

Orenburg Regional Clinical Hospital, Russia
Interventional CardioAngiology Department



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**THE USE OF INTRAVASCULAR
ULTRASOUND FOR THE
MEASUREMENT OF PATENT
DUCTUS ARTERIOSUS**

CLINICAL CASE

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Current status: complaints to heartaches, dispnoe, low compliance to physical activity.

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Diameter of PDA according to angiography data – 3,8 mm





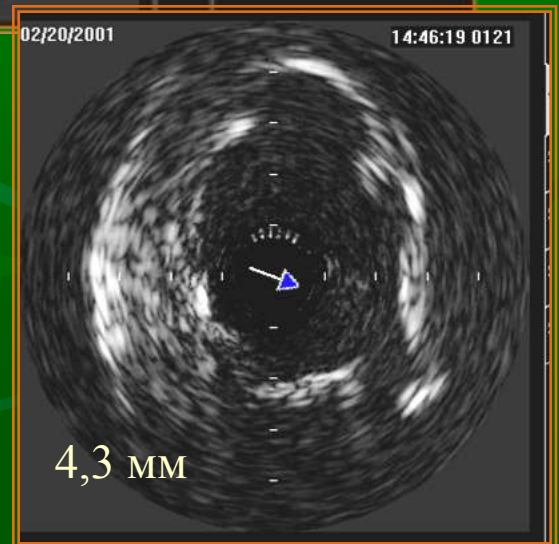
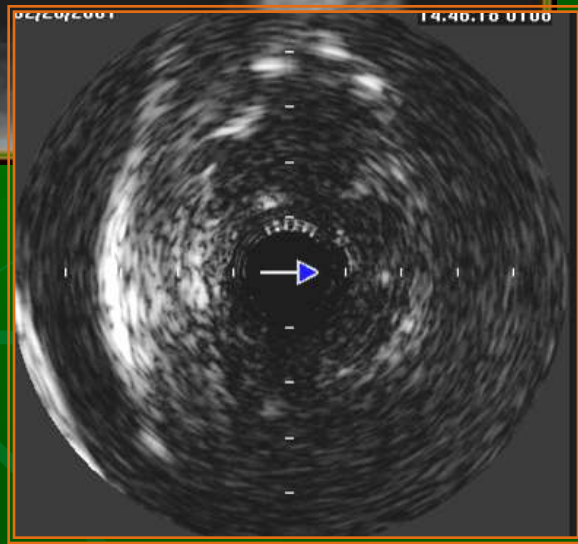
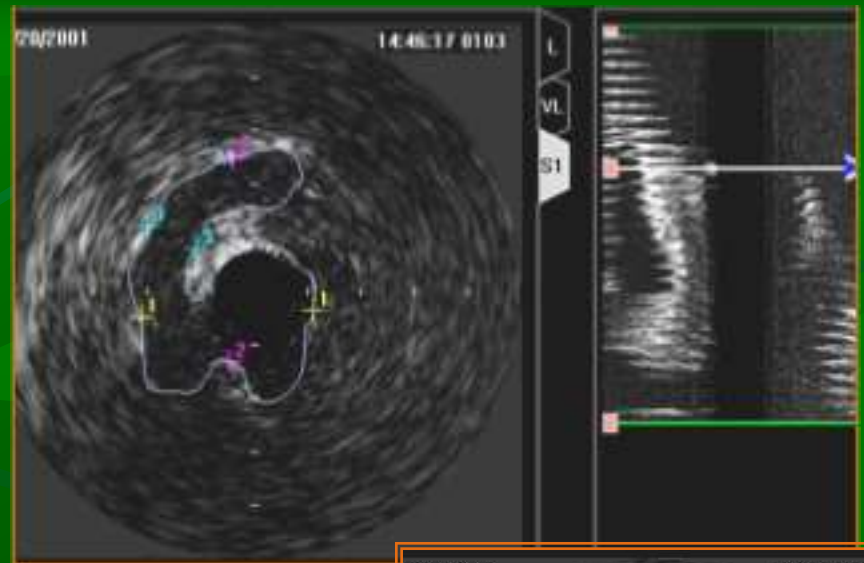
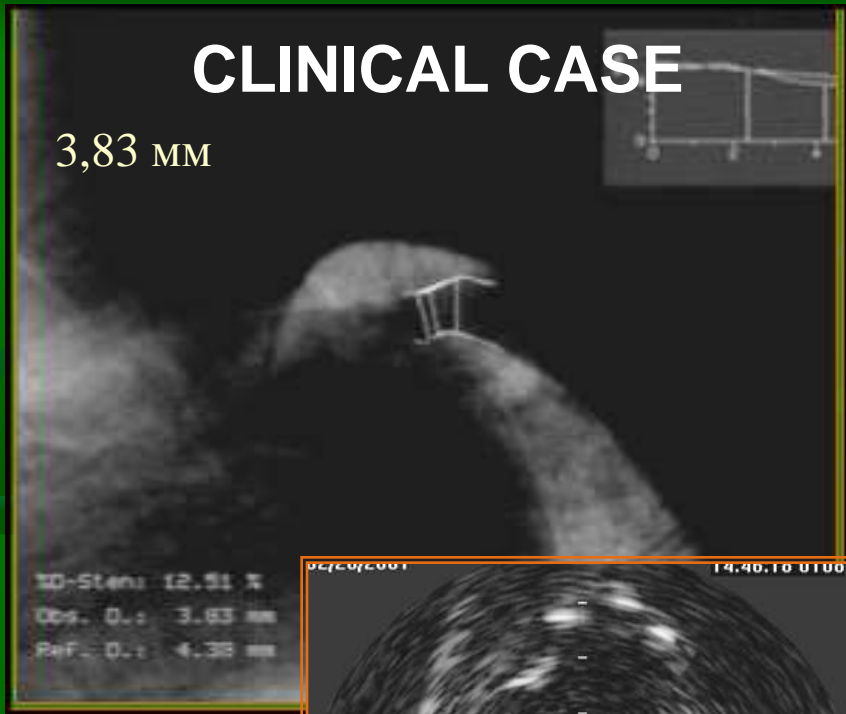
Since 2000, IVUS has been using as a method of visualization of PDA at the Orenburg regional clinical hospital.

We have been performing precise direct estimation of the minimum diameter of patent ductus arteriosus and its ampulla.

However, while performing IVUS analysis, we found some qualitative morphological characteristics of PDA, which were never described before. These characteristics can be of significant clinical value.

CLINICAL CASE

3,83 mm



According to IVUS the diameter of PDA of our patient was 4,3 mm and the wall of PDA was thickened and exactly visible along the whole perimeter. The ductus is well visible on the third projection, and it has severely irregular shape on cross section image.

CLINICAL CASE

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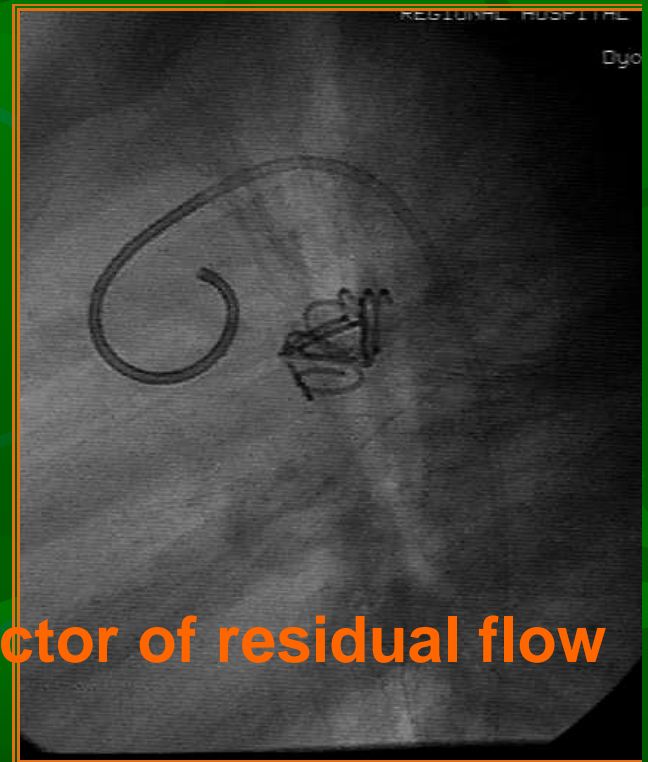
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WHAT COULD POSSIBLY be a predictor of residual flow after repeated interventions?

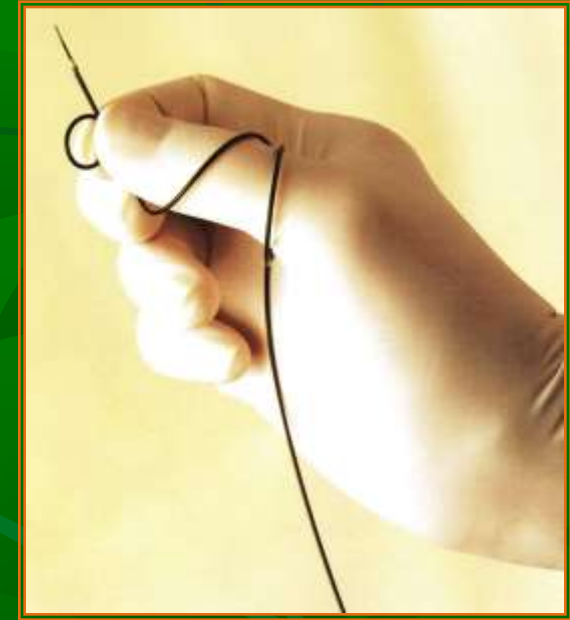


416 procedures of endovascular closure of PDA were done overall, including: 330 procedures, using fixed coils (Flipper); 2 – Procubovskij botaloccluders; 59 –Amplatz, Cera, HeartR, PDA-R occluders; 25 – Nit-Occlud PDA

IVUS was used in 265 cases (63.7%)

IVUS was not used while performing repeated procedures and due to the small size of PDA, that initially needed to be predilated for the passage of the delivery system.

IVUS was used at the diagnostic stage in 31 cases, when the embolization procedure was not performed due to different reasons.



Catheters:

Vision F/x
Vision F/x Five 64
Avanar F/x
Vision PV 018
Eagle Eye
Eagle Eye Gold
Eagle Eye Platinum

The sizes of patent ductus arteriosus

Mean diameter (angiography)	– 2,20 ± 0,12 mm
Mean ductus area (angiography)	– 4,70 ± 0,45 mm ²
Mean diameter (IVUS)	– 2,71 ± 0,71 mm
Mean ductus area (IVUS)	– 7,34 ± 0,42 mm ²

IVUS > Ag	-	62,1 %
IVUS < Ag	-	15,5 %
IVUS = Ag	-	22,4 %

The sizes of patent ductus arteriosus

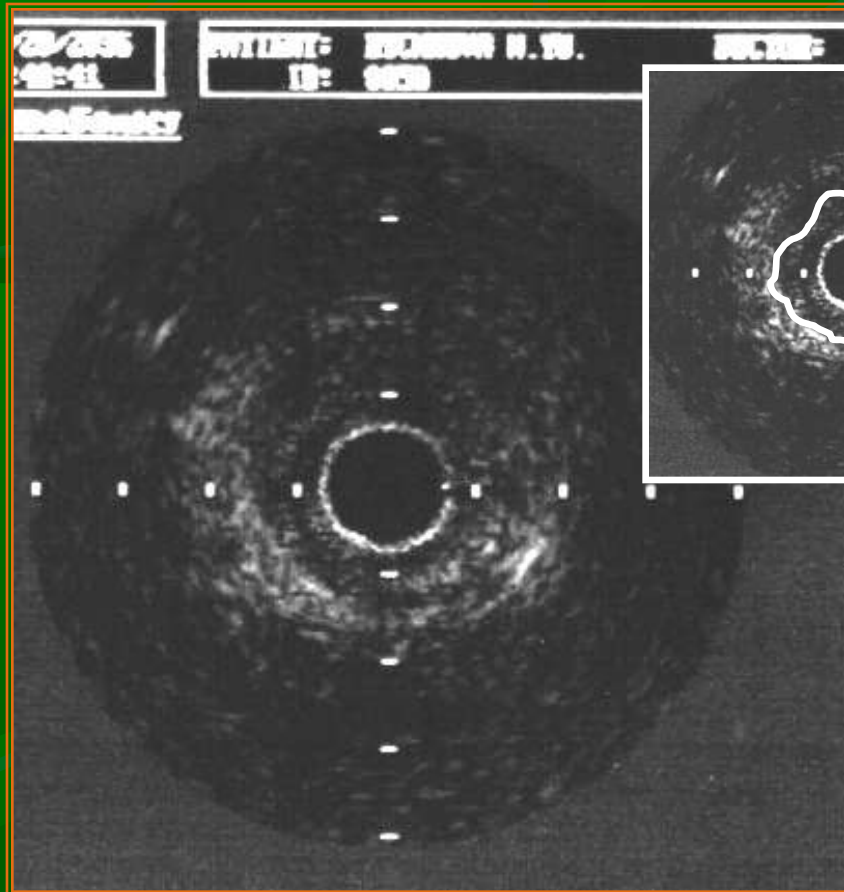
The data from 41.4 % of observations differed that much, so it affected the process of instrument size selection

In 77.1% of these cases, the diameter, according to IVUS analysis was significantly bigger

In 22.9% of these cases, the diameter, according to IVUS analysis was significantly smaller

Anatomic types of PDA according to IVUS data

According to IVUS data we derive 3 anatomical types of PDA

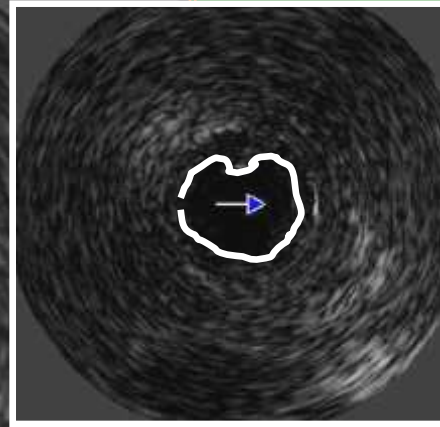
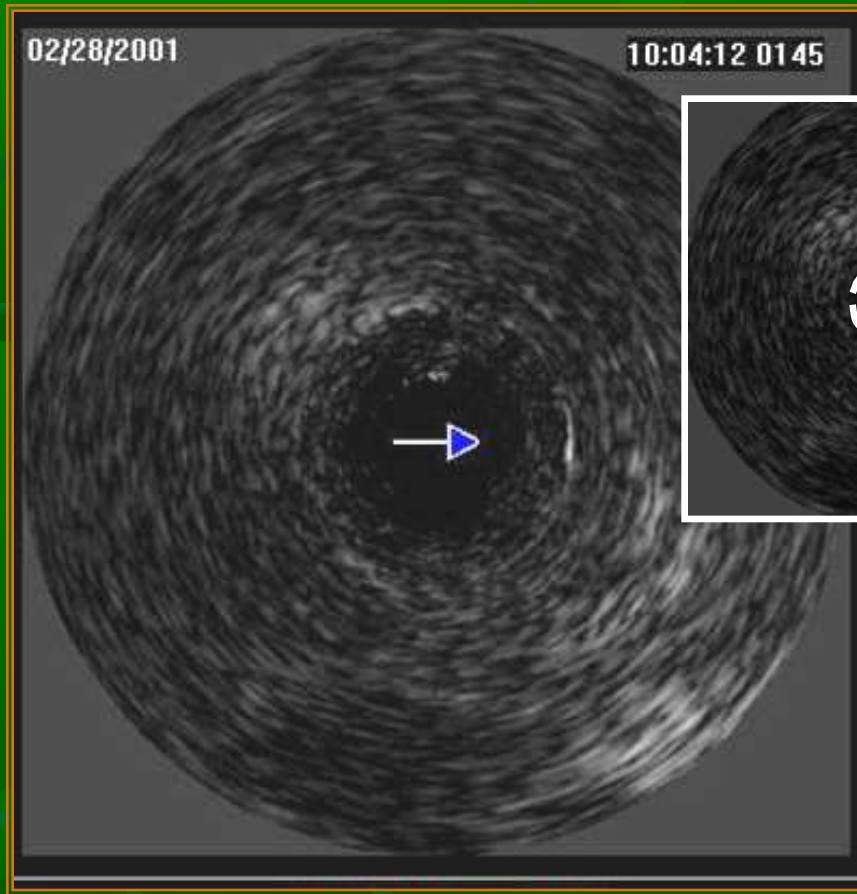


54,5 %



Type 1. The wall of the ductus has small and abnormally distributed thickness without precisely visible internal structure. Very often, lumen has abnormal character and can be observed at recanalization after surgical treatment. This type of PDA is common for 54 % of cases.

Anatomic types of PDA according to IVUS data

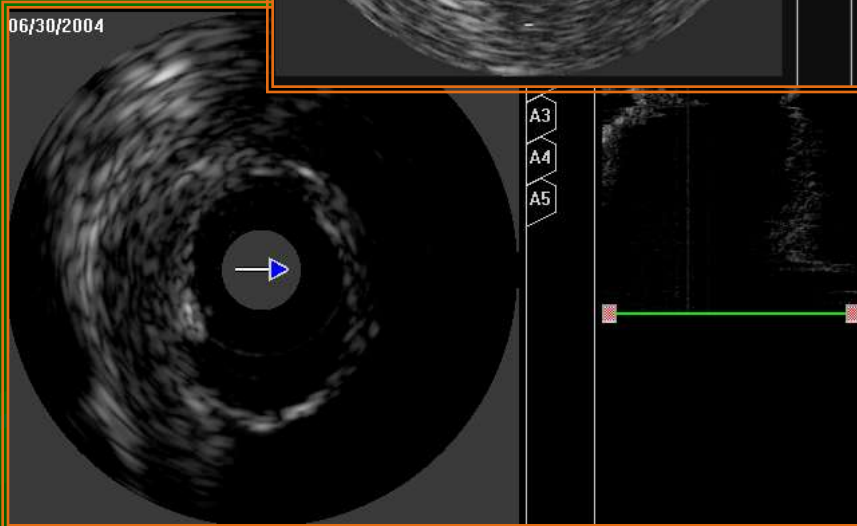
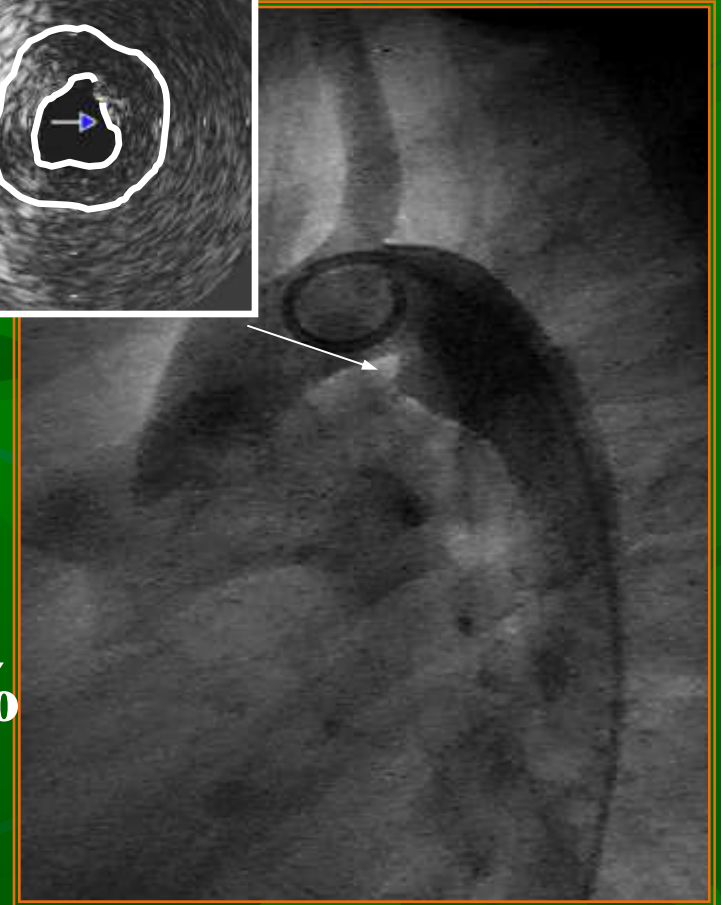
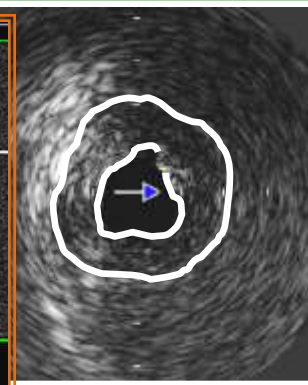
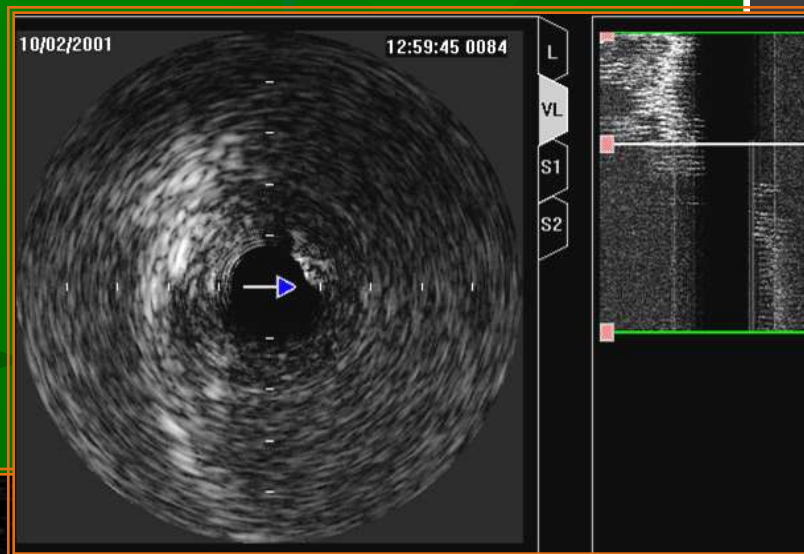


27,3 %



Type 2. The wall of the ductus is not echo-contrast, what makes its boundaries not visible by one frame, so it is necessary to perform the dynamic review of the recording. This type of PDA is common for 27 % of cases.

Anatomic types of PDA according to IVUS data

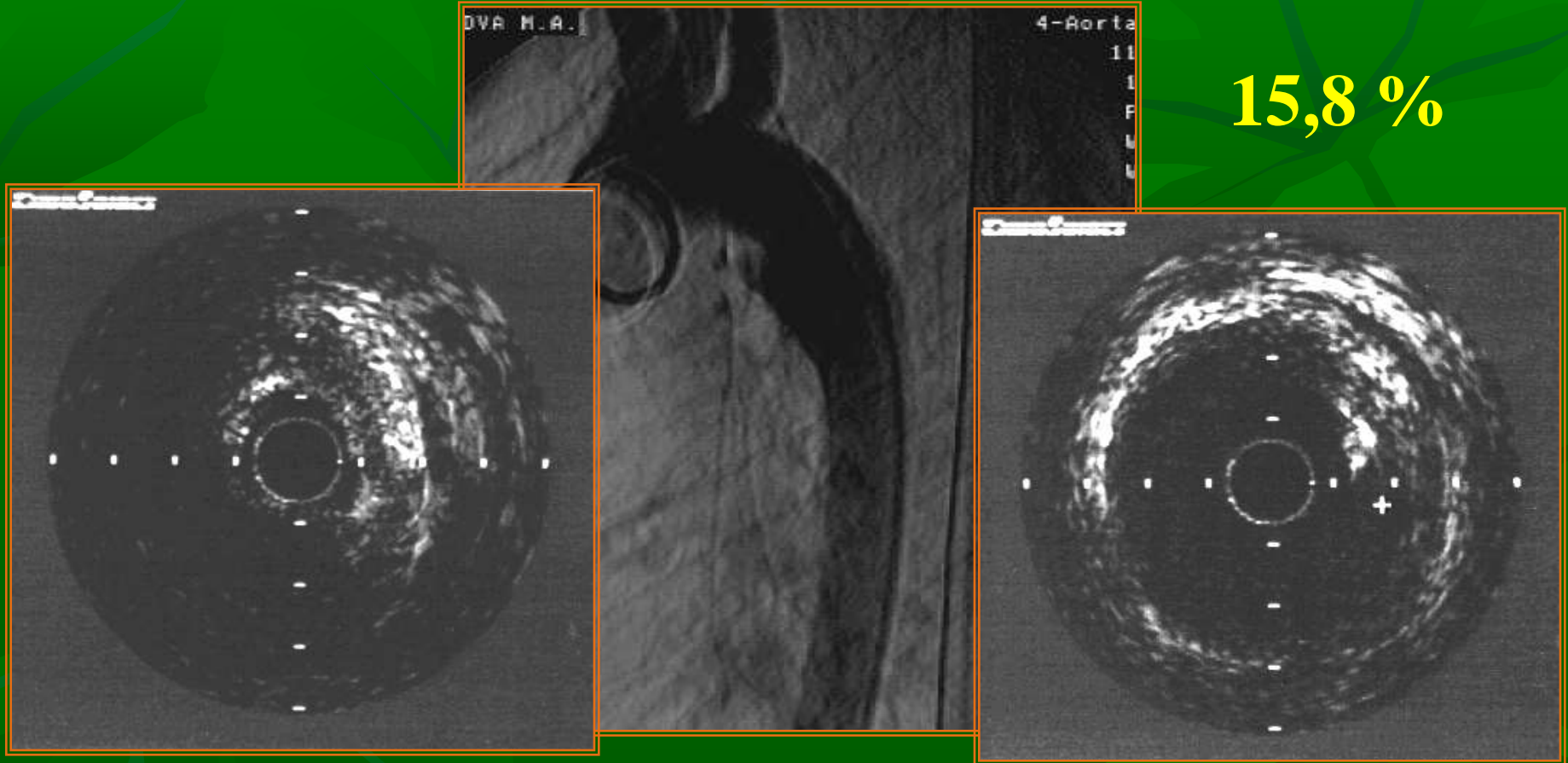


18,2 %

Type 3. The ductus has exactly visible wall along the whole perimeter. In some cases the wall is thickened, and in some cases it has multislice structure. The ductus can be well visible on the third projection. This type of PDA is common for 18 % of cases.

Anatomic features of PDA according to IVUS data

Besides these 3 types of PDA, we also derive 2 anatomical features of PDA



The ductus with the pulsation of the wall and with the significant change of the diameter and the cross section area in systole and diastole

Anatomic features of PDA according to IVUS data



27.8 %

The oval shaped ductus. The shaped is quantitatively characterized by the eccentricity coefficient more than 1.2-1.3 (relation of the maximum ductus diameter to minimum ductus diameter, according to IVUS data at the site of minimum cross section area)

The closure of PDA based on IVUS data

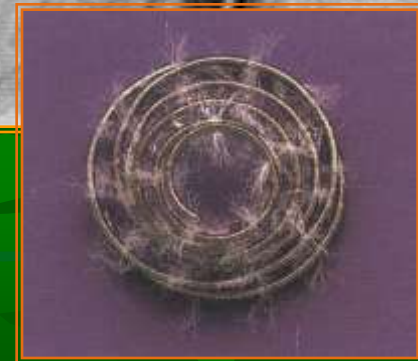
- Priority to the sizes, derived from the IVUS analysis

2000 - 2004

- The concentric shaped ductus < 3.5 mm – embolization with coil

- The concentric shaped ductus $3.5 - 4.0$ mm, or oval or irregular shaped PDA $3.0 - 4.0$ mm – embolization with 2 (or more) coils

- The PDA with diameter > 4 mm – surgical treatment



The closure of PDA based on IVUS data

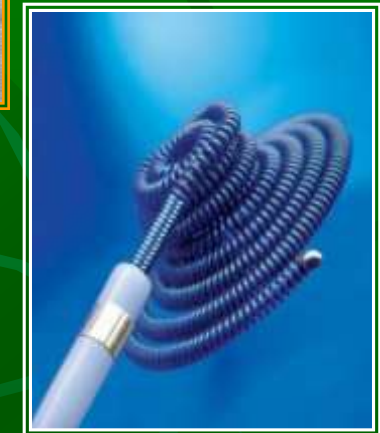
- **Priority to the sizes, derived from the IVUS analysis**

2005 - 2015

- **The concentric shaped ductus < 2.5 mm – embolization with coil**

- **The concentric shaped ductus $2.5 - 3.5$ mm, or oval or irregular shaped PDA $2.0 - 3.0$ mm – embolization with coil occluder (Nit-Occlud)**

- **The concentric shaped ductus > 3.5 mm or oval or irregular shaped PDA > 3.0 mm – the use of Amplatz occluder or similar device**



The ductus closure

While residual flow remained unchanged after embolization, the oval shaped ductus, irregular structure of ductus, and their combinations were observed in 60-70% of cases

✦ Residual flow

at angiography – 5.9 %

at Echocardiography – 9.7 %

Type 1	50,0 %	58.6 %
Type 2	33,3 %	31,0 %
Type 3	16,7 %	10,3 %
oval shape	38,1 %	36.4 %
irregular shape	42,9 %	39.4 %
The ductus pulsation	9,5 %	21.2 %
Any morphological phenomenon	61,9 %	72.7 %

The ductus closure

- ✦ **Repeat embolization**
- ✦ **at 6 month-2 years – 3.4%**
- ✦ **(8 patients, 2 of which underwent this procedure twice)**

тип 1 – 50 %

тип 2 – 12.5 %

тип 3 – 37.5 %

oval shape – 25 %

irregular shape – 25 %

The ductus pulsation – 50 %

Any morphological phenomenon – 75 %

Conclusions

- IVUS analysis allows for more precise measurements of PDA sizes than angiography.
- IVUS allows determining of different types and characteristics of PDA anatomy, which are not possible to determine by angiography.
- The use of IVUS allows more accurate type and size selection of the device for interventions.
- Morphological features of PDA based on IVUS measurements can be a predictor of residual flow after repeated interventions.
- The use of IVUS at the setting of congenital heart disease is safe and can provide valuable diagnostic information for the future use.