: a novel way to determine the optimal angle of implantation during transcatheter aortic valve replacement while minimizing contrast load

Ernesto Ruiz-Rodriguez[1] · Timinder Biring[1] · Emil Missov[1] · Ganesh Raveendran[1]

Int J Cardiovasc Imaging (2016) 32:541–542
DOI 10.1007/s10554-015-0815-7

Right radial artery pigtail in the non coronary cusps

Left femoral artery pigtail in the right coronary cusps

Right femoral artery pigtail in the left coronary artery cusps

- accessi arteriosi

+ no MdC

- time consuming

Follow the Right Cusp

AORTOGRAFIA

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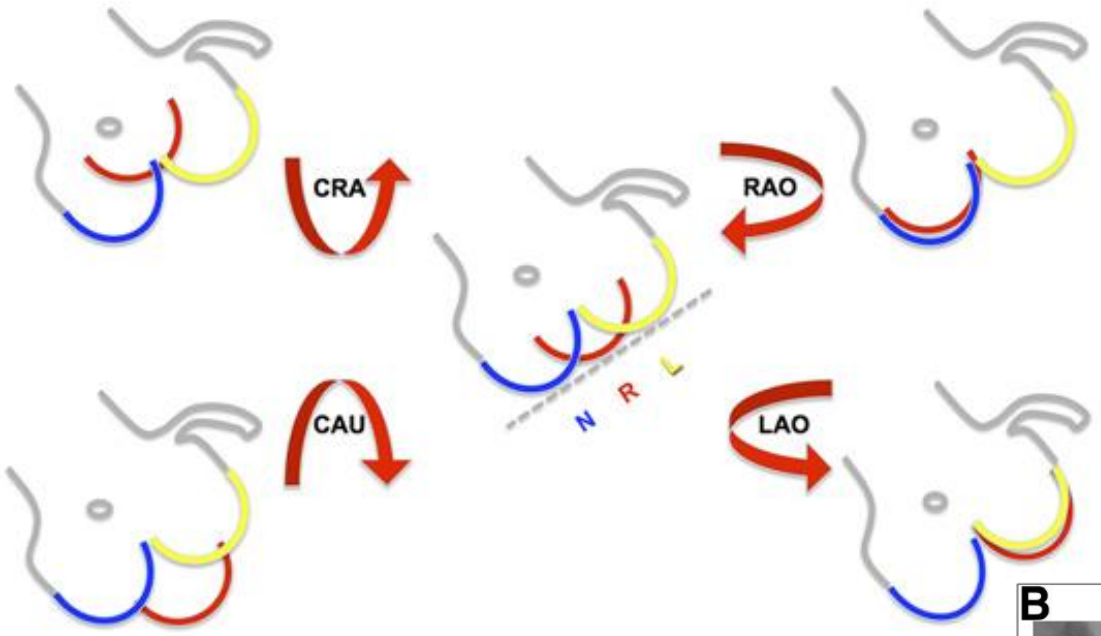
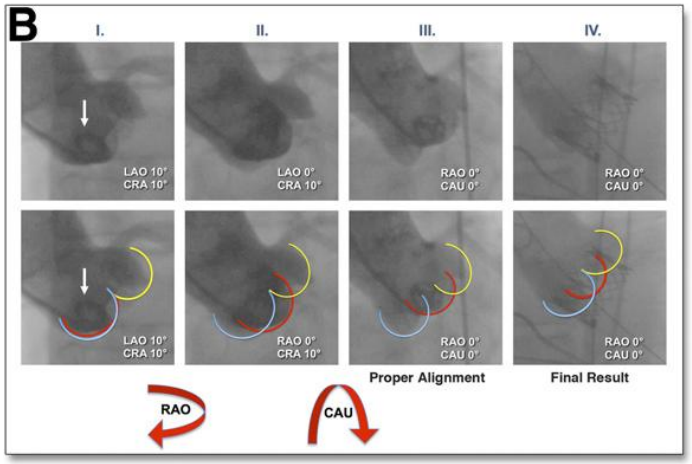
Tecnica follow the right cusp

Giochiamo insieme



VOL. 6, NO. 2, 2013
ISSN 1936-878X/$36.00



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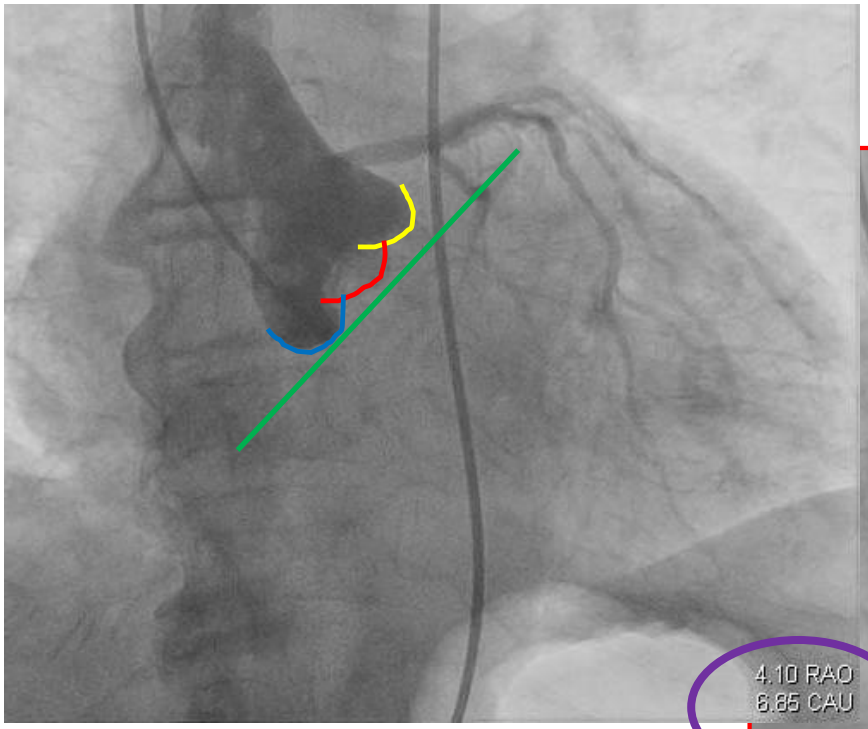
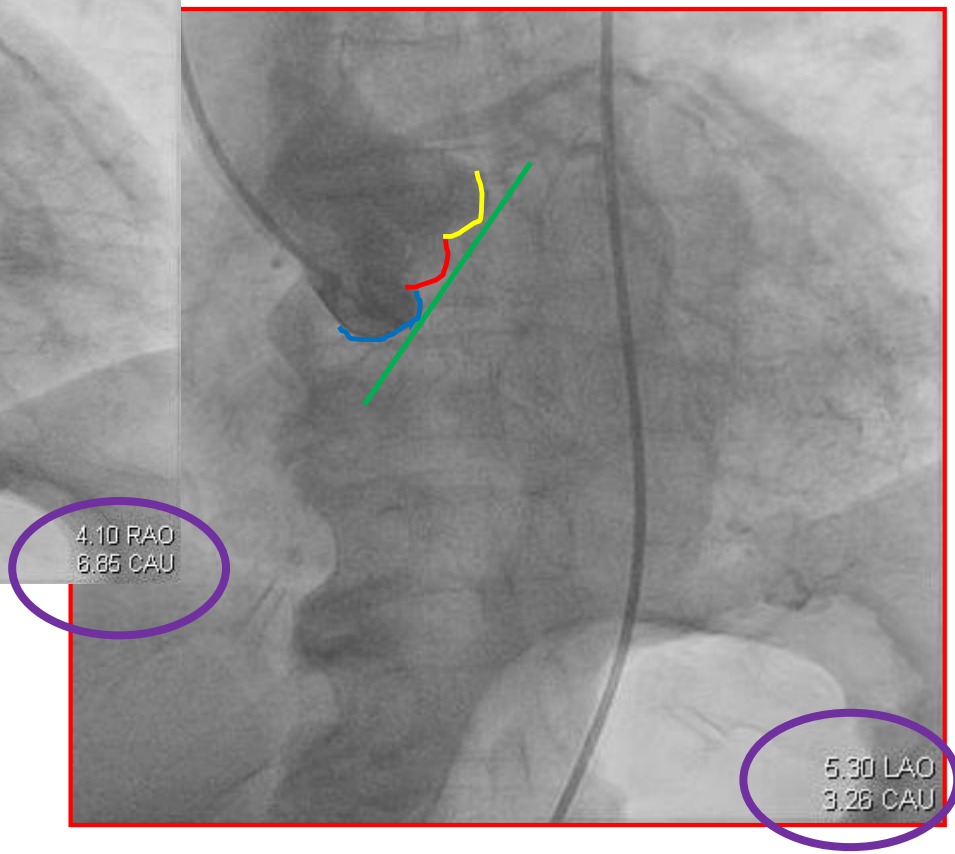
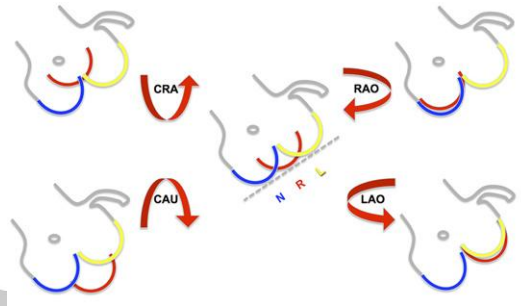
Aortografia 20ml @ 15ml/s







Conclusioni

CONCLUSIONI

Il software HN si è rivelato ottimo strumento di planning pre procedurale TAVI

- Time consuming
- Semplicità utilizzo
- Simulazione valvole protesiche

TSRM Imaging Specialist 3C

TEAMWORK = DREAMWORK

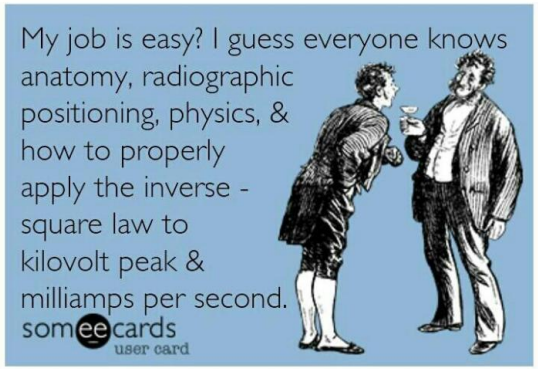
Dott.ssa Gandolfo Caterina
Dott. Cannata Stefano

Clementina Battaglia
Vito Gambina
Tiziana Patricolo
Rocco Nicosia
Marcello Russo
Vincenzo Dimajo
Marco Guadagna

Calogero Caruso
Giuseppe Fiorello
Giuseppe Salvatore Gallo
Roberta Gerasia
Corrado Tafaro
Armando Pasta
Letizia Lombardo

Cardiologi Interventisti
Infermieri di cardiologia interventistica
TRSM

GRAZIE



A chi è ancora sveglio:
GRAZIE
per la cortese attenzione