ISSN 1727-818X

International Journal of Interventional Cardioangiology

№36
2014

Read in the Journal:

RUSSIAN SOCIETY OF INTERVENTIONAL CARDIOANGIOLOGY

ISSN 1727-818X

INTERNATIONAL JOURNAL OF INTERVENTIONAL CARDIOANGIOLOGY

№ 36-2014

"International Journal of Interventional Cardioangiology". peer-reviewed scientific and practical journal. Founded in 2002.

Website: www.ijic.ru

Address of the Editions:
101000, Moscow,
Sverchkov per., 5
Phone (+7 495) 624 96 36
Fax (+7 495) 624 67 33

Translation:
Translation bureau
MEDTRAN

Prepared by:
VIDAR Publishing House

Computer makeup:
Yu. Kushel

Corrector:
T. Lukovskaya

Special gratitude to
George Guiguineishvili,
doctor and artist,
for the offered opportunity
to put the photocopy
of his painting
"Interventional
Cardioangiology"
on the cover
of the magazine

ISSN 1727-818X
9 771727 818001

Board of the Russian Society of Interventional Cardioangiology

Russia, 101000, Moscow, Sverchkov per., 5
Moscow City Center of Interventional Cardioangiology
(Secretary of RSICA E. Bogatyrenko)
Phone: +7 (495) 624 96 36, +7 (495) 625 32 16
Fax+7 (495) 624-67-33
E-mail : elenita712@gmail.com
Website: www.rnoik.ru

HONORARY MEMBERS of Russian Society of Interventional Cardioangiology

COLOMBO Antonio	Milan, Italy
CONTI, C.Richard	Gainesville, USA
DORROS Gerald Phoenix	Arizona, USA
FAJADET Jean	Toulouse, France
HOLMES David R., Jr.	Rochester, Minnesota, USA
IOSSELIANI David	Moscow, Russian Federation
KATZEN, Barry T.	Miami, USA
KING Spencer B., III	Atlanta, Georgia, USA
LUDWIG Josef	Erlangen, Germany
MEIER Bernhard	Bern, Switzerland
PROKUBOVSKY Vladimir	Moscow, Russian Federation
RIENMULLER Rainer	Graz, Austria
SERRUYS Patrick W.	Rotterdam, Netherlands
SHAKNOVICH Alexander	New York, USA
SIGWART Ulrich	Geneva, Switzerland
SIMON Rudiger	Kiel, Germany
SUKHOV Valentin	St.Petersburg, Russian Federation
VAHANIAN Alec	Paris, France
VOLYNSKY Youry	Moscow, Russian Federation

Instructions for authors

The International Journal of Interventional Cardioangiology (IJIC) publishes peer-reviewed articles on all aspects of cardiovascular disease, as well as the abstracts of communications, presented at the scientific congresses, sessions and conferences, held by the Russian Scientific Society of Interventional Cardioangiology.

All manuscripts should be addressed to:
International Journal
of Interventional Cardioangiology,
Sverchkov per., 5, Moscow, 101000, Russia.
Fax: (7 495) 624 67 33
e-mail: davidgi@mail.ru
elenita712@gmail.com

Manuscripts are considered for review only under the conditions that they are not under consideration elsewhere and that the data presented have not appeared on the Internet or have not been previously published. On acceptance,written transfer of copyright to the IJIC, signed by all authors, will be required. The IJIC will maintain copyright records. The publication of manuscript is free.

No part of materials published in IJIC may be reproduced without written permission of the publisher.

Address permission requests to:
International Journal
of Interventional Cardioangiology,
Sverchkov per., 5, Moscow, 101000, Russia.
Fax: (7 495) 624 67 33
e-mail: elenita712@gmail.com

The Editors require authors to disclose any financial associations that might pose a conflict of interest in connection with the submitted article. If no conflict of interest exists, please state this in the cover letter. Along with a cover letter, submit two complete copies of the manuscript, two sets of figures and tables, and two copies of the cover letter. If supplementary materials such as “in press” references are included, provide two copies. The manuscript should be typed double-spaced throughout, on one side only, on 22 x 28 cm (8.5 x II’’) white paper with 3-cm margin on all sides (8-cm at bottom of tide page). Please use a standard 10 cpi font or a laser printer font no smaller than 12 points.

Structure of the article: (1) Title page; **(2)** Condensed abstract and keywords; **(3)** Structured abstract; **(4)** List of abbreviations; **(5)** Text; **(6)** Acknowledgements (if applicable); **(7)** References; **(8)** Legends for figures; **(9)** Tables. The pagination should start from the title page.

TITLE PAGE

Include the title, authors' names (including full first name and middle initial, degrees and, where applicable, SICA), and a brief title of no more than 45 characters. List the departments and institutions with which the authors are affiliated, and indicate the specific affiliations if the work is generated from more than one institution (use the footnote symbols). Also provide information on grants, contracts and other forms of financial support, and list the cities and states of all foundations, funds and institutions involved in the work. Under the heading, “Address for correspondence”, give the full name and complete postal address of the author to whom communications, printer’s proofs and reprint requests should be sent. Also provide telephone and fax numbers and E-mail address.

STRUCTURED ABSTRACT

Provide a structured abstract of no more than 250 words, presenting essential data in five paragraphs introduced by separate headings in the following order: Objectives, Background, Methods, Results, Conclusions. Use complete sentences. All data in the abstract must also appear in the manuscript text or tables.

CONDENSED ABSTRACT
(for the summary)

Provide a condensed abstract of no more than 100 words, stressing clinical implications, for the expanded table of contents. Include no data that do not also appear in the manuscript text or tables.

TEXT

To save space in the Journal, up to 10 abbreviations of common terms may be used throughout the manuscript. On a separate page following the

condensed abstract, list the selected abbreviations and their definitions. Editors will determine which lesser known terms should not be abbreviated. Use headings and subheadings in the Methods, Results and, particularly, Discussion sections. Every reference, figure and table should be cited in the text in numerical order according to order of mention. The list of keywords is mandatory.

STATISTICS

All publishable manuscripts will be reviewed for appropriate accuracy of statistical methods and statistical interpretation of results. Provide in the Methods a subsection detailing the statistical methods, including specific methods used to summarize the data, method for hypothesis testing (if any) and the level of significance or hypothesis testing. When using more sophisticated statistical methods (beyond t tests, chi-square, simple linear regression), specify statistical package used.

REFERENCES

Identity references in the text by Arabic numerals in parentheses on the line. The reference list should be typed double-spaced (separate from the text); references must be numbered consecutively in the order in which they are mentioned in the text. Do not cite personal communications, manuscripts in prepation or other unpublished data in the references; these may be cited in parentheses. Use Index Medicus (National Library of Medicine) abbreviations for journal titles. Use the following style and punctuation for references.

Periodical. List all authors if four or fewer, otherwise list the first three and add the et al.

Chapter in book. Provide inclusive page numbers, authors, chapter titles, book title, editor, publisher and year.

Book (personal author or authors). Provide a specific (not inclusive) page number.

FIGURE LEGENDS

Figure legends should be typed double-spaced on pages separate from the text; figure numbers must correspond with the order in which they are mentioned in the text. All abbreviations used in the figure should be identified either after their first mention in the legend or in alphabetical order at the end of each legend. All symbols used (arrows, circles, etc.) must be explained If previously published figures are used, written permission from original publisher and author is required. Cite the source of the figure in the legend.

FIGURES Submit two sets of laser prints or clean photocopies in two separate envelopes. Two sets of glossy prints should be provided for all half-tone or color illustrations. Note: The artwork of published articles will not be returned to authors. Figures, particularly graphs, should be designed to take as little space as possible. Lettering should be of sufficient size to be legible after reduction for publication. The optimal size after reduction is 8 points. Symbols should be of a similar size. All graphs and line drawings must be professionally prepared or done on a computer and reproduced as high quality laser prints. Decimals, lines and other details must be strong enough for reproduction. Use only black and white, not gray, in charts and graphs. The first author's last name, the figure number, and the top location should be indicated on the back of each figure, preferably on an adhesive label. Figure title and caption material must appear in the legend, not on the figure.

TABLES

Tables should be typed double-spaced on separate sheets, with the table number and tide centered above the table and explanatory notes below the table. Use Arabic numbers. Table numbers must correspond with the order cited in the text. Abbreviations should be listed in a footnote under the table in alphabetical order. Tables should be self-explanatory, and the data presented in them should not be duplicated in the text or figures. If previously published tables are used, written permission from the original publisher and author is required. Cite the source of the table in the footnote.

Contents

Thrombus Management in *STEMI* Interventions

S. Mehta[*a, b], *J.C. Kostela*[c], *E. Oliveros MD*[c], *O. Reynbakh MD*[c], *Chi Zhang*[c], *C. Pena*[c], *D. Patel*[c], *M. M. Ossa Galvis*[c], *D. Rodriguez*[c]

[a] *Voluntary Associate Clinical Professor of Medicine, University of Miami – Miller School of Medicine*
[b] *Chairman, Lumen Foundation*
[c] *Lumen Foundation Miami, USA*

Distal embolization and no-reflow are associated with: less angiographic success, reduced myocardial blush, less ST resolution after PPCI, larger enzymatic infarct size, lower left ventricular ejection fraction at discharge and higher long-term mortality in STEMI. We believe that with the use of thrombectomy devices, either by catheter aspiration or mechanical thrombus removal, these shortcomings can be minimized. Given the current lack of formal guidelines for the management of thrombus burden and based on our experience as per the Single INdividual Community Experience Registry (SINCERE) database, we formulated a selective thrombus burden management strategy – the Mehta Strategy for thrombus management.
Key words: *ST-elevation myocardial infarction, massive thrombosis, thrombo-aspiration, primary percutaneous coronary intervention.*

Background. Given the current lack of formal guidelines for the management of thrombus burden and since thrombus burden or grade can be quickly assessed angiographically, a thrombus-grade approach is practical.

Methods. Between October 2003 and presently, the Single INdividual Community Experience Registry (SINCERE) data base has included short D2B time STEMI interventions in 5 community hospitals in South Florida. Standardized, thrombus management strategies, using our Selective Strategy for Thrombus Mananagement has been successfully applied for 1,178 procedures. This strategy involves selective thrombectomy use based upon the thrombus grade, with direct stenting recommended for low grade thrombus, aspiration thrombectomy for moderate and mechanical thrombectomy for high grade thrombus.

Results. Short D2B times with excellent acute and long-term outcomes were achieved in 1,178 consecutive STEMI interventions in SINCERE.

Conclusion. Based on our experience as per the SINCERE database, we formulated a selective thrombus burden management strategy – the Mehta Strategy for thrombus management.

* *Адрес для переписки:*
Sameer Mehta, MD, FACC
Chairman, Lumen Foundation Voluntary Associate Clinical Professor of Medicine, University of Miami – Miller School of Medicine
55 Pinta Road, Miami, FL 33133
Тел.: (305) 860-2843, (305) 856-2351 (fax)
E-mail: sameer.lumenglobal@gmail.com
Статья получена 15 февраля 2014 г.
Принята к публикации 12 марта 2014 г.

Abbreviations:

PPCI – Primary percutaneous coronary intervention
STEMI – *ST*-elevation myocardial infarction
SINCERE – Single INdividual Community Experience
D2B – door-2-balloon
TIMI – thrombolysis in myocardial infarction
STR – *ST*-resolution
MBG – myocardial blush grade
AMI – acute myocardial infarction
PCI – percutanous coronary intervention

Introduction

Thrombus is central to the pathophysiology of *ST*-elevated myocardial infarction (STEMI) –its identification and compulsive management constitute absolute essentials in optimal door-to-balloon (D2B) STEMI interventions. Distal thrombus embolization during STEMI occurs frequently and is also associated with compromised long-term outcomes, not limited to larger enzymatic infarct size, increased major in-hospital complications lower left ventricular ejection fraction at discharge, higher long-term mortality in STEMI and increased incidence of emergency bypass surgery (1–4). A high thrombus burden in STEMI as been assoicated with postprocedural epicardial and myocardial perfusion and higher no reflow and distal embolization (Clin Appl Thromb Hemost. 2013 Mar 27). Several mechanical adjunctive devices and pharmacologic options have shown diverse benefits in managing thrombus.(5,6)

In our structured approach to D2B STEMI interventions that are particularly challenged

by the constraints of a clicking clock, identification of the culprit lesion and compulsive management of thrombus, remain the critical determinant of procedural success. Our compulsive methodology for thrombus management in STEMI interventions has been developed from our extensive work with the SINCERE (Single INdividual Community Experience Registry) database, which has included 1,178 short D2B interventions. The Mehta Strategy for selective thrombus management has recently been published in the Interventional Cardiology Clinics (7) and we anticipate that the simplicity of our quantitatively based strategy makes it an attractive management option.

Pathophysiology of Thrombus

Atherosclerosis is the chronic inflammatory process that is fundamental to intimal plaque development in human vasculature, including the coronary vessels. Several risk factors, including advanced age, male sex, genetics, hyperlipidemia, hypertension, tobacco use, and diabetes mellitus predisposes to endothelial injury. Atherogenesis or plaque formation, involves a dynamic interplay of endothelial injury and inflammatory element recruitment (lipoproteins, macrophages, platelets, smooth muscle cells, collagen, etc.) and deposition (8).

In addition to locally produced mediators, products of blood coagulation and thrombosis likely contribute to atheroma evolution and complication. This involvement justifies the use of the term atherothrombosis to convey the inextricable links between atherosclerosis and thrombosis.(8) Plaque is subjected to a variety of intrinsic and extrinsic stressors which lead to an acute plaque change.(9) The rupture, fissuring, erosion, or ulceration of plaque initiates the thrombosis cascade in one of two pathways.(8) The first pathway involves exposed collagen of the vessel wall. The exposed collagen of disrupted endothelium interacts with platelet glycoproteins. Specifically, platelet glycoprotein VI binds with the collagen of the exposed vessel, while platelet glycoprotein Ib-V-IX interacts with the collagen-bound von Willebrand factor. This process not only secures the adherence of platelets to the vessel wall, but also initiates platelet activation and granule release, independent of thrombin.(10) Ultimately this pathway leads to the formation of the “white thrombi” consisting of varying amounts of cellular debris, fibrin, and platelets and a limited number of erythrocytes. Succeeding the “white thrombi”, the second pathway leads to formation of a “red thrombi”, an erythrocytes and thrombin rich complex (11).

A membrane protein – tissue factor, mediates the second pathway. Among its functions, tissue factor initiates the extrinsic coagulation cascade. It binds to the activated factor VII, which then activates factor IX; ultimately leading to the cascade that generates thrombin. The thrombin then cleaves protease-activated receptor 4 on the platelet surface. This cleavage in turn activates platelets, causing the release of adenosine diphosphate (ADP), serotonin, and thromboxane A2, all of which are agonists in the activation of other platelets.(10) Depending on the initial size of plaque, both pathways can occlude the lumen of the coronary vessel, leading to an MI (12–16). The timing and intrinsic ability of the second pathway to stabilize, enlarge and increase the density of the primary “white thrombi”, (11) contributes to the complexity of management of thrombus especially in the setting of D2B time constraints.

Thrombus and STEMI

Thrombus is dynamic, presenting in the very early stages of AMI as a platelet-based, white thrombus that progresses in the next few hours into a dense, organized red thrombus comprising of RBC’s and fibrin strands. Figure 1 demonstrates the dynamism of thrombus and provides a framework for early and aggressive thrombus management. Amongst procedural variables, assessment of thrombus grade and applying a thrombus grade-based thrombectomy strategy is strongly advocated.

Methods

The TIMI thrombus grade classifies the thrombus based on angiography (Table 1) and is the basis for the Mehta Strategy for Thrombus Management (Table 3). The pioneering work by Sianos et al (17) lead to this classification that has now been routinely practiced in over 1145 short D2B STEMI interventions in the SINCERE database (18). Table 4 has formulated the step-wise technique of performing the entire STEMI procedure using this standardized algorithm.

Optimal angiographic visualization of thrombus is the first step; however, thrombus is very labile and its grading for the purpose of further management is better done after crossing the thrombotic STEMI lesion with the guide wire. Balloon catheters are not recommended as they cause distal embolization and myocardial

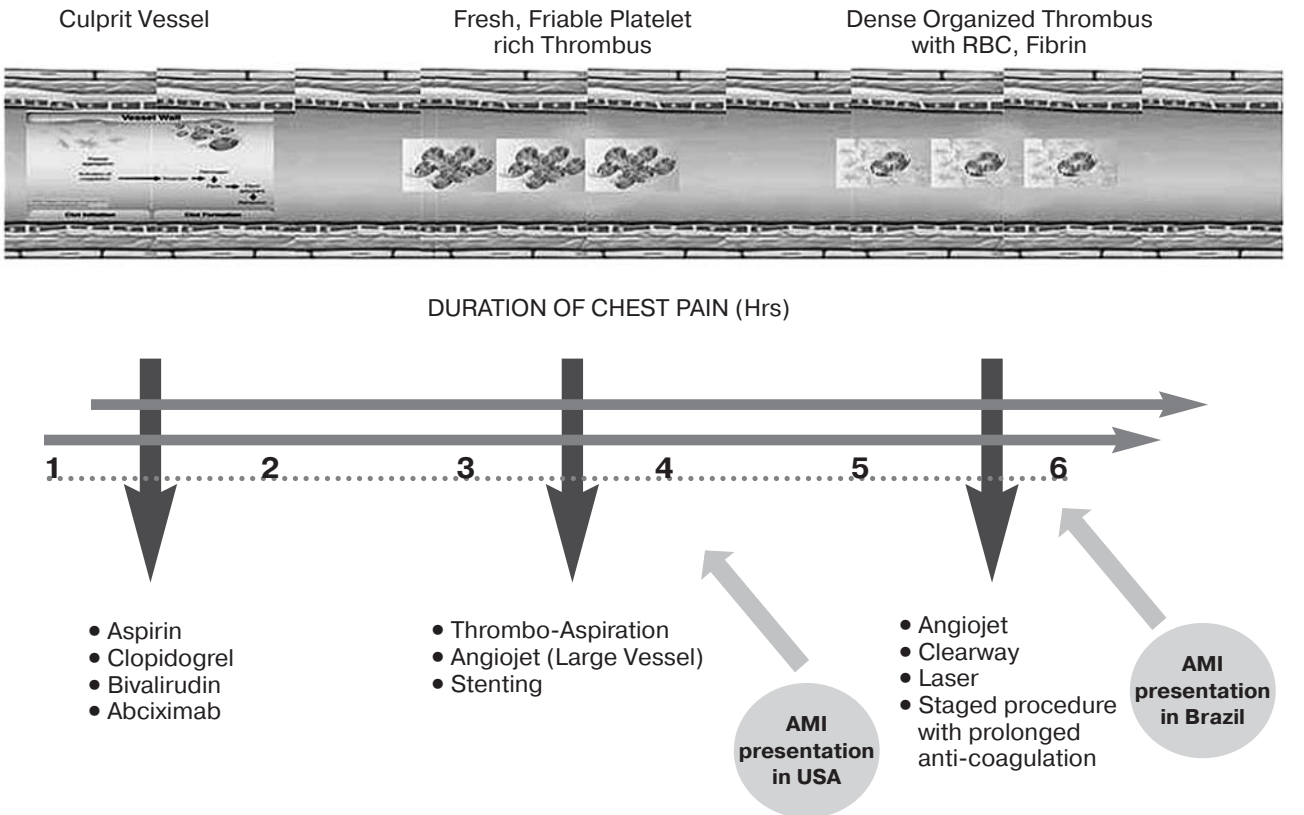


Figure 1. Dynamic thrombus.

necrosis. We recommend to use of them only for 3 rare situations: 1) Uncertainty, whether the guide wire is in the true lumen, after it has crossed a thrombotically-occluded segment; in this situation, a small 2.0 mm balloon can be rapidly inflated; 2) For a patient with overwhelming ischemia and massive *ST* segment elevation – the role of the balloon is to achieve some TIMI flow rapidly, however, even this may result in thrombus migration and this strategy must be used with great discretion; and 3) Unavailable Thrombectomy catheters and/or devices.

Often, there is no change in thrombus grade, but thrombus grade 5 most commonly is downsized after wire passage. If the extent of thrombus is small (thrombus grade 0–1), direct angioplasty and stenting may be sufficient (Figures 2–5). Moderate thrombus burden, grades 2–3, warrants pretreatment with an aspiration catheter. Several randomized controlled trials have demonstrated that aspiration

Table 1. TIMI thrombus grade

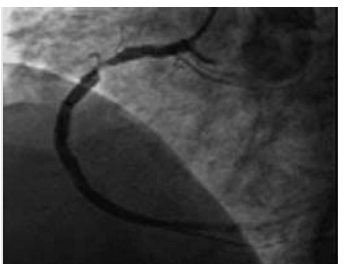
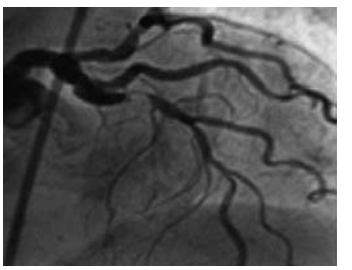
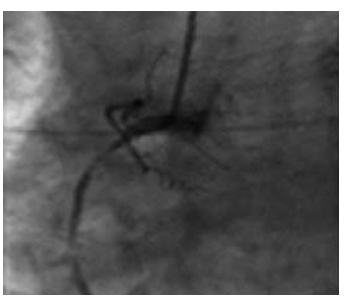
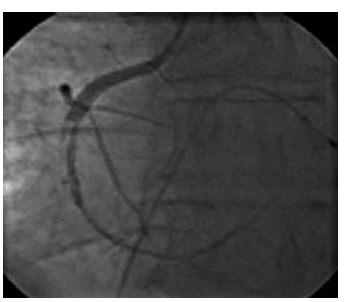
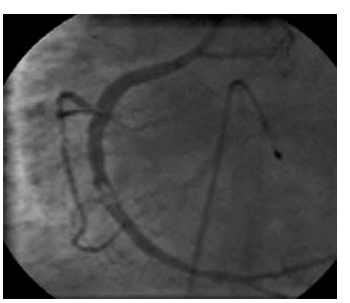
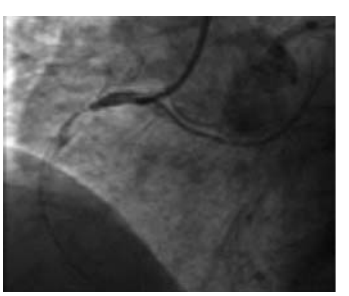
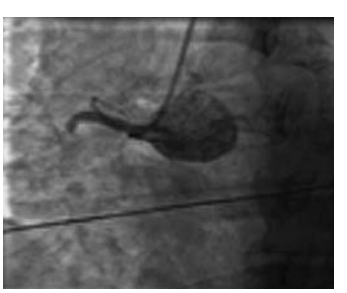
0	No cineangiographic characteristics of thrombus present
1	Possible thrombus present. Angiography demonstrates characteristics such as reduced contrast density, haziness, irregular lesion contour or a smooth convex “meniscus” at the site of total occlusion suggestive but not diagnostic of thrombus
2	Thrombus present-small size: Definite thrombus with greatest dimensions less than or equal to $^1/_2$ vessel diameter
3	Thrombus present – moderate size: Definite thrombus but with greatest linear dimension greater than $^1/_2$ but less than 2 vessel diameters
4	Thrombus present – large size: As in Grade 3 but with the largest dimension greater than or equal to 2 vessel diameters
5	Total occlusion

From:

The TIMI–IIIA Investigators. Early effects of tissue-type plasminogen activator added to conventional therapy on the culprit coronary lesion in patients presenting with ischemic cardiac pain at rest. Circulation 1993,87, 38–52.

van’t Hof AW, Liem A, Suryapranata H, et al. Angiographic assessment of myocardial reperfusion in patients treated with primary angioplasty for acute myocardial infarction: myocardial blush grade. Zwolle Myocardial Infarction Study Group. Circulation 1998, 97, 2302–2306.

Table 3. Strategy based on thrombus-grade for management of the STEMI lesion: mehta strategy

Grade	Thrombus Definition	Angiographic Examples
0	No cine angiographic characteristics of thrombus present	
1	Possible thrombus present. Angiography demonstrates reduced contrast density, haziness, irregular lesion contour at the site of total occlusion suggestive but not diagnostic of thrombus	 
2	Thrombus present-small size. Definite thrombus with greatest dimensions less than or equal to 1/2 vessel diameter	 
3	Thrombus present-moderate size: Definite thrombus but with greatest lineardimension greater than 1/2 but less than 2 vessel diameters	 
4	Thrombus present-large size: largest dimension greater than or equal to 2 vessel diameters	 
5	Total occlusion	 

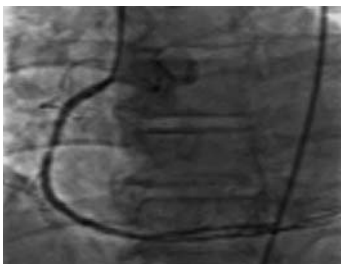
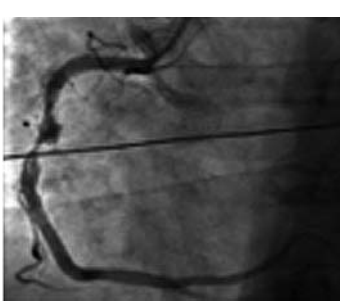
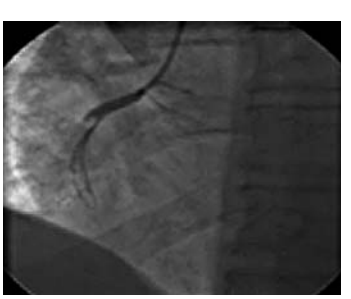
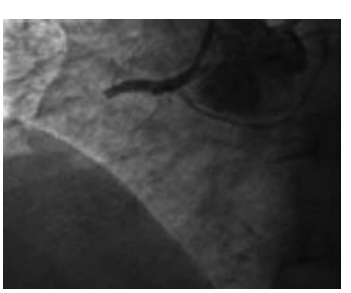
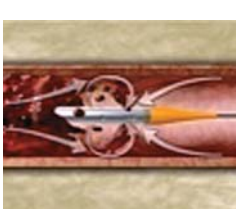
	Mehta Classification	Technical Tips of Use	
		Aspiration Catheter	AngioJet
	Direct Stent +/– Pre dilatation	• Most effective with fresh clot; organized thrombus is more resistant to debulking. • Have different profiles, different push-ability, tractability and aspiration rates. • All are 6F-compatable. It is useful to stock and be familiar with the use of at least one. • Flush catheter lumen well before use as it facilitates better tracking over the wire • Avoid kinking the catheter-advance slowly over the initial, softer portion of the catheter. • Monitor distal tip of the guide wire as the aspiration catheter is advanced – it is not uncommon for the guide wire to advance during • Advance the aspiration catheter through the entire length of occlusive disease	• Can be used from the radial route. Although LAD and some LCX may not need a TPM, I place TPM's in all Angiojet procedures. • Often, multiple passes will be required. Try to pause after every 2-3 pases to enable hemodynamics to optimize guide wire and guiding catheter support and to evaluate the results. • Often, just the first passage will restore adequate flow • Resistant and stubborn thrombus will require more distal advancement that must be done more carefully. • Avoid advancing in severe tortuosity and in vessels <2mm • Since the Angiojet is used for large thrombus burden and high thrombus grade, consider Abciximab as adjunctive therapy.
 	 Aspiration thrombectomy		
 	 AngioJet		

Table 4. Thrombectomy devices

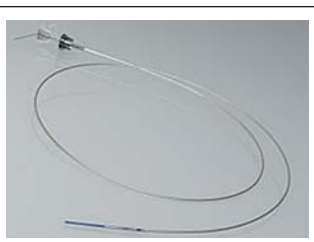
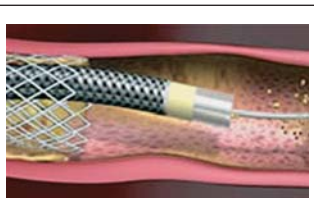
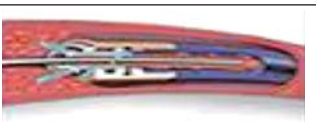
Device	Unique Characteristics
	Aspiration Thrombectomy
Diver C.E.	 • Available in 2 versions: Aspiration lumen with side holes (for fresh thrombus removal, 2-6 post symptoms onset) and aspiration lumen without side holes (for organized thrombus removal, 6–24 hrs post symptoms onset). • Ultra flexible shaft from increased trackability.
Export®	 • The distal end is flexible with high-density variable braiding. • The proximal end has low-density variable braiding for support and pushability.
Pronto	 • Embedded longitudinal wire enhances deliverability and kink resistance. • Patented Silva distal tip provides vessel protection.
QuickCat™	 • 6F aspiration catheter with a low profile. • Moderate suction ability, kink easily and could perform better with more tensile strength of catheter.
FETCH	 • Rapid exchange and 6F compatible. • Braided shaft with hydrophilic coating and convex tip.
HUNTER	 • Rapid exchange with dual lumen and 6F compatible.
THROMBUSTER	 • Low frictional resistance, kink resistance and deliverability enhanced with a metal braided shaft. • Large aspiration lumen and hydrophilic coating.
FAST FUNNEL	 • Delivered over guidewire proximal to the occlusion, funnel occluder arrest blood through, preventing distal flow of debris. A standard syringe allows removal of thrombus and stagnant blood flow. • 7F compatible.
XTRACT	 • Large single lumen with a free floating guide wire. • Circular right angle tip to allow catheter placement immediately adjacent to lesion. • Curved, directional tip with excellent torque response to enable full sweep of the vessel.

Table 4.

Device		Unique Characteristics
VMAX		• 5F and 6F compatible. • Short tip design. • Large aspiration port allows higher rate of aspiration and great volume.
FETCH 2		• Coiled shaft for kink resistance. • Low pitch distal shaft for flexibility with high pitch proximal shaft for pushability • Distal radiopaque band for visability.
ELIMINATE		• Preloaded stylet, fully braided shaft and 6F compatible.
	Mechanical Thrombectomy	
Angiojet®		• Rheolytic thrombectomy system that utilizes high-velocity saline jets at the distal catheter tip. The jets creates a negative pressure to collect the thrombus. • Only thrombectomy device indicated for native coronary arteries and synthetic grafts.
X-Sizer®		• The Archimedes screw is designed to grab thrombus on contact – quickly drawing it in, shearing and removing it.
RINSPIRATOR		• 3 lumens – first allows passage of standard guidewire, second allows aspiration, third allows simultaneous saline infusion through exit points proximal to the aspiration lumen, yielding turbulence that may improve the efficiency of thrombus removal. • Infusion holes at distal end direct rising spray and central lumen aspirate thrombi.
RESCUE		• No active thrombus fragmentation, but connected to a vacuum motor unit. • 4.5F for monorail polyethylene catheter with a guidewire exit hole 30cm from the distal tip – compatible with a 0.014" or smaller guidewire. • Platinum marker band at the distal tip for visibility.
TVAC		• Effective length 1350mm, radiopaque marker with 250 mm effective coating and 7F compatible. • Single lumen catheter with a beak-shaped distal tip. • The catheter is attached to an aspiration pump for vacuum and removal of thrombotic material.

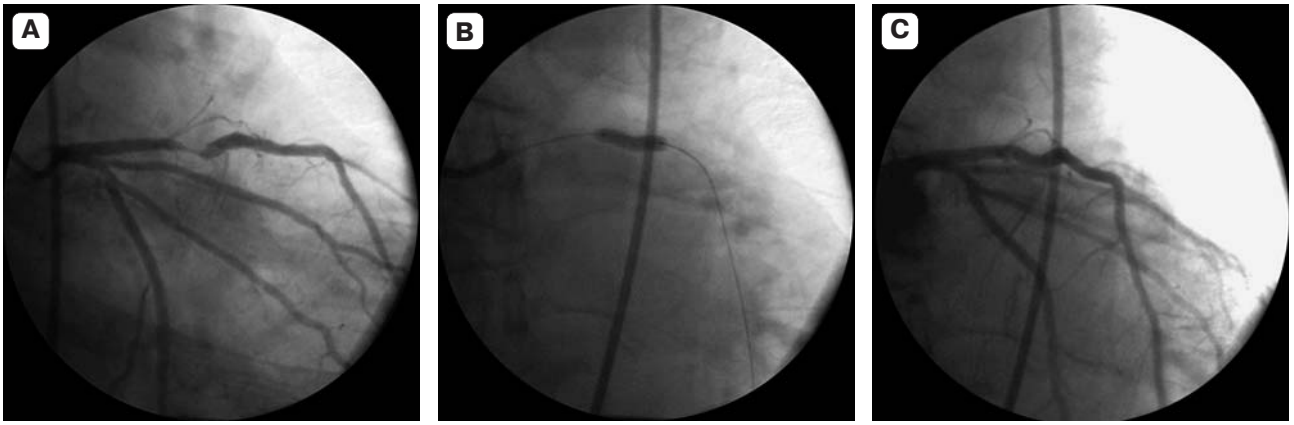


Figure 2. Primary PCI for stemi with low thrombus burden. Lesions with low grade thrombus can be treated safely without the need for more complex catheters or procedures. The following angiograms are from a patient who presented with an acute anterior wall ST-elevation MI. The initial angiogram demonstrated a critical mid LAD culprit lesion with a low grade 0–1 thrombus burden (A). The lesion was direct stented with a 3.5 mm drug-eluting stent (B) with a door to balloon time of 56 minutes, and final angiography demonstrating TIMI 3 flow (C).

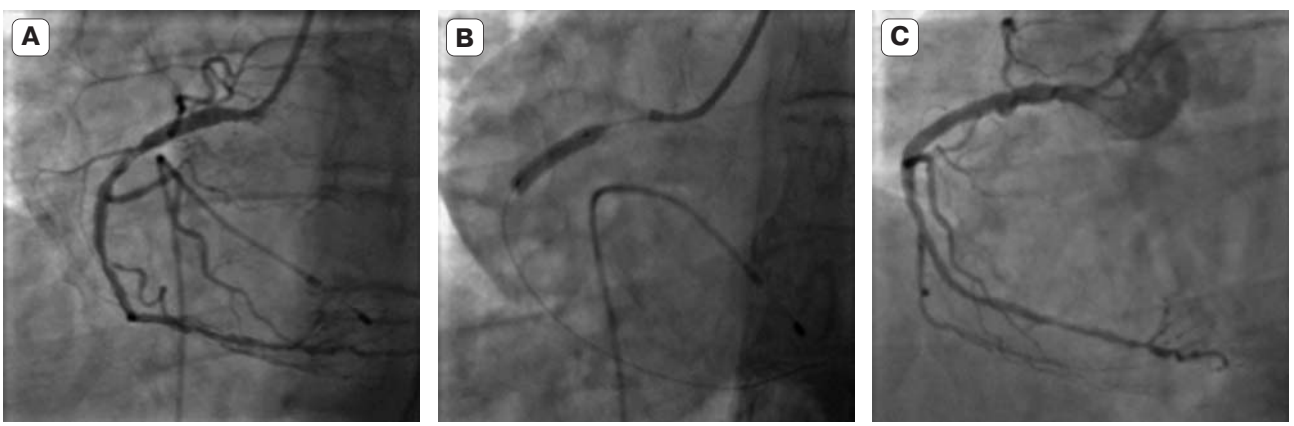


Figure 3. Direct stenting for low grade thrombus. A) Grade 1 thrombus; B) Direct Stenting with 4.0 mm BMS; C) Post stenting.

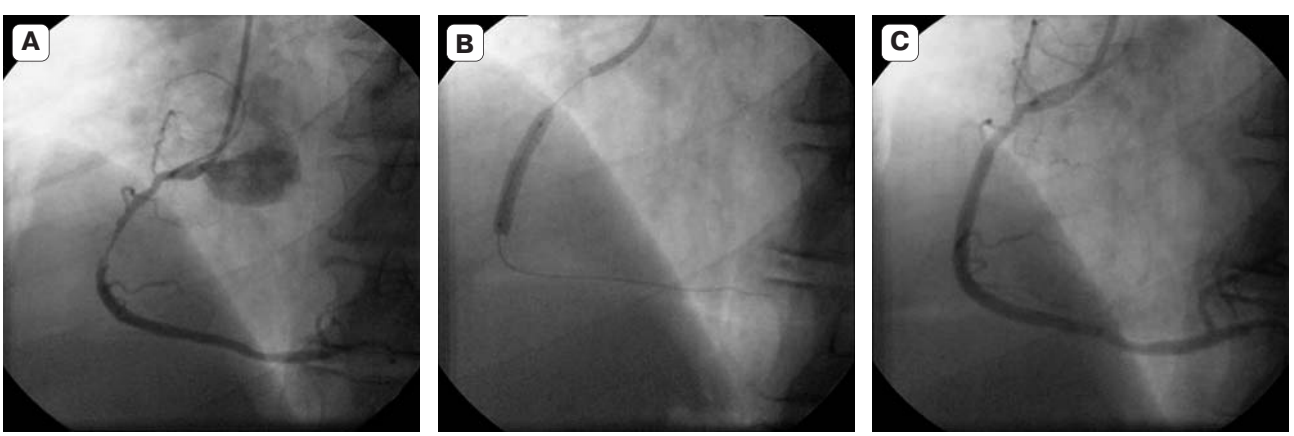


Figure 4. Direct stenting for low grade thrombus. A) Grade 1 thrombus; B) Direct Stenting with 4.0 mm BMS; C) Post stenting.

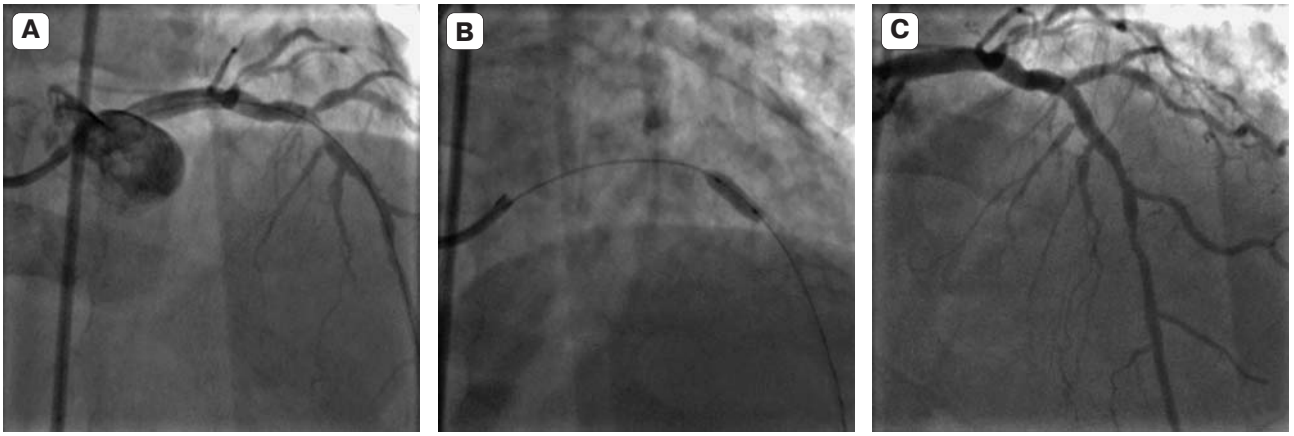


Figure 5. Direct stenting for low grade thrombus. A) Grade 1 thrombus; B) Direct Stenting with 4.0 mm BMS; C) Post stenting.

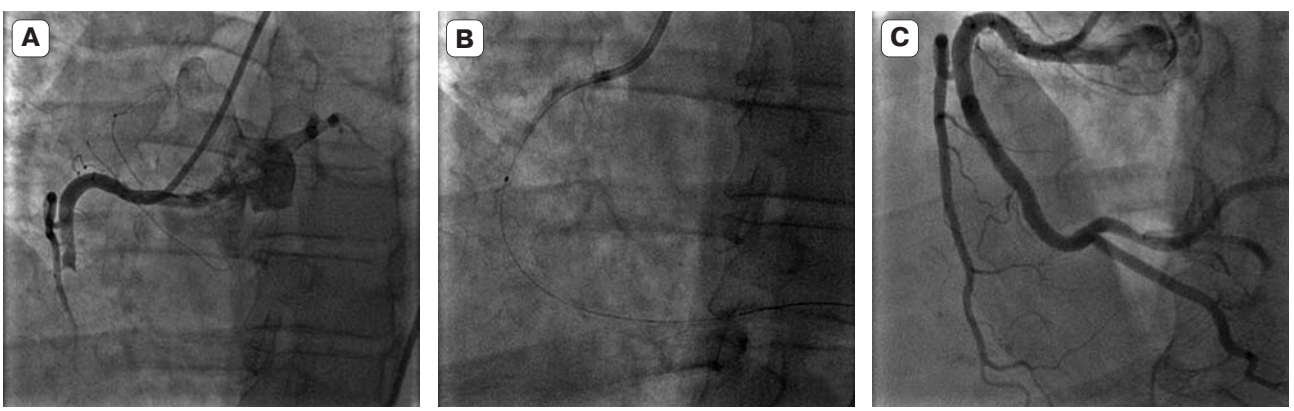


Figure 6. Primary PCI for stemi with moderate thrombus burden. Lesions with moderate grade thrombus are best treated with aspiration thrombectomy devices, prior to definitive treatment and stenting. The next angiogram shows a moderate thrombus (grade 3) in a patient with *ST*-elevation in leads DII–III. The first angiogram demonstrate a discerning mid RCA culprit lesion with a moderate grade thrombus (A). The lesion was treated then with an aspiration catheter (B) followed by angioplasty and stenting with a 4.0 mm bare-metal stent with a door to balloon time of 61 minutes with great results (C).

catheters result in superior MBG, STR, improved clinical outcome, rates of TIMI 3 flow rates, and decreased angiographic evidence of distal embolization (18–20). Figures 6–9 demonstrate aspiration pretreatment in a STEMI with moderate thrombus burden.

Results

Grade 0–1

With low thrombus grades, direct stenting is an acceptable strategy and we advocate it over the use of pre-dilatation that carries its individual risk of distal embolization. Clearly, we complement this strategy, as with all STEMI interventions, with the use of intracoronary vasodilators. Although various pharmacological agents can be used for this purpose (adenosine, verapamil, diltiazem, nicardipine, clevidipine), our preferred agent as an intracoronary vasodilator is nitroprusside.

Grade 2–3

Moderate thrombus burden management with aspiration catheters can be augmented with some practical techniques. Passes with the aspiration catheters should be made until there is no angiographic evidence of thrombus; often just two passes is sufficient. It is important to advance the catheter throughout the entire length of thrombus. Despite their ease of use and effectiveness, the aspiration catheters are not perfect monorail devices and attention should be paid to the tip of the guide wire as these catheters are advanced. Reducing the imaging magnification and monitoring the distal end of the guide wire as the aspiration catheter

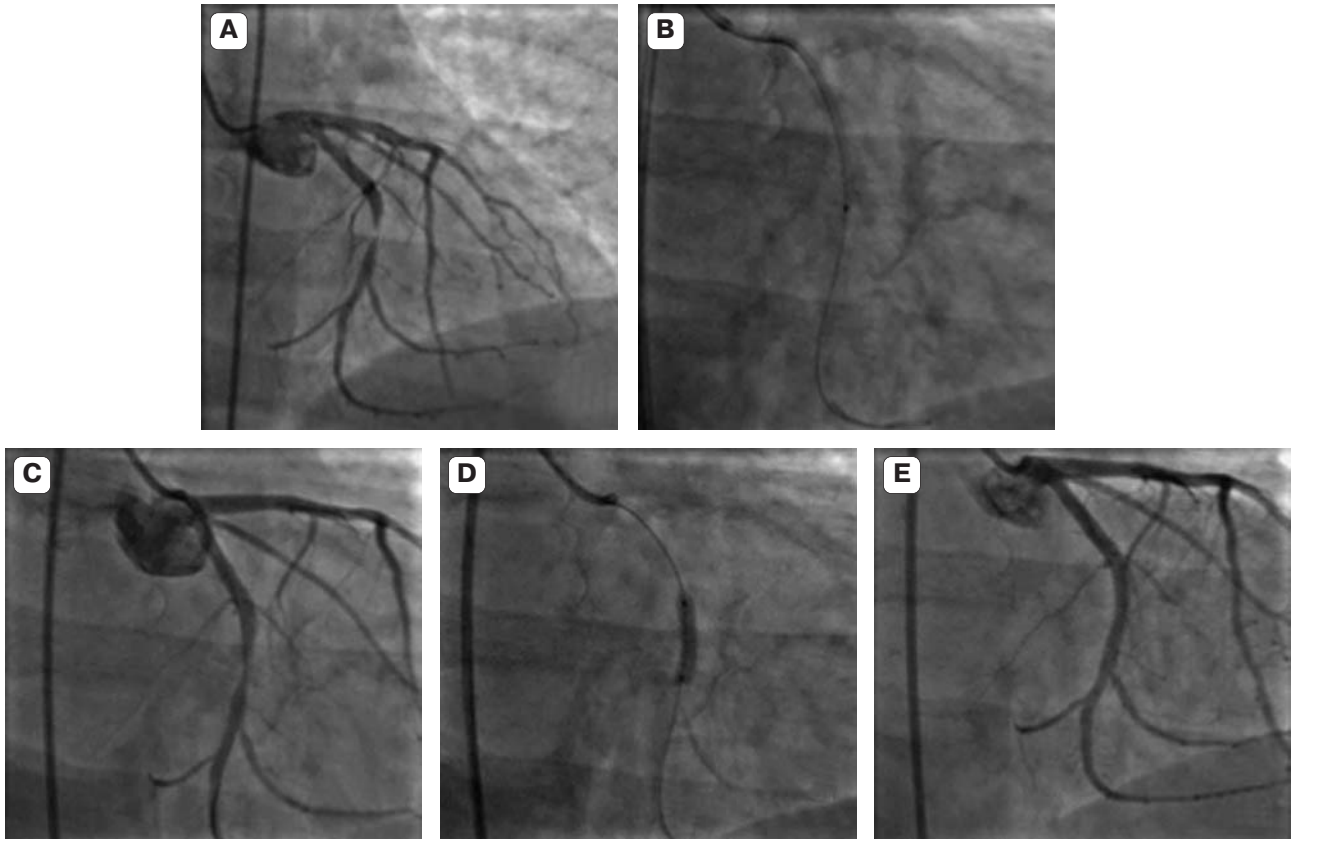


Figure 7. Thrombo-aspiration for moderate thrombus. A) Grade 2 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 3.5 mm BMS; E) Post stenting.

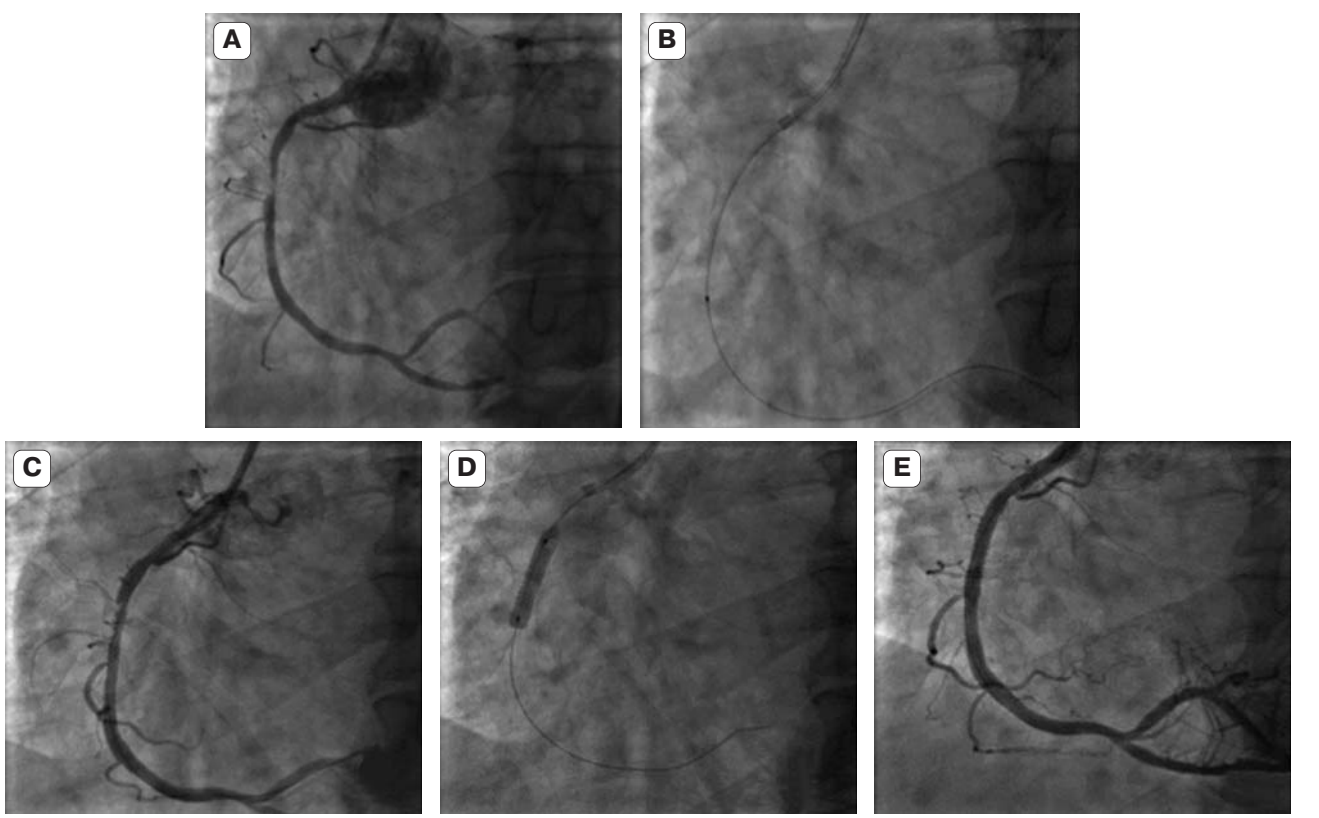


Figure 8. Thrombo-aspiration for moderate thrombus. A) Grade 1/2 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 3.5 mm BMS; E) Post stenting.

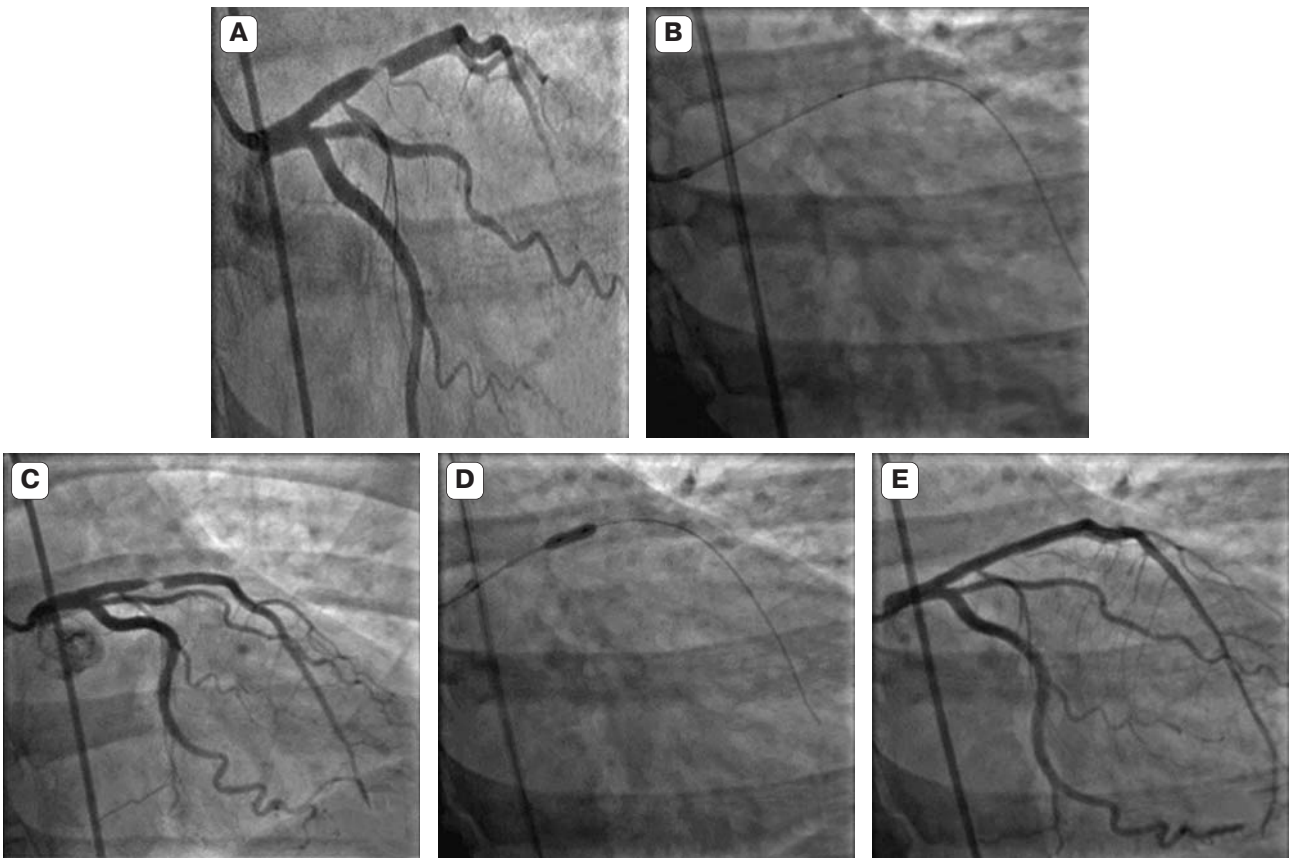


Figure 9. Thrombo-aspiration for moderate thrombus. A) Grade 2/3 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 3.5 mm DES; E) Post stenting.

is advanced are practical techniques in preventing adverse results. Thrombus will often clog the aspiration holes of these catheters halting aspiration. Before abandoning them as unsuccessful, it is important to remove the catheter, flush it profusely, and reuse. Finally, in rare situations, the aspiration catheter will drag the tail of a long thread thrombus that may get dislodged. In one clinical case documented in the SINCERE database, a thrombus was dragged from the obtuse marginal branch (OMB) and lodged at the bifurcation of the left circumflex (LCX) – this was managed by suctioning with the AngioJet®. The newer, aspiration catheters are very easy to use and their use has now become the default strategy for managing thrombus for most lesions, except for those with very large thrombus burden, where mechanical thrombectomy is invaluable.

Grade 4–5

Larger thrombus burden (grades 4–5) presents more challenges. As demonstrated in Figures 10–13, aspiration may be insufficient in cases with grade 4–5 thrombus. In such cases, thrombectomy may be justified. The AngioJet® catheter is an effective device for debulking such voluminous thrombi. Thrombus is aspirated and extracted after high velocity water jets create a vacuum in this catheter-based system (21). Compared to stenting alone, trials have found the AngioJet® to be very successful in improving epicardial flow, frame count, myocardial blush grade, and infarct size (20, 22). The VeGAS (Vein Graft AngioJet Study) 2 trial found that the AngioJet® catheter system was superior to intracoronary urokinase administration in improving device and procedural success, with lower major adverse effects, bleeding, and vascular complications (23).

Some practical techniques in using the AngioJet® thrombectomy device improve clinical outcomes. The new Spiroflex Angiojet® device is very quick to set up – the speed of set up is vital to maintain the goals of achieving short D2B times. The new catheters, including the 4F Thrombectomy catheter, track well. Thrombectomy should be performed through the entire length of thrombus; in fact, the most frequent error with this device is inadequate passes and not ablating through the complete length of the thrombotic segment. In addition

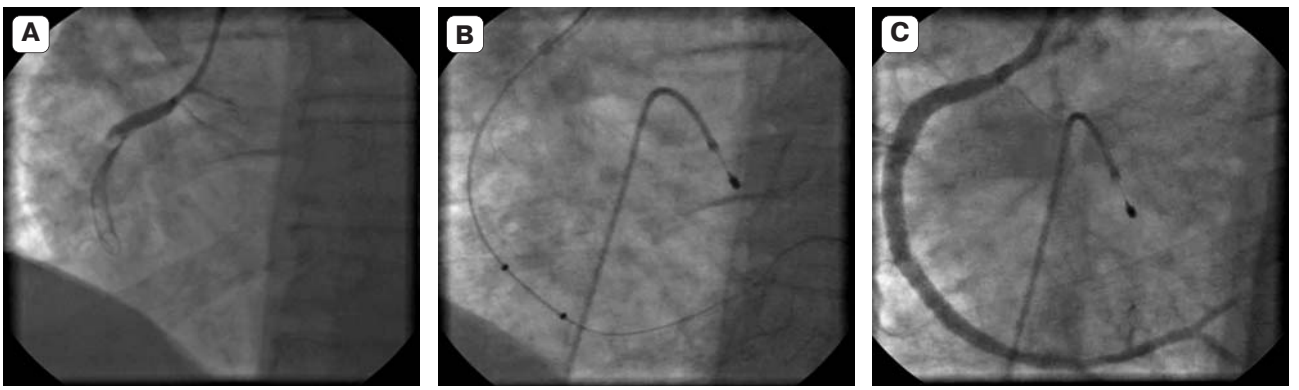


Figure 10. Primary PCI for stemi with large thrombus burden. Lesions with high grade thrombus may require some thrombectomy prior to definitive treatment and stenting. The initial angiogram on this patient, who presented with an acute inferior wall ST-elevation MI, demonstrated a large amount of thrombus (grade 3–4) (A). An Angiojet® catheter (B) was initially used for rheolytic thrombectomy and after angioplasty and stenting, the final angiographic result was excellent (C).

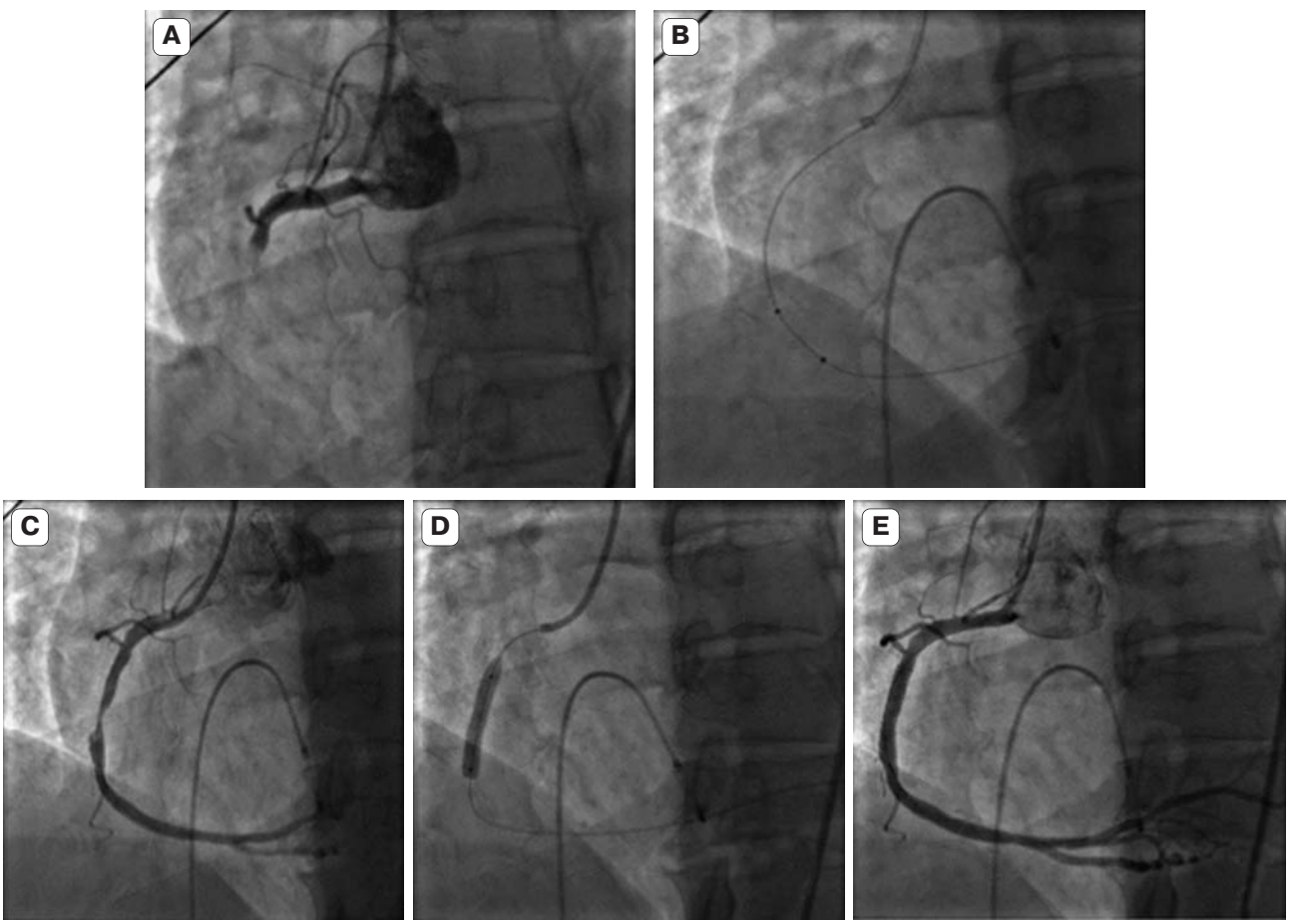


Figure 11. Rheolytic thrombectomy for large thrombus. A) Grade 5 thrombus; B) Rheolytic Thrombectomy performed with Angiojet®; C) Post thrombectomy; D) 4.0 mm BMS; E) Post stenting.

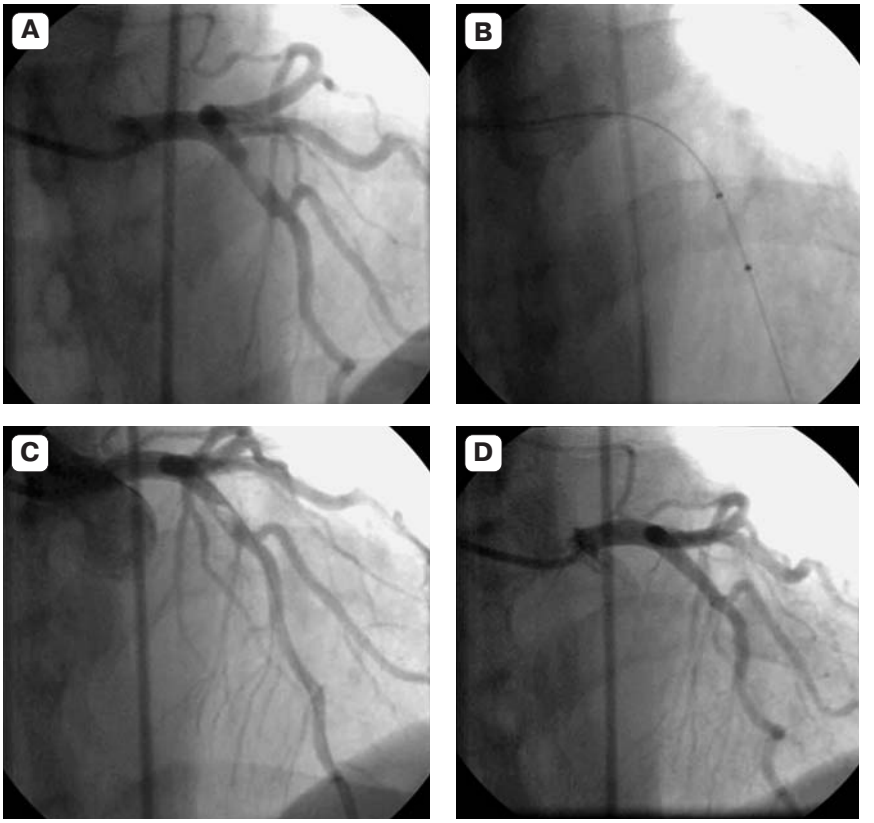


Figure 12. Rheolytic thrombectomy for large thrombus. A) Large, bulky thrombus in mid LAD; B) Rheolytic Thrombectomy performed with Angiojet®; C) Post thrombectomy; D) Post stenting, final result.

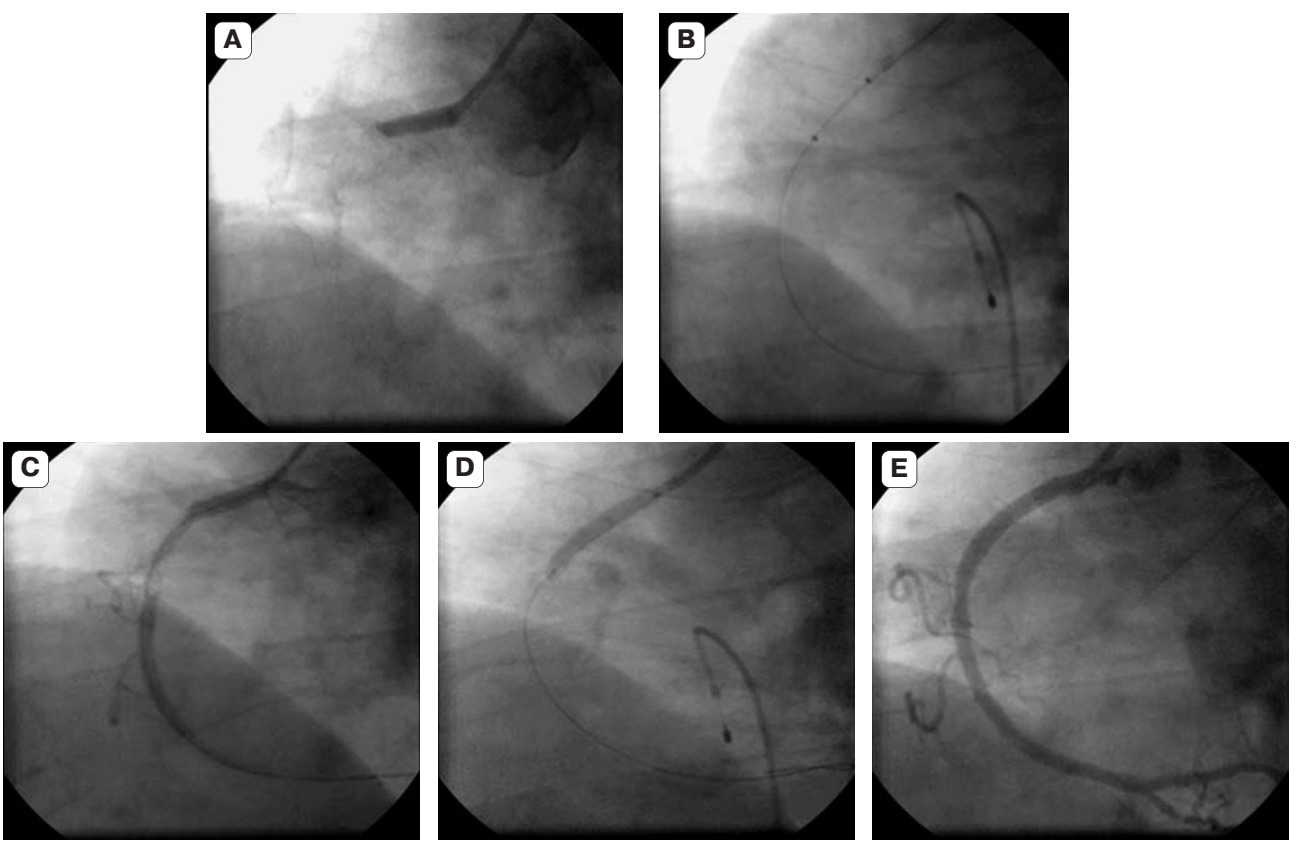


Figure 13. Rheolytic thrombectomy for large thrombus. A) Grade 5 thrombus; B) Rheolytic Thrombectomy performed with Angiojet®; C) Post thrombectomy; D) 4.5 mm BMS; E) Post stenting.

to being a critical device for removing large and bulky thrombus, the AngioJet® is invaluable in managing organized thrombus in late-presenting patients. In fact, SINCERE database includes several successful AngioJet® procedures where aspiration thrombectomy catheters were unsuccessful in aspirating such dense, organized thrombus. Temporary pacing is recommended for all Angiojet® procedures. The pacing wire can be removed after the procedure, even though pacing is rare.

We offer another valuable tip for using both the aspiration and mechanical catheters – when is thrombectomy deemed adequate. To reach this point of optimal thrombectomy, we advocate making successive passes till the last pass makes no further progress in debulking. Sometimes, this can be difficult to assess by angiography, but this broad strategy provides a philosophical approach to approaching these thrombotic lesions with thrombectomy devices. For unsuitable anatomy or unavailability of rheolytic thrombectomy, a strategy of de thrombosis with intracoronary abciximab via the Clearway™ catheter is an acceptable approach.

Limitations of the Mehta strategy

1. Several catheterization laboratories are not equipped with mechanical thrombectomy devices (Angiojet®, X-sizer®, and ThromCat®), or operators are not familiar with their use or find their use causes D2B delays. In these situations, we feel that drug-delivery of Abciximab via the Atrium Clearway™ catheter provides a good alternative.

2. The same recommendation as #1 exist with unfavorable anatomy for the Angiojet® (our preferred mechanical thrombectomy device), although the newer 4F catheter have narrowed our relative contraindications for their use in STEMI interventions (<2.5 mm vessel size and severe tortuosity).

3. Although we recommend mechanical thrombectomy for large thrombus grade, we have been very surprised in numerous cases where thrombo-aspiration works extremely well in large thrombus grade. We have presented numerous examples of these situations (Figures 14–19) – clearly, thrombus grade is high, 4–5, yet, excellent debulking is observed with the simple aspiration catheters. We suspect that this happens in patients that present very early, with fresh, red, soft thrombus that is easily and completely aspirated with these catheters. This observation is contrary to our proposed hypothesis; yet, this powerful observation is shared for its tremendous practical benefit. We have observed this finding most often in thrombotic occlusions where it made sense in any case to advance a small aspiration catheter than a more bulky mechanical device. Incidentally, this is also a rare situation where we will use a low-profile balloon to verify that the guide wire is in the true lumen. Based upon an increasing number of similar cases, as the illustrations in Figures 14–19, we are currently postulating thrombo-aspiration as a default strategy. The rationale for this is simple – the aspiration catheters are user-friendly, relatively inexpensive and take no more than a balloon catheter to prep and deploy. With this methodology, we grade thrombus nevertheless, then quickly make a pass with the aspiration catheter, and either persist with more thrombo-aspiration or advance to using mechanical thrombectomy.

4. Similarly, we have also experienced numerous cases, even with moderate thrombus burden, where the dense, organized thrombus cannot be debulked with thrombo-aspiration. In these situations, the default strategy clearly gives way to using mechanical thrombectomy – consistent with the Mehta Strategy.

5. Although several newer trials appear to validate our strategy with the appropriate presently available device, greater scientific validity is needed. Founded on extensive experience, we feel confident in our strategy for effective thrombus management for STEMI interventions; nevertheless, this strategy needs endorsement by clinical trials. A single individual experience, irrespective of its expertise, cannot substitute for data from large, randomized, clinical trials and/or established guidelines.

6. We have also explored possibilities of using a time-to-presentation based strategy for applying a thrombectomy device. This idea is akin to use of Prehospital lysis, as in the CAPTIM (Comparison of Angioplasty and Prehospital Thrombolysis in Acute Myocardial Infarction) Trial, where the cohorts of very early AMI patients benefit from very early lysis.(24) This probably results from effective lysis of a fresh clot. The same principles as very early lysis may be extended to the use of a thrombectomy device during STEMI, with thrombo-aspiration working as very effective therapy for early presenters (<3 hours) and mechanical thrombectomy for late presenters (>3 hours). Of course, calculating the time-to-presentation is not with-

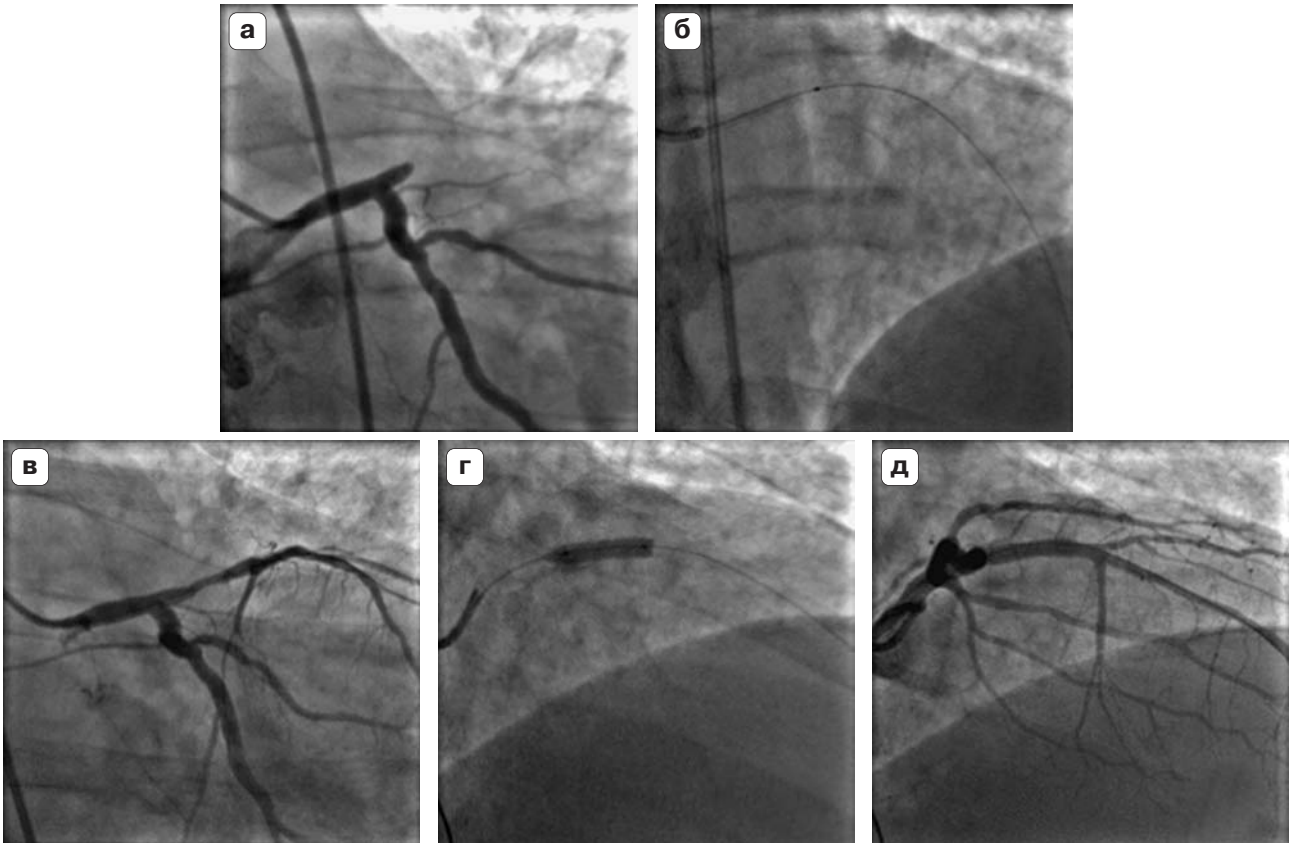


Figure 14. Thrombo-aspiration as default strategy. A) Grade 5 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 3.5 mm Xience DES; E) Post stenting.

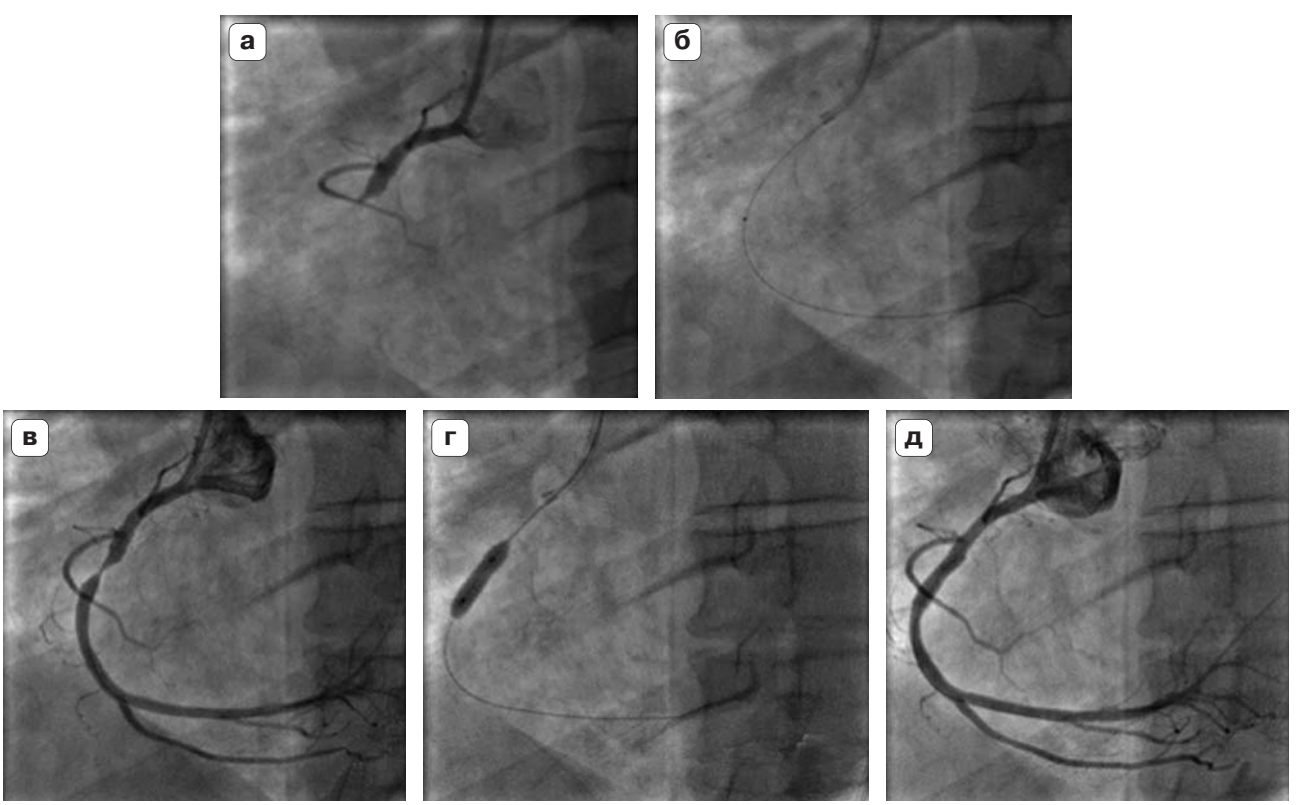


Figure15. Thrombo-aspiration as default strategy. A) Grade 5 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 4.0 BMS; E) Post stenting.

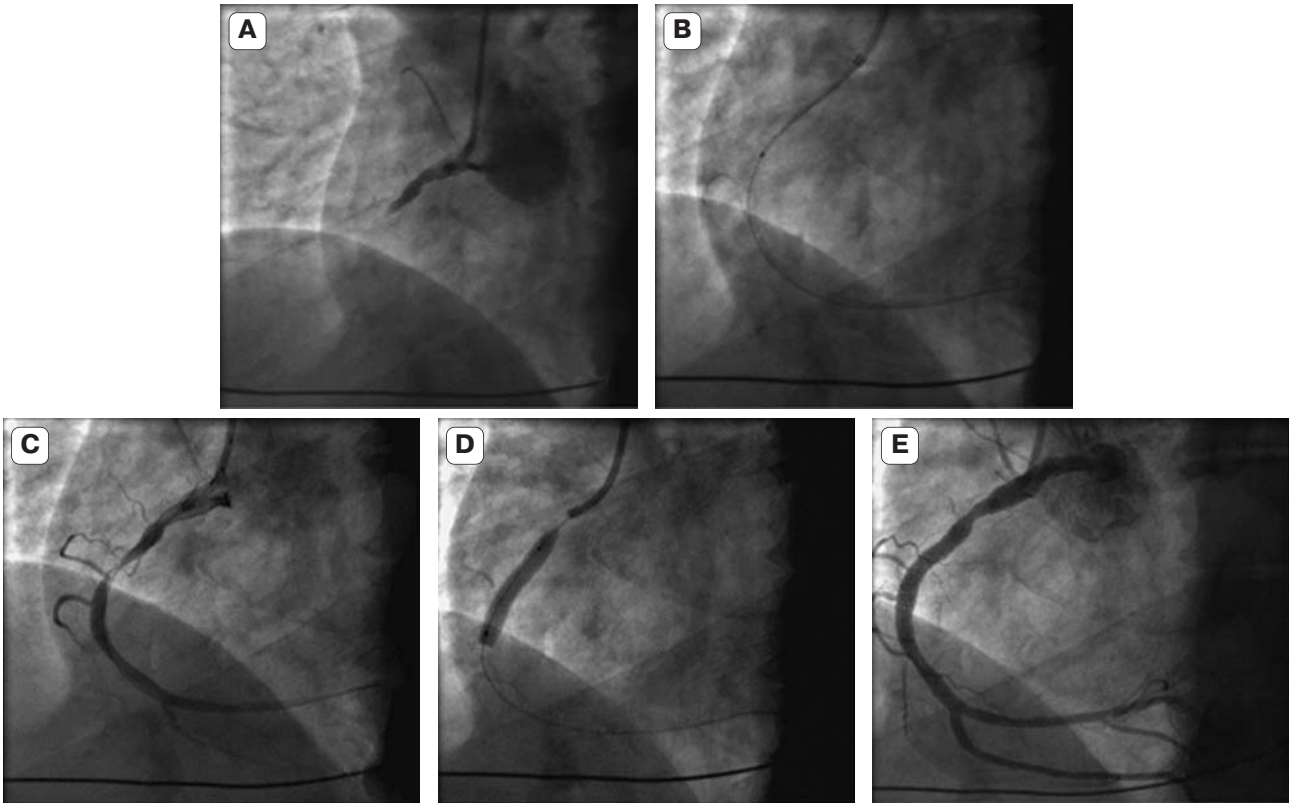


Figure 16. Thrombo-aspiration as default strategy. A) Grade 5 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 4.0 BMS; E) Post stenting.

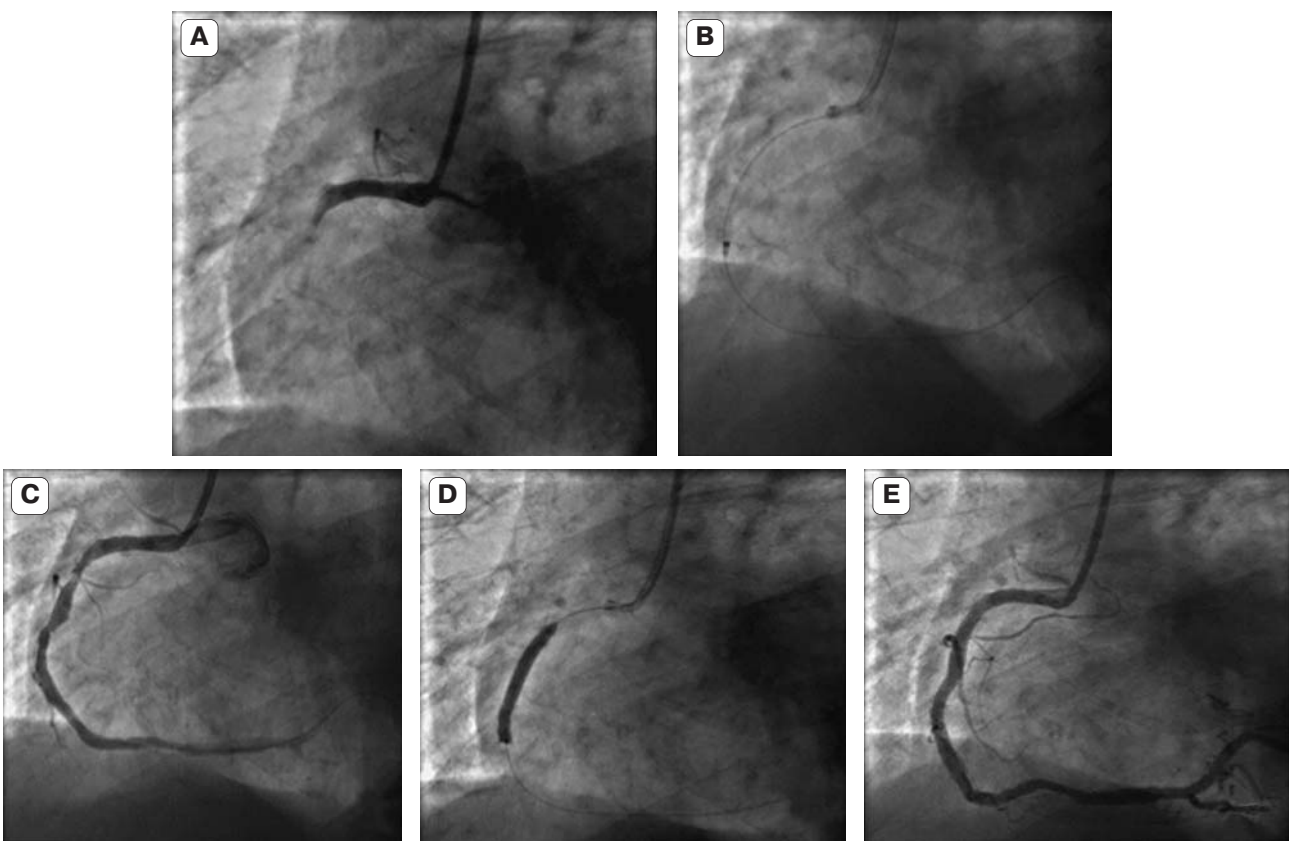


Figure 17. Thrombo-aspiration as default strategy. A) Grade 5 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 4.0 BMS; E) Post stenting.

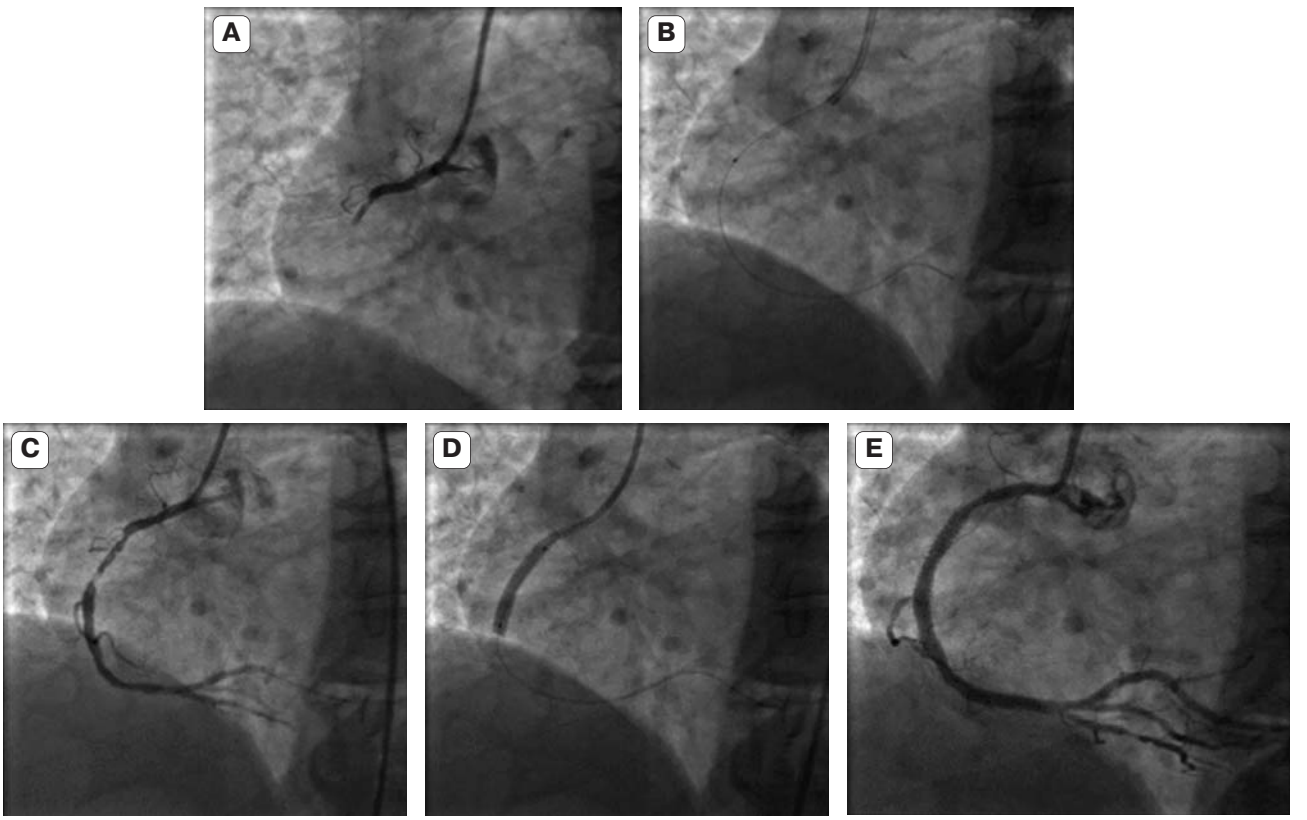


Figure 18. Thrombo-aspiration as default strategy. A) Grade 5 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 4.0 BMS; E) Post stenting.

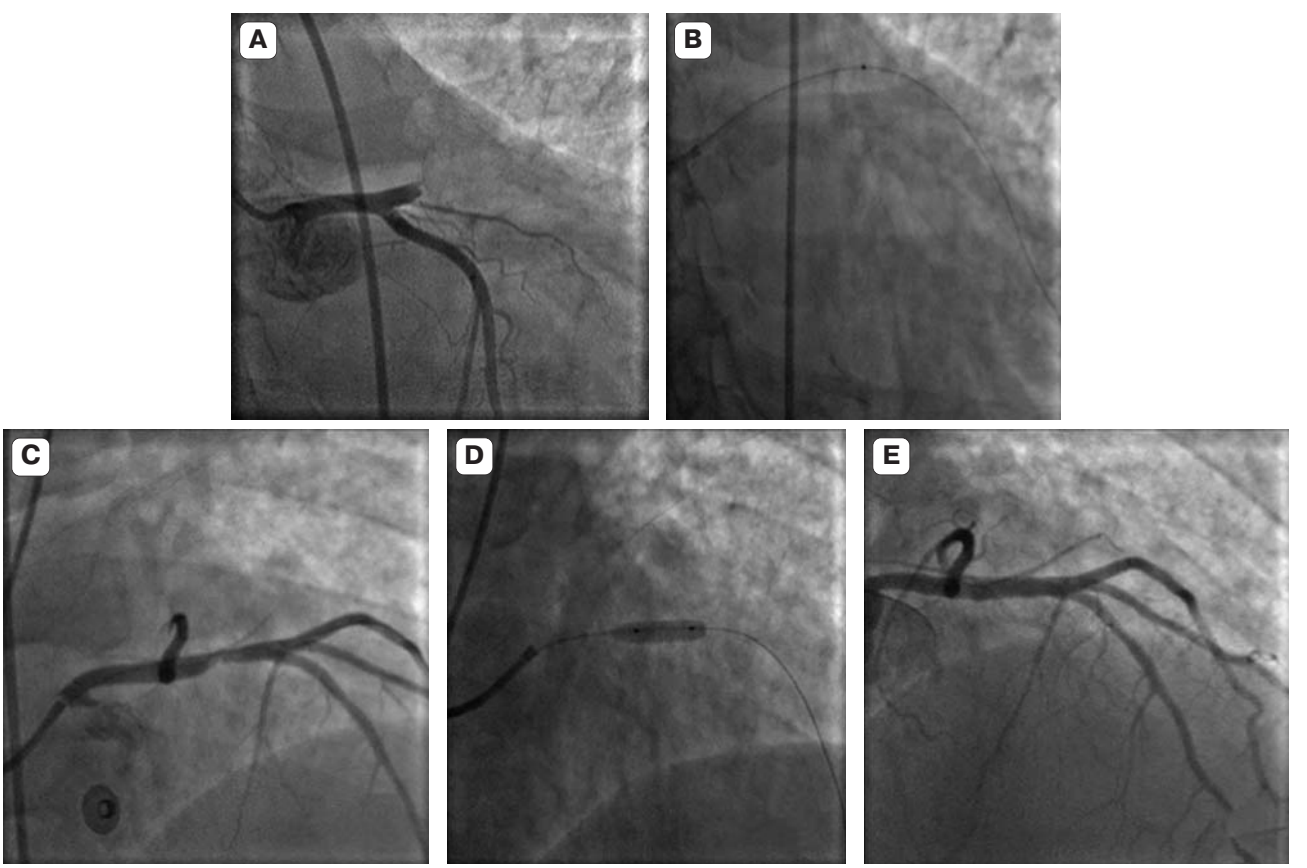


Figure 19. Thrombo-aspiration as default strategy. A) Grade 5 thrombus; B) Thrombo-aspiration performed by Export Catheter; C) Post thrombectomy; D) 4.0 Xience V DES; E) Post stenting.

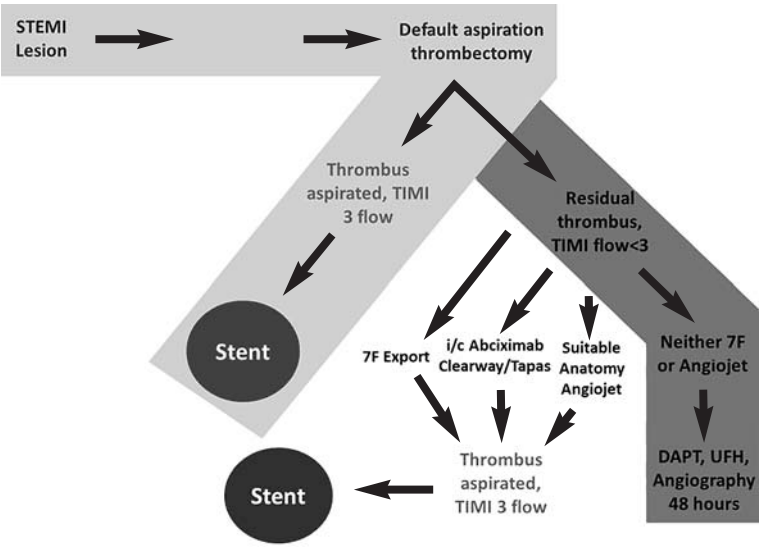


Figure 20. Thrombus management strategy.

out its challenges. We also recognize the numerous variables that affect thrombus presentation in STEMI and the heterogeneity of thrombus and of its over-simplification. Yet, this topic deserves further attention as interventional management of soft, red, early thrombus is quite different than that of dense, organized thrombus.

Discussion

With early hospital triage and pre-hospital management, a STEMI procedure involves managing white thrombus that is relatively easy to treat. With less developed STEMI management pathways and delayed treatment, operators confront dense, organized thrombus that requires more cumbersome thrombectomy techniques. Figure 20 depicts how management of the dynamic thrombus varies in different STEMI systems. The grey area in the figure demonstrates efficient and organized systems. In such organized pathways, patients present early, intelligent ambulance systems exist, pre hospital management is present and the efficient pathway confronts the white, less organized thrombus. It is usual to have maximal benefit from simple thrombectomy devices in this group. As is depicted in the figure, several of these early presenting patients, in particular, those that have been treated with effective antiplatelet and anti-coagulants, will demonstrate TIMI 3 throw and thrombus removal with simple thrombectomy techniques. This differentiation clearly demonstrates how an efficient STEMI process contributes to an easier and better STEMI procedure. Creating an intelligent ambulance system and educating the patient contributes to improved procedural results with better management of thrombus. In the red section depicted in Figure 20, and often seen in developing countries, the STEMI process is disorganized and there are considerable system delays. The dynamic thrombus continues to proceed to a red thrombus with erythrocytes and fibrin strands – clearly, these do not disrupt with simple thrombectomy techniques and simply cannot be suction by mere application of syringe-based thrombectomy systems. For such dense, organized thrombus, as advocated in our Thrombus strategy, more intense thrombectomy techniques, included mechanical thrombectomy may be required. Figure 20 also describes a flow chart for interventional options when there is residual thrombus and less than TIMI 3 flow. An essential component of this strategy is to avoid stenting in the presence of residual thrombus.

Thrombus burden (TB) has been shown to adversely affect clinical outcomes in both cerebrovascular accidents and acute coronary syndromes (25–28). Barreto et al. undertook a retrospective review of stroke patients and correlated the clinical outcomes to the angiographic TB, using the same classification scheme outlined in Table 1. As compared to the patients with thrombus grades 0–3, patients with thrombus grade 4 required longer treatment times, and experienced increased mechanical clot disruption, poor outcomes, and mortality (29). Using the same classification scheme, Sianos et al demonstrated in their landmark work the importance of TB in clinical outcomes in acute coronary syndromes.(17) Compared to small TB (grades 0–3), they found that large intra-

coronary TB (grade 4) was an independent predictor of mortality and major adverse cardiovascular event (MACE). Evidently, clinical outcome is dependent upon thrombus burden.

Thrombus removal prior to STEMI intervention has mixed results to standard PCI alone as shown by randomized controlled trials and retrospectives studies as outlined in Table 2. Based on the results from Table 2 it is apparent that prior meta-analyses from both single and multi-center trials such as TAPAS(19), JETSTENT (AngioJET Thrombectomy and STENTing for Treatment of Acute Myocardial Infarction) (20), MUSTELA(30) (MUltidevice thrombectomy in acute *ST*-Segment ELevation Acute myocardial infarction) INFUSE-AMI(31) and SMART-AMI(32) showed both positive negative results with a wide variety of primary endpoints. Lack of consistent primary endpoints across studies also makes interpreting and comparing studies challenging if not impossible.

Despite the mixed clinical outcomes of these trials, we strongly believe that these studies are constrained by having a single strategy for all-comers without volumetric adjustments for thrombus burden. Although philosophically, we remain in complete agreement with the intent to aspirate thrombus, as is clearly demonstrable in the TAPAS trial, we believe that this sole aspiration strategy does not suffice for all thrombus grades and it particularly fails to effectively treat dense, organized thrombus that is commonly seen in delayed presentations. Dense, organized thrombus in late-presenting AMI is the commonest presentation in developing countries that lack sophisticated ambulance systems and STEMI systems of care. In such situations, it is infrequent to find the easy to treat, white thrombus with aspiration thrombectomy, as was demonstrable in the TAPAS trial. Dense, organized thrombus that is present often in these infarct-related vessels is simply too complex to manage with simple, presently available, aspiration catheters. Based upon our work, we strongly consider that such lesions are better managed by mechanical devices, such as the Angiojet® (Possis Medical, Inc., Minneapolis, Minnesota), provided the anatomy is favorable (avoid severe tortuosity and vessels <2.5 mm). So far as clinical support for our selective thrombus management strategy, the drawback of using a single aspiration thrombectomy strategy has been partially corrected in the JETSTENT (AngioJET Thrombectomy and STENTing for Treatment of Acute Myocardial Infarction) trial, which uses angiography to grade the thrombus burden prior to thrombus aspiration and subsequent PCI intervention.(20) Yet, despite using a selective strategy for thrombus intervention, the overall results of the trial provide little advance.

We recognize the scientific observations of the large TASTE (33) trial in which doubts have been raised on thrombectomy. Clearly the Swedish group has performed an exceptional long-term evaluation of thrombectomy in STEMI. Their study is the largest ever evaluation of thrombectomy devices in STEMI. However, it is still our firm believe that thrombectomy is most effective when it is directed in a selective fashion and when selection is based on thrombosis grade. Therefore, not discounting the robust findings we present our viewpoint or a strategy that has been successful employed in the SINCERE database for more that an decade. For almost the same reasons of lacking a selective strategy, we have some reluctance accepting the results of the INFUSE-AMI and MUSTELA trials and are apprehensive of the ongoing TOTAL (34) trial, another large outcome study investigating the role of manual aspiration for similar reasons.

A recent single center experience in elderly patients evaluating the use of thrombus aspiration in STEMI was conducted in Italy by Valente et al., 2013, using Mechanical (Export Medtronic device) or Rheolyctic (AngioJet) devices (35). They found that in elderly STEMI patients thrombus aspiration in PPCI was associated with a better survival rate at 1-year follow-up. Thrombus aspiration has proven to be a safe procedure, because there is no significant difference in the incidence of acute kidney injury and bleeding. Although the group that underwent thrombectomy had a lower grade of TIMI flow pre PCI, there was no difference in TIMI flow post PCI and there was an increased incidence of *ST* resolution >50% in the thrombectomy patients. Therefore this suggests a beneficial effect of thrombus aspiration on coronary flow and myocardial reperfusion.

A meta-analysis by Costopoulos et al. 2013 evaluated the advantages of using thrombectomy devices in PPCI STEMI patients. According to them, the use of manual thrombectomy devices is associated with significant improvements in *ST*-segment resolution (STR) ($p < 0.00001$), Myocardial Blush Grade (MBG) 3 ($p < 0.00001$), Thrombolysis in Myocardial Infarction (TIMI) grade 3 flow ($p = 0.01$) as well as clinical parameters (43% reduction in mortality, $p = 0.04$) in patients undergoing PPCI (36).

Table 2. Trials of thrombus aspiration

Study	Thrombectomy device	Primary and clinical endpoints
ASPIRATION THROMBECTOMY		
INFUSE-AMI 2012 (31)	Export®	(=) IS
TROFI 2012(54)	Eliminate	(=) minimum flow area
Ciszewski et al 2011(38)	Rescue/Diver C.E.	(+) Myocardial salvage, (=) In-hospital mortality
TOTAL 2010(34)	Export®	Ongoing
TASTE 2010 (33)	Export®	(=) 30-day mortality
EXPIRA 2009 (39,40)	Export®	(+) MBG >2, (+) STR, (+) IS, (+) 2-yr CD, (+) 2-yr MACE
Liistro et al 2009 (41)	Export®	(+) STR, (=) 6-month MACE
Lipiecki et al (42)	Export®	(=) IS
TAPAS 2008 (19)	Export®	(+) MBG 0-1, (+) STR, (+) 1-yr mortality, (+) 1-yr CD
EXPORT (44)	Export®	(+) MBG 3, (+) STR, (=) 30-day MACCE
VAMPIRE 2008 (45)	TVAC	(+ trend) SR/NR, (+) 8-month MACE
Chao et al 2008 (46)	Export®	(+) TIMI flow, (+) MBG
PIHRATE 2008 (47)	Diver C.E.	(=) STSR, (=) 6-month mortality
Anderson et al (48)	Rescue	(+) Left ventricular function
Dudek et al 2006 (49)	Rescue	(+) TIMI 3 flow, (+) MBG 3
Kaltoft el al. 2006 (50)	Rescue	(–) Myocardial salvage, (=) 30-day MACE
DEAR-MI 2006(51)	Pronto	(+) MBG 3, (+) STR, (=) 30 – day MACE
De Luca et al 2006(52)	Diver C.E.	(+) TIMI flow, (+) MBG 3, (+) 30-day MACE
REMEDIA 2005(53)	Diver C.E.	(+) STR, (+) MBG ⩾2
MECHANICAL THROMBECTOMY		
MUSTELA 2011(30)	AngioJet®	(+) STR, (=) IS, (=) 1-yr MACE
SMART-PCI 2011(32)	AngioJet®	(=) STR, (+) TIMI flow
JETSTENT 2010 (55)	AngioJet®	(+) STR, (=) IS, (+) 1-yr MACE
AIMI 2006 (56)	AngioJet®	(+) IS, (–) TIMI flow, (–) MBG, (–) STR, (–) 30 – day MACE
X-AMINE ST 2005(57)	X-Sizer	(–) IS, (–) TIMI flow, (–) 30-day MACE
Antoniucci et al 2004(20)	AngioJet®	(+) STR, (–) 30-day MACE
Napodano et al(58)	X-Sizer	(+) MBG 3, (=) 30-day MACE
Beran et al(59)	X-Sizer	(+) STR, (=) 30-day MACE

TRIALS OF THROMBUS ASPIRATION: (+), improved endpoint; (=), neutral effect on endpoint; (–) worsened endpoint. Abbreviations: AIMI, AngioJet Rheolytic Thrombectomy in Patients Undergoing Primary Angioplasty for Acute Myocardial Infarction; CD, cardiac death; DEAR-MI, Dethrombosis to Enhance Acute Reperfusion in Myocardial Infarction; EXPIRA, Thrombectomy With Export Catheter in Infarct-Related Artery During Primary Percutaneous Coronary Intervention; EXPORT, Prospective, Multicentre, Randomized Study of the Export Aspiration Catheter; INFUSE-AMI, Intracoronary Abciximab and Aspiration Thrombectomy in Patients with Large Anterior Myocardial Infarction; IS, infarct size; JETSTENT, Comparison of AngioJet Rheolytic Thrombectomy Before Direct Infarct Artery Stenting With Direct Stenting Alone in Patients With Acute Myocardial Infarction; MACE, major adverse cardiac event MACCE, major adverse cardiac and cerebral events; MBG, myocardial blush grade; MUSTELA, Multidevice Thrombectomy in Acute *ST*-Segment ELevation Acute Myocardial Infarction; NR, no-reflow; PIHRATE, Polish-Italian-Hungarian Randomized Thrombectomy Trial; REMEDIA, Randomized Evaluation of the Effect of Mechanical Reduction of Distal Embolization by Thrombus Aspiration in Primary and Rescue Angioplasty; SMART-PCI, Comparison of Manual Aspiration With Rheolytic Thrombectomy in Patients Undergoing Primary PCI; SR, slow-reflow; STR, *ST*-segment resolution; TAPAS, Thrombus Aspiration During Percutaneous Coronary Intervention in Acute Myocardial Infarction Study; TASTE, Thrombus Aspiration in *ST*-Elevation myocardial infarction in Scandinavia; TIMI, thrombolysis in myocardial infarction flow grade; TOTAL, A Trial of Routine Aspiration Thrombectomy With Percutaneous Coronary Intervention (PCI) Versus PCI Alone in Patients With *ST*-Segment Elevation Myocardial Infarction Undergoing Primary PCI; TROFI, Effect of Thrombus Aspiration on Flow Area in STEMI Patients; VAMPIRE, Vacuum Aspiration Thrombus Removal; X-AMINE *ST*, X X-sizer in AMI for Negligible Embolization and Optimal *ST* Resolution.

Table 5. Step-By-Step Technique for Stemi Interventions

Step	Technique	Comments
1.	Obtain a clean, 6F arterial access	Routinely from the right femoral route (radial route for failed attempt with both groins, and for selected pharmaco-invasive, transfer patients)
2.	Cineangiography with 6F diagnostic catheter of the non-infarct-related vessel	Two orthogonal views for LCA and a single LAO projection for the RCA
3.	6 Fr guiding catheter for culprit vessel cannulation	Obtaining set-up shots that precisely define the occluded segment
4.	Hydrophilic 0.014-inch guide wire	Particularly useful for crossing thrombotic lesions
5.	Accurately assessing thrombus grade and using a selective thrombectomy strategy	Direct stenting for low grade thrombus, thrombo-aspiration for moderate thrombus and mechanical thrombectomy for large thrombus burden
6.	Abciximab for large thrombus burden	Preferably via intra-coronary use
7.	Stenting	DES for LAD, diabetic, long lesions and small vessels
8.	Liberal intracoronary nitroprusside	After confirming satisfactory stent result and removing the guide wire
9.	Left ventriculography	In RAO projection
10.	Sheath removal	With closure device
	Preferred Rheolytic Mechanical Thrombectomy	
A	For thrombus Grade 4 and 5	
B	In large vessels with voluminous thrombus	
C	SVG STEMI interventions	
D	For treating dense, organized thrombus, in particular, in patients that present late	
E	Failure to treat thrombotic lesions with aspiration thrombectomy	

Since thrombus burden or grade can be quickly assessed angiographically, a thrombus-grade approach is practical. This is the major advantage of the Mehta Strategy (Table 3) as it provides a selective strategy for thrombus management, based upon the thrombus grade. This methodology contradicts the notion that thrombus can be managed by a single modality, as proposed by the TAPAS Trial that used thrombo-aspiration as an effective strategy, irrespective of the thrombus grade (19). In this manuscript, we present numerous cases that support our rationale for a selective, thrombus-grade based strategy. Specifically, we cite numerous procedures where dense, organized thrombus could not be effectively managed by thrombo-aspiration, instead requiring a change to mechanical thrombectomy. Table 4 outlines available thrombectomy devices for STEMI and PCI. In Table 5, we have identified five distinct situations where the use of mechanical thrombectomy appears mandatory. In fact, some of the most memorable successes in the SINCERE database employed these tenets. The situation with organized, dense thrombus in late-presenting STEMI patients is the most noteworthy of these cases. These can be extremely difficult cases and their management - from crossing the impenetrable lesions to debulking them, requires considerable skills, and often, mechanical thrombectomy. Based on the aforementioned meta-analyses, aspiration threombectomy is a class IIa recommendation with level of evidence B in the 2013 ACCF/AHA STEMI guidelines (37).

Conclusion

The management of thrombus in STEMI interventions is of paramount importance. To accomplish this complex task successfully, a systematic approach is necessary. Due to the dynamic nature of thrombosis formation, an interventional approach must incorporate a thrombus grading system, which also integrates mechanical adjunct devices. The limitations of equivocal clinical results from multiple trials fails to endorse the true potential of mechanical adjunct devices for STEMI intervention. The Mehta strategy skillfully tackles this problem. Ultimately the Mehta strategy is offered as: a selective strategy for thrombus management in STEMI interventions based upon the thrombus grade, with direct stenting recommended for low grade thrombus, thrombo-aspiration for moderate thrombus, and rheolytic thrombectomy for high grade thrombus (depending upon suitable anatomy). The algorithm has produced, a thrombus-graded adjunct device approach to managing thrombus burden, which has produced excellent clinical results as demonstrated in the SINCERE database.

References

1. Ellis S.G., Roubin G.S., King S.B., 3rd et al. Angiographic and clinical predictors of acute closure after native vessel coronary angioplasty. Circulation, 1988, 77(2), 372–379.
2. Singh M., Berger P.B., Ting H.H. et al. Influence of coronary thrombus on outcome of percutaneous coronary angioplasty in the current era (the Mayo Clinic experience). Amer. J. Cardiol., 2001, 88 (10), 1091–1096.
3. Mabin T.A., Holmes D.R. Jr., Smith H.C. et al. Intracoronary thrombus: role in coronary occlusion complicating percutaneous transluminal coronary angioplasty. J. Amer. Coll. Cardiol., 1985, 5 (2 Pt 1), 198–202.
4. White C.J., Ramee S.R., Collins T.J. et al. Coronary thrombi increase PTCA risk. Angioscopy as a clinical tool. Circulation. 1996, 93 (2), 253–258.
5. Tamhane U.U., Chetcuti S., Hameed I. et al. Safety and efficacy of thrombectomy in patients undergoing primary percutaneous coronary intervention for acute *ST* elevation MI: a meta-analysis of randomized controlled trials. BMC Cardiovasc Disord., 2010, 10, 10.
6. Mongeon F.P., Belisle P., Joseph L. et al. Adjunctive thrombectomy for acute myocardial infarction: A bayesian meta-analysis. Circ Cardiovasc Interv. , 2010, 3 (1), 6–16.
7. Mehta S., Kostela J.C., Oliveros E., Flores A.I. Compulsive Thrombus Management in STEMI Interventions. Intervent. Cardiol. Clin., 2012, 1 (4), 485–505.
8. Kumar V A.A., Fausto N., Robbins S.L., Cotran R.S. Robbins and Cotran pathologic basis of disease. 7th ed. Philadelphia: Elsevier Saunders, 2005.
9. Falk E., Shah P.K., Fuster V. Coronary plaque disruption. Circulation, 1995, 92 (3), 657–671.
10. Furie B., Furie B.C. Mechanisms of thrombus formation. New Engl. J. Med., 2008, 359 (9), 938–949.
11. Friedman M., Van den Bovenkamp G.J. The pathogenesis of a coronary thrombus. Amer. J. Pathol., 1966, 48 (1), 19–44.
12. DeWood M.A., Spores J., Notske R. et al. Prevalence of total coronary occlusion during the early hours of transmural myocardial infarction. New Engl. J. Med., 1980, 303 (16), 897–902.
13. Davies M.J., Thomas A. Thrombosis and acute coronary-artery lesions in sudden cardiac ischemic death. New Engl. J. Med., 1984, 310 (18), 1137–1140.
14. Davies M.J., Thomas A.C. Plaque fissuring--the cause of acute myocardial infarction, sudden ischaemic death, and crescendo angina. Brit. Heart J., 1985, 53 (4), 363–373.
15. Horie T., Sekiguchi M., Hirosawa K. Coronary thrombosis in pathogenesis of acute myocardial infarction. Histopathological study of coronary arteries in 108 necropsied cases using serial section. Brit. Heart J., 1978, 40 (2), 153–161.
16. Grines C.L., Browne K.F., Marco J. et al. A comparison of immediate angioplasty with thrombolytic therapy for acute myocardial infarction. The Primary Angioplasty in Myo-

cardial Infarction Study Group. New Engl. J. Med., 1993, 328 (10), 673–679.
17. Sianos G., Papafaklis M.I., Daemen J. et al. Angiographic stent thrombosis after routine use of drug-eluting stents in *ST*-segment elevation myocardial infarction: the importance of thrombus burden. J. Amer. Coll. Cardiol., 2007, 50 (7), 573-583.
18. Mehta S., Alfonso C., Oliveros E., Briceno R., Pena C. Lesson from th Single INdividual Community Experience REgistry for Primary PCI (SINCERE) Database. In: Kappur R, ed. Texbook of STEMI Interventions. 2 ed. Malvern: HMP Communications; 2010, 131–148.
19. Svilaas T., Vlaar P.J., van der Horst I.C. et al. Thrombus aspiration during primary percutaneous coronary intervention. New Engl. J. Med., 2008; 358 (6), 557–567.
20. Antoniucci D., Valenti R., Migliorini A. et al. Comparison of rheolytic thrombectomy before direct infarct artery stenting versus direct stenting alone in patients undergoing percutaneous coronary intervention for acute myocardial infarction. Amer. J. Cardiol., 2004, 93 (8), 1033–1035.
21. Whisenant B.K., Baim D.S., Kuntz R.E., Garcia L.A., Ramee S.R., Carrozza J.P. Rheolytic thrombectomy with the Possis AngioJet: technical considerations and initial clinical experience. J. Invasive Cardiol., 1999, 11 (7), 421–426.
22. Margheri M., Falai M., Vittori G. et al. Safety and efficacy of the AngioJet in patients with acute myocardial infarction: results from the Florence Appraisal Study of Rheolytic Thrombectomy (FAST). J. Invasive Cardiol., 2006, 18 (10), 481–486.
23. Kuntz R.E., Baim D.S., Cohen D.J. et al. A trial comparing rheolytic thrombectomy with intracoronary urokinase for coronary and vein graft thrombus (the Vein Graft AngioJet Study (VeGAS 2)). Amer. J. Cardiol., 2002, 89 (3), 326–330.
24. Steg P.G., Bonnefoy E., Chabaud S. et al. Impact of time to treatment on mortality after prehospital fibrinolysis or primary angioplasty: data from the CAPTIM randomized clinical trial. Circulation, 2003, 108 (23), 2851–2856.
25. Rezkalla S.H., Kloner R.A. No-reflow phenomenon. Circulation, 2002, 105 (5), 656–662.
26. Okamura A., Ito H., Iwakura K. et al. Detection of embolic particles with the Doppler guide wire during coronary intervention in patients with acute myocardial infarction: efficacy of distal protection device. J. Amer. Coll. Cardiol., 2005, 45 (2), 212–215.
27. Fukuda D., Tanaka A., Shimada K. et al. Predicting angiographic distal embolization following percutaneous coronary intervention in patients with acute myocardial infarction. Amer. J. Cardiol., 2003, 91(4), 403–407.
28. Tanaka A., Kawarabayashi T., Nishibori Y. et al. No-reflow phenomenon and lesion morphology in patients with acute myocardial infarction. Circulation, 2002, 105 (18), 2148–2152.
29. Barreto A.D., Albright K.C., Hallevi H. et al. Thrombus burden is associated with clinical outcome after intra-arterial therapy for acute ischemic stroke. Stroke, 2008, 39 (12), 3231–3235.
30. De Carlo M., Aquaro G.D., Palmieri C. et al. A prospective randomized trial of thrombectomy versus no thrombectomy in patients with *ST*-segment elevation myocardial infarction and thrombus-rich lesions: MUSTELA (MUltidevice Thrombectomy in Acute *ST*-Segment ELevation Acute Myocardial Infarction) trial. JACC. Cardiovascular interventions, 2012, 5 (12), 1223–1230.
31. The INFUSE-Anterior Myocardial Infarction (AMI) Study. ClinicalTrials.gov - A service of the U.S. National Institutes of Health http://clinicaltrials.gov/ct2/show/NCT00976521. Accessed 02/25/12.
32. Antoniucci D. Comparison of manual aspiration with rheolytic thrombectomy in patients undergoing primary PCI. The SMART-PCI trial. http://clinicaltrials.gov/ct2/show/NCT01281033. Accessed March 26, 2012.
33. Fröbert O., Lagerqvist B., Olivecrona G.K. et al. Thrombus aspiration during *ST*-segment elevation myocardial infarction. N. Engl. J. Med., 2013, 369 (17), 1587–1597.
34. Jolly S. TOTAL trial: A Trial of Routine Aspiration Thrombectomy With Percutaneous Coronary Intervention (PCI) Versus PCI Alone in Patients With *ST*-Segment Elevation Myocardial Infarction (STEMI) Undergoing Primary PCI http://www.clinicaltrials.gov/ct2/show/NCT01149044. Accessed Jan 1, 2014.
35. Valente S., Lazzeri C., Mattesini A. et al. Thrombus aspiration in elderly STEMI patients: A single center experience. Intern. J. Cardiol., 2013, 168 (3), 3097–3099.
36. Costopoulos C, Gorog DA, Di Mario C, et al. Use of thrombectomy devices in primary percutaneous coronary intervention: a systematic review and meta-analysis.
Intern. J. Cardiol., 2013, 163 (3), 229–241.
37. O'Gara P.T., Kushner F.G., Ascheim D.D. et al. 2013 ACCF/AHA guideline for the management of *ST*-elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J. Amer. Coll. Cardiol., 2013, 61 (4), e78–140.
38. Ciszewski M., Pregowski J., Teresinska A. et al. Aspiration coronary thrombectomy for acute myocardial infarction increases myocardial salvage: single center randomized study. Catheter Cardiovasc Interv., 2011, 78 (4), 523–531.
39. Sardella G., Mancone M., Bucciarelli-Ducci C. et al. Thrombus aspiration during primary percutaneous coronary intervention improves myocardial reperfusion and reduces infarct size: the EXPIRA (thrombectomy with export catheter in infarct-related artery during primary percutaneous coronary intervention) prospective, randomized trial. J. Amer. Coll. Cardiol., 2009, 53 (4), 309–315.
40. Burzotta F., De Vita M., Gu Y.L. et al. Clinical impact of thrombectomy in acute ST-elevation myocardial infarction: an individual patient-data pooled analysis of 11 trials. Eur .Heart J., 2009, 30 (18), 2193–2203.
41. Liistro F., Grotti S., Angioli P. et al. Impact of thrombus aspiration on myocardial tissue reperfusion and left ventricular functional recovery and remodeling after primary angioplasty. Circ. Cardiovasc. Interv., 2009, 2 (5), 376–383.
42. Lipiecki J., Monzy S., Durel N. et al. Effect of thrombus aspiration on infarct size and left ventricular function in high-risk patients with acute myocardial infarction treated by percutaneous coronary intervention. Results of a prospective controlled pilot study. Amer. Heart J., 2009, 157 (3), 583 e1–7.
43. Vlaar P.J., Svilaas T., van der Horst I.C. et al. Cardiac death and reinfarction after 1 year in the Thrombus Aspiration during Percutaneous coronary intervention in Acute myocardial infarction Study (TAPAS): a 1-year follow-up study. Lancet, 2008, 371 (9628), 1915–1920.

44. Chevalier B., Gilard M., Lang I. et al. Systematic primary aspiration in acute myocardial percutaneous intervention: a multicentre randomised controlled trial of the export aspiration catheter. EuroIntervention, 2008, 4 (2), 222–228.
45. Ikari Y., Sakurada M., Kozuma K. et al. Upfront thrombus aspiration in primary coronary intervention for patients with ST-segment elevation acute myocardial infarction: report of the VAMPIRE (VAcuuM asPIration thrombus REmoval) trial. JACC. Cardiovascular interventions, 2008, 1 (4), 424–431.
46. Chao C.L., Hung C.S., Lin Y.H. et al. Time-dependent benefit of initial thrombosuction on myocardial reperfusion in primary percutaneous coronary intervention. Int .J. Clin. Pract., 2008, 62 (4), 555–561.
47. Anzai H., Yoneyama S., Tsukagoshi M. et al. Rescue percutaneous thrombectomy system provides better angiographic coronary flow and does not increase the in-hospital cost in patients with acute myocardial infarction. Circ. J., 2003, 67 (9), 768–774.
48. Andersen N.H., Karlsen F.M., Gerdes J.C. et al. No beneficial effects of coronary thrombectomy on left ventricular systolic and diastolic function in patients with acute *ST* elevation myocardial infarction: a randomized clinical trial. J. Am. Soc. Echocardiogr., 2007, 20 (6), 724–730.
49. Kaltoft A., Bottcher M., Nielsen S.S. et al. Routine thrombectomy in percutaneous coronary intervention for acute ST-segment-elevation myocardial infarction: a randomized, controlled trial. Circulation, 2006, 114 (1), 40–47.
50. Silva-Orrego P., Colombo P., Bigi R. et al. Thrombus aspiration before primary angioplasty improves myocardial reperfusion in acute myocardial infarction: the DEAR-MI (Dethrombosis to Enhance Acute Reperfusion in Myocardial Infarction) study. J. Amer. Coll. Cardiol., 2006, 48 (8), 1552–1559.
51. De Luca L., Sardella G., Davidson C.J. et al. Impact of intracoronary aspiration thrombectomy during primary angioplasty on left ventricular remodelling in patients with anterior ST elevation myocardial infarction. Heart, 2006, 92 (7), 951–957.
52. Burzotta F., Trani C., Romagnoli E. et al. Manual thrombus-aspiration improves myocardial reperfusion: the randomized evaluation of the effect of mechanical reduction of distal embolization by thrombus-aspiration in primary and rescue angioplasty (REMEDIA) trial. J. Amer. Coll. Cardiol., 2005, 46 (2), 371–376.
53. Onuma Y., Thuesen L., van Geuns R.J. et al. Randomized study to assess the effect of thrombus aspiration on flow area in patients with *ST*-elevation myocardial infarction: an optical frequency domain imaging study-TROFI trial. Eur. Heart J., 2013, 34 (14), 1050–1060.
54. Dudek D., Mielecki W., Legutko J. et al. Percutaneous thrombectomy with the RESCUE system in acute myocardial infarction. Kardiol. Pol., 2004, 61 (12), 523–533.
55. Migliorini A., Stabile A., Rodriguez A.E. et al. Comparison of AngioJet rheolytic thrombectomy before direct infarct artery stenting with direct stenting alone in patients with acute myocardial infarction. The JETSTENT trial. J. Amer. Coll. Cardiol., 2010, 56 (16), 1298–1306.
56. Ali A., Cox D., Dib N. et al. Rheolytic thrombectomy with percutaneous coronary intervention for infarct size reduction in acute myocardial infarction: 30-day results from a multicenter randomized study. J. Amer. Coll. Cardiol., 2006, 48 (2), 244–252.
57. Lefevre T., Garcia E., Reimers B. et al. X-sizer for thrombectomy in acute myocardial infarction improves ST-segment resolution: results of the X-sizer in AMI for negligible embolization and optimal ST resolution (X AMINE ST) trial. J. Amer. Coll. Cardiol., 2005, 46 (2), 246–252.
58. Napodano M., Pasquetto G., Sacca S. et al. Intracoronary thrombectomy improves myocardial reperfusion in patients undergoing direct angioplasty for acute myocardial infarction. J. Amer. Coll. Cardiol., 2003, 42 (8), 1395–1402.
59. Beran G., Lang I., Schreiber W. et al. Intracoronary thrombectomy with the X-sizer catheter system improves epicardial flow and accelerates *ST*-segment resolution in patients with acute coronary syndrome: a prospective, randomized, controlled study. Circulation, 2002, 105 (20), 2355–2360.

Immediate Results of Invasive Strategies in Patients with Acute Coronary Syndrome

V. A. Ivanov[1] , S.A. Belyakin[1], E.V. Tsymbal[1], A.V. Ivanov[1], I.S. Bazanov[2], S.B. Zharikov[2]*

[1] Federal State Clinical Institution A.A. Vishnevsky 3rd Central Military Clinical Hospital of the Ministry of Defence of the Russian Federation, Krasnogorsk

[2] Department of Hospital Surgery with Pediatric Surgery Course, Peoples' Friendship University of Russia, Moscow

Percutaneous coronary interventions (PCIs) are currently recognized as the most effective treatment options for patients with acute coronary syndrome (ACS). From 2008 to 2012, 496 ACS patients were treated in A.A. Vishnevsky 3rd Central Military Clinical Hospital and 369 subjects out of them underwent PCI. The study results demonstrate that PCI is the highly effective treatment option for patients with acute types of coronary heart disease. The early invasive approach helps to achieve the best immediate results in this subset of patients.

Key words: *acute coronary syndrome, percutaneous coronary intervention.*

List of abbreviations:

ACS – acute coronary syndrome
MI – myocardial infarction
UA – unstable angina
PCI – percutaneous coronary intervention

Over the last decades, wide introduction of reperfusion methods, primarily percutaneous interventions and new medicinal products, into the clinical practice has dramatically changed outcomes in the patients with acute coronary syndrome (ACS) (9, 10). Currently, the early invasive approach is considered as the main treatment option for restoration of adequate myocardial perfusion. From the point of modern knowledge, combined application of interventional cardiology strategies and modern pharmaceutical agents is the "gold standard" for treatment of ACS patients (1, 2).

In cases when there are inconsistencies between clinical electrocardiographic and coronary angiographic data not allowing clear identification of the infarct-related artery, visualization methods (EchoCG) and complex assessment of coronary vessels (intravascular ultrasound, fractional flow reserve) may be successfully used; more frequently this refers to patients with multivessel coronary disease.

* *Address for correspondence:*
Vladimir Aleksandrovich Ivanov
Federal State Clinical Institution A.A. Vishnevsky 3rd Central Military Clinical Hospital of the Ministry of Defence of the Russian Federation
143420, Krasnogorsk, post-office Arkhangelskoye
E-mail: ivanov-angio@yandex.ru
The article was received on February 25, 2014
Accepted for publication March 24, 2014

Usually, patients with multivessel coronary disease, decreased left ventricle ejection fraction, diabetes mellitus, and ACS undergo coronary artery bypass grafting (CABG). Meanwhile, some proportion of these patients may be successfully treated using endovascular techniques.

From 2008 to 2012, 496 patients with acute types of coronary heart disease were observed at the Federal State Clinical Institution A.A. Vishnevsky 3rd Central Military Clinical Hospital of the Ministry of Defence of the Russian Federation, and 132 subjects out of them had confirmed myocardial infarction and 364 – unstable angina (see Table 1).

On admission, all patients underwent diagnostic coronary angiography within the first 2 hours. The treatment strategy for ACS patients was selected by council of specialists including cardiologists, cardiac surgeons and endovascular specialists.

Diagnostic coronary angiography revealed the following lesions: left anterior descending artery and its branches – 33.6% of cases (166 patients), circumflex artery and its branches – 16.8% of cases (83 patients), right coronary artery and its branches – 21.5% of cases (106 patients) (table 2).

In 74% of cases (366 patients) the percutaneous coronary interventions for the target vessel were prioritized. CABG was selected in 26% of cases (127 patients) with multivessel coronary disease and impossibility to determine the ischemia-related artery.

Femoral access was preferably used for diagnostic coronary angiographies and PCIs – 67.8% of cases (336 patients), radial access

Table 1. PCIs and CABGs for MI and UA from 2008 to 2012

	PCI		CABG	
	MI	UA	MI	UA
2008	27	71	4	14
2009	8	35	2	27
2010	22	38	4	17
2011	27	53	4	25
2012	23	65	9	21
Total:	107	262	23	104

Table 2. Characteristics of patients who underwent PCI for MI and UA (n = 496)

Access for coronary angiography/PCI	
Femoral, % (n)	67.8
Radial, % (n)	32.2
Pharmacotherapy during PCI	
Unfractionated heparin, % (n)	96.8
Bivalirudin, % (n)	0.4
IIb/IIIa receptor inhibitors, % (n)	2.8
Ischemia-related artery	
LAD	33.6%
CxA	16.8%
RCA	21.5%
Implanted stents	
Drug eluting stents, % (n)	33.6
Bare metal stents, % (n)	66.4
More than 1 stent implanted, % (n)	27.9
Coronary stent grafts implanted, % (n)	0.4
Thrombus extraction during MI, % (n)	5.2
Complications	
Death, % (n)	0.6
Perforations, % (n)	1.2
Urgent CABG, % (n)	0.6

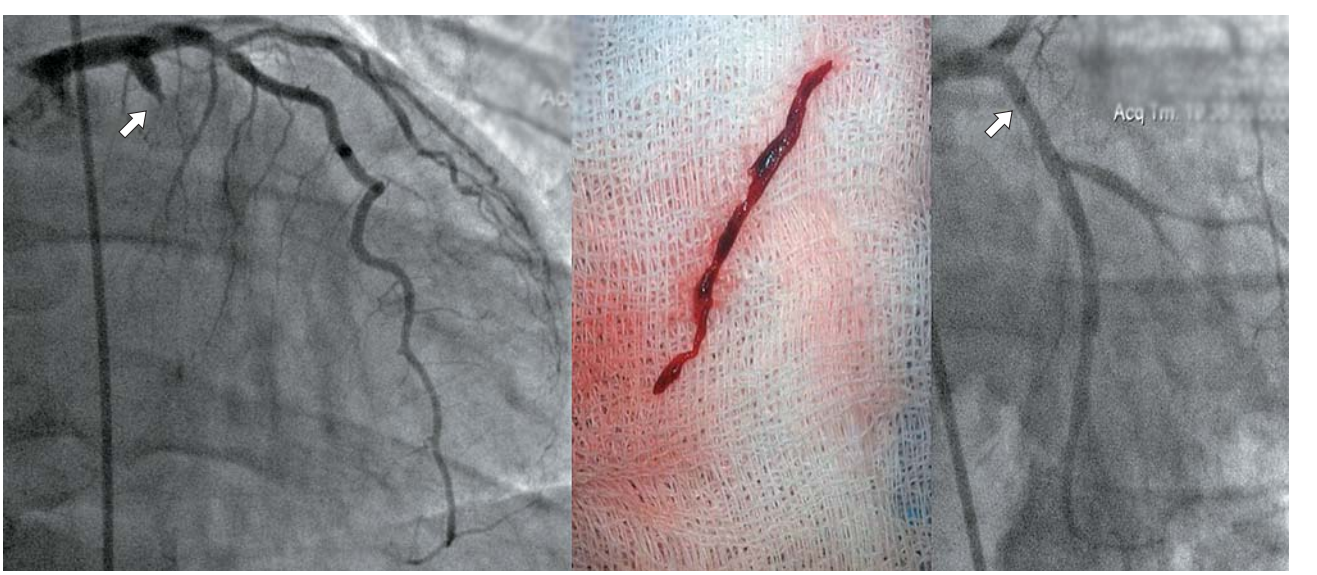


Figure 1. Patient A., 56 y.o. admitted with ST elevation ACS. Coronary angiography detected CxA thrombosis. The thrombus was extracted using thrombus aspiration catheter. Control coronary angiography shows restored CxA blood flow – TIMI III.

was used less frequently – 32.2% of cases (160 patients). Radial access should be routinely used only in patients with high risk of hemorrhagic complications (3), especially when aggressive modern antiaggregant and anticoagulant drugs are used (6).

Thrombus aspiration was used in 24.2% of patients with confirmed MI (Figure). In numerous authors' opinion, this approach helps to reduce significantly the risk of no-reflow caused by distal coronary embolization followed by coronary spasm, thus improving PCI long-term results (4, 5).

Following PCI, restoration of blood flow up to TIMI III was achieved in 98.5% of cases (331 patients). Failed attempts in 1.2% of cases (4 patients) were caused by coronary perforation which required urgent CABG in one patient. One patient developed cardiac arrest, with resuscitation measures which were unsuccessful.

Conclusions

1. ACS patients are indicated for early diagnostic coronary angiography and myocardial revascularization.

2. The decision made by the group of specialists helps to achieve the best clinical outcome and significantly decrease the risk of complications.

3. In emergency settings, PCI is the gold standard, primarily for confirmed myocardial infarction.

References

1. 2011 ACCF/AHA Focused update incorporated into the ACC/AHA 2007 – Guidelines for management of patients with unstable angina/Non ST-elevation myocardial infarction: A Report of American College of Cardiology Foundation/ American Heart Association Task Force on Practice Guidelines. Circulation. 2011, 123, e426–e579.
2. Kushner FG, Hand M et al. 2009 focused updates: ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction (updating the 2004 guideline and 2007 focused update) and ACC/AHA/SCAI guidelines on percutaneous coronary intervention (updating the 2005 guideline and 2007 focused update) a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J. Am. Coll. Cardiol. 2009, 54, 2205–2241.
3. Mehran R, Pocock SJ, Nikolsky E, Clayton T, Dangas GD, Kirtane AJ, Parise H, Fahy M, Manoukian SV, Feit F, Ohman ME, Witzenbichler B, Guagliumi G, Lansky AJ, Stone GW. A risk score to predict bleeding in patients with acute coronary syndromes. J. Am. Coll. Cardiol. 2010, 55, 2556–2566.
4. Svilaas T, Vlaar PJ, van der Horst IC, Diercks GF, de Smet BJ, van den Heuvel AF, Anthonio RL, Jessurun GA, Tan ES, Suurmeijer Am. J,, Zijlstra F. Thrombus aspiration during primary percutaneous coronary intervention. N. Engl. J. Med. 2008, 358, 557–567.
5. Vlaar PJ, Svilaas T, van der Horst IC, Diercks GF, Fokkema ML, de Smet BJ, van den Heuvel AF, Anthonio RL, Jessurun GA, Tan ES, Suurmeijer AJ, Zijlstra F. Cardiac death and reinfarction after 1 year in the Thrombus Aspiration during Percutaneous coronary intervention in Acute myocardial during infarction Study (TAPAS): a 1-year follow-up study. Lancet. 2008, 371, 1915–1920.
6. Stone G.W., Ware J.H., Bertrand M.E. et al. Antithrombotic strategies in patient with acute coronary syndrome undergoing early invasive management: One-year results from the ACUITY trial. JAMA. 2007, 298, 21, 2497–2506.
7. Dundua D.P., Babunashvili A.M., Kavteladze Z.A., Kartashov D.S. et al. Coronary angioplasty for acute coronary syndrome. International Journal of Interventional Cardioangiology. 14, 2008, 37–41.
8. Soloveva N.V., Burova N.N., Glebovskaya T.D., Mikhalchikova N.A. Assessment of one vessel coronary disease probability in patients with non-ST elevation acute coronary syndrome. International Journal of Interventional Cardioangiology. 2012, 28, 48–53.
9. Bokeria L.A., Buziashvili Yu.I., Rabotnikov V.S. et al. Acute coronary syndrome. 2004, 78–99.
10. Oganov R.G. Cardiovascular diseases in the Russian Federation. Cardiology, 2001, 8, 8-11.

Modern Methods of Intravascular Visualization – Strategies of Development, Search of New Technologies

V.V. Demin
Orenburg Regional Clinical Hospital, Orenburg, Russia

Progress of intravascular visualization methods is closely related to development of interventional methods of diagnostics and treatment. Intravascular ultrasound (IVUS) examination traces its origin to the early 80s of the XXth century; commercially available devices for optical coherence tomography (OCT) appeared at the beginning of the XXIst century. Main strategies of possible development of the methods were established already at the dawn of their appearance. N.G. Pandian and T.L. Hsu in 1992 [1] pointed out the following among the prospective ways of development: miniaturization of image systems, development of low-frequency systems to obtain images of cardiac chambers, appearance of forward-looking transducers, multi-frequency ultrasound transducers and multifunctional ultrasound consoles, approach to real-time three-dimensional imaging, conduction of automatic contouring and characteristics of the tissue, studying of myocardial perfusion.

This list remains very topical and precisely reflects the nature of the problem even right now, 20 years later. Some problems are successfully solved, the rest remain the subject of active investigation. Nevertheless, over the last few years alone we observe a tendency towards a real occurrence of new developments; however, this process is not always consistent and not as fast as we would like. For a long time insufficient power of computers which did not allow us to process online enormous aggregation of data related to high-definition images was one of the causes of this situation. The other reason is still topical nowadays: it is the high cost of development of the devices itself which makes it difficult both to conduct research works and to ensure available prices at the output and, therefore, it keeps the volume of purchases down.

* *Address for correspondence:*
Dr. Viktor Demin
Orenburg Regional Clinical Hospital
23, ul. Aksakova, Orenburg, 460024, Russia
E-mail: angiorenvd@mail.ru
Manuscript received on January 15, 2014
Accepted for publication on March 20, 2014

The following strategies of further development of intravascular visualization methods can be pointed out:

- development of methods for reconstruction and representation of data obtained with the help of standard techniques;
- improvement of technical and physical characteristics of transducers;
- creation of new types of transducers;
- development of hybrid catheters combining diagnostic transducers with interventional instruments as well as transducers of various modalities;
- creation of hybrid stations combining several diagnostic modalities.

Each of these trends is future-directed, however, bourgeons of them all in some way are already present nowadays.

Development of methods for reconstruction and representation of data obtained with the help of standard techniques

Nowadays, the only standard opportunity which is provided by commercially available systems for intravascular ultrasound scanning in terms of image reconstruction is construction of a real-time third longitudinal projection. In this context, intravascular ultrasound systems are inferior to almost all modalities present at the visualization market – multispiral computed tomography, magnetic resonance imaging, angiography and optical coherence tomography which has the most similar nature of image. Possibly, three-dimensional image alone is not that topical for IVUS, as the most significant information is hidden inside the lumen. However, there are multiple variants of image representation (semi-cylindrical, clamshell, sectoral, pseudo-angioscopic) which have been

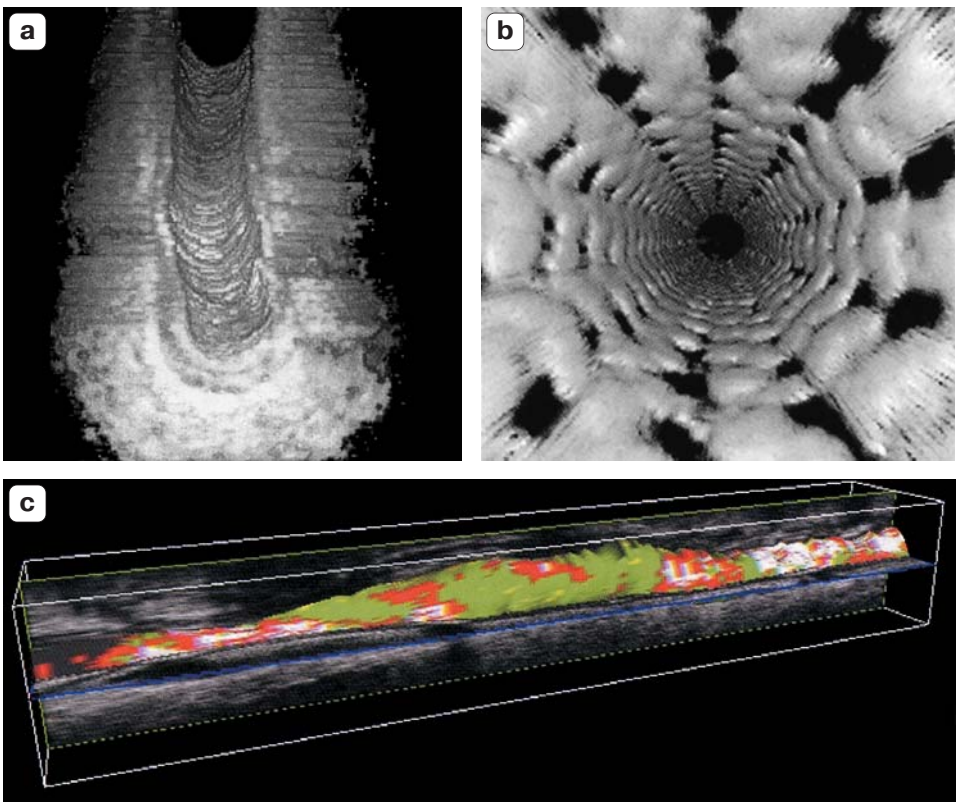


Figure 1. Types of three-dimensional reconstructions of intravascular ultrasound image: a – semi-cylindrical view; b – pseudo-angioscopic image; c – three-dimensional reconstruction of a vessel with visualization of plaque components marked by color in accordance with "virtual histology" data [2, 3].

developed rather long time ago and are implemented in separate stations for processing and synthesis of diagnostic data (Figure 1a, b).

Virtual histology and similar ways of transforming the ultrasound signal make it possible to more vividly present tissues with different acoustic and morphologic density on the final tissue image via color segmentation. However, still a little attention is paid to the fact that fixation of distribution peculiarities of tissues with different density at the cross section is not as important and demonstrative as solid representation. Distribution of plaques along the vessel and into the depth of the wall, rather than the presence of unstable or calcified plaque alone, determines clinical significance of diagnostic findings. Modern systems provide an opportunity to calculate volumetric parameters containing more precise information on the plaque condition before and after the intervention; however, this data is rather uneasy to interpret. Therefore, an image similar to demonstrational ones acquired during the method development would have been of greater clinical interest (Figure 1c).

Although the possibility of three-dimensional IVUS data representation is implemented in the post-processing stations belonging to third-party manufacturers, it probably will be less popular than in OCT analysis due to a poorer detalization related to resolution of the initial image. Combination of standard ultrasound images with three-dimensional model of angiographic image allowing us to demonstrably compare IVUS data with their topographic localization is an interesting compromise. Siemens and Volcano have independently developed two different types of such representation.

The method of optical coherence tomography is significantly more advanced in the issue of three-dimensional data reconstruction. The latest development of St. Jude Medical, Ilumien Optis station, which is positioned by the manufacturer as a fifth generation OCT system is the first device which almost implemented an idea of creating a three-dimensional intravascular image in the online regimen. Many opportunities allowing us to objectively increase the amount of information due to such reconstruction have been implemented: automatic detection of the lumen with corresponding measurements on each chosen shot, reconstruction of luminal profile which allows us to determine the area of maximal narrowing and reference segments in the most precise way, demonstrative construction of a 3D-model with good visualization of the plaque, bifurcation, stent and its pos-

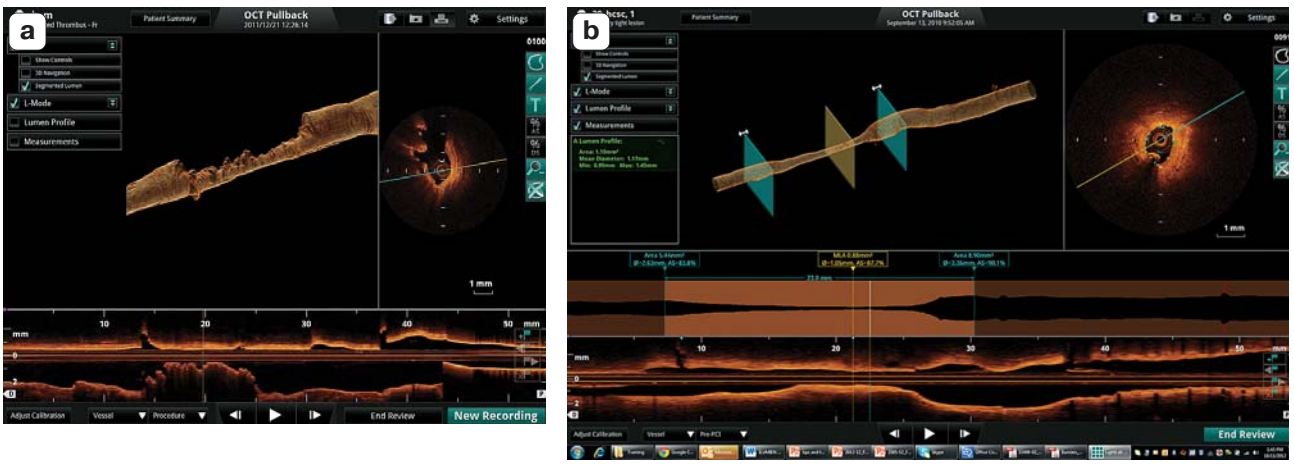


Figure 2. Types of image representation on the monitor of Ilumien Optis station: a – full-scale three-dimensional plaque reconstruction; b – navigation along a three-dimensional image reconstruction, creating a lumen profile synchronously with longitudinal projection.

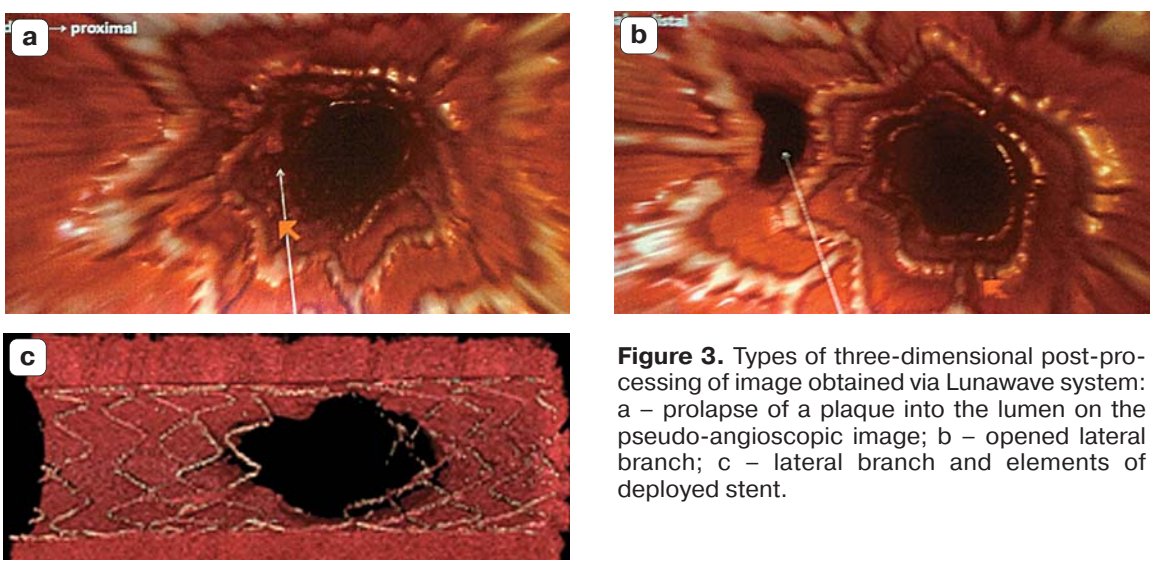


Figure 3. Types of three-dimensional post-processing of image obtained via Lunawave system: a – prolapse of a plaque into the lumen on the pseudo-angioscopic image; b – opened lateral branch; c – lateral branch and elements of deployed stent.

sible deformations, 3D-navigation along the built model similar to one earlier described for IVUS (Figure 2a, b).

The second large OCT market participant, Terumo, for now offers only post-processing using a separate working station for Lunawave system. Conclusive pseudo-angioscopic picture with good visualization of lateral branches, stent malapposition and deformation is a peculiarity of three-dimensional imaging based on Lunawave system data. All developers continue working on automatic fixation of malapposition areas and on quantitative calculation of its area (Figure 3a, b, c).

Enhancement of technical and physical characteristics of transducers

It is the most natural process of development for visualization systems which is continuously taking place. The main controversy which has to be overcome on this way for intravascular ultrasound is as follows: increased frequency of ultrasound signal makes it possible to achieve better resolution ability, while decreasing the depth of sharpness of the visualized space. Therefore, transducers with the highest frequency are able to scan coronary vessels of small and medium diameter and can be hardly used even for the left main coronary artery. Vice versa, transducers able to scan aorta are significantly inferior to coronary ones in terms of visualizing the wall. Actually, current generation of transducers does not fundamentally differ from those that have been there ten and twenty years ago. Phase-electronic transducers have stopped their development at 20 MHz, mechanical – at 40–45 MHz depending on the manufacturer. Evolutionary development of transducers includes a gradual decrease in the profile of the carrier catheter, variations with its tip, emergence of additional labels for easier manipulations. Volcano prepares moderniza-

tion of the software product which will improve the quality of the image obtained via Revolution mechanical transducer. Clinical implementation of high-definition intravascular ultrasound (HD-IVUS) can become a possible fundamental step. Informative image value of this method which operates at the frequency of 60 MHz is approaching to OCT in a number of parameters, with almost the same speed of broach taking place in the blood and not in the replacement fluid. Boston Scientific also prepares a new generation of transducers of higher frequency (50 kHz) which will be combined with a new mechanism of broaching.

A fundamental step in OCT systems included transition from occluding catheters requiring temporary interruption of blood flow to the systems allowing to shoot during administration of the contrast medium due to a high broach speed of transducer. After that, broach systems and software became subject to changes to a greater extent than catheters, which made it possible to increase the speed up to 36 mm/sec (St. Jude Medical) and 40 mm/sec (Terumo), the broach length – to 75 and 150 mm, respectively, frame frequency – to 180 and 160 fps. There are prognoses of possible increase in broach speed up to 100 mm/sec.

Creation of new types of transducers

Creation of new types of transducers extending the borders of method opportunities is of great interest. Development of intravascular ultrasound catheter with controlled tip that eventually could provide a possibility to perform investigation or intervention without X-ray control is also one of the prospective tasks. This could significantly increase the availability of IVUS and make it feasible even in the intensive care unit. Such catheters for intracardiac ultrasound investigations have been already designed (AccuNav, Siemens).

One of the most expected innovations is creation of forward-looking transducer. Such transducers, on one hand, would allow us to estimate parameters of recanalized segment and to pre-select the optimal size of balloons and stents, and on the other hand, they could provide valuable information on the nature of occluding substrate, the presence of "weak points" in it, and would make it possible to control the process of recanalization (e.g., by being introduced over the hydrophilic guide wire). For the past few years we have been expecting the first commercial forward-looking Volcano transducer compatible with s5 platform. Based on preliminary information, the first generation catheter PreView must have carried a mechanical transducer with operating frequency of 45 MHz (Figure 4a, b, c). The second generation version of the transducer is even more interesting, it is an example of integrated catheter and it also must have included an electrode for radiofrequency ablation. This could have provided new opportunities in recanalization of chronic occlusions. In May 2013, at the PCR congress, the release of the next version of s5 platform compatible with this transducer was announced. Unfortunately, by the end of 2013 it was reported about the suspension and even discontinuation of research on this device.

At the same time, Volcano continues its work on preparing the new kind of transducers for focused acoustic tomography (FACT) for the clinical use. Their image quality is also aimed at intermediate between IVUS and OCT, combining the advantages of both methods.

Active research is also conducted with other technologies. Prototypes of transducers based on harmonic tissue visualization have been created and have shown encouraging results in the experiment on animals. Due to this technology, obtained reflected ultrasound signal contains the most harmonious impulses out of those emitted due to nonlinear sound propagation. Image quality improves due to combination of low harmonic component in the near field, narrowing of the beam and reduction of the side lobes level. Such transducers are used in echocardiography, studies for IVUS are ongoing.

One more method used in low-frequency ultrasound systems is ultrasound imaging with the use of contrast media. The experiment has demonstrated that contrast IVUS has a potential of visualizing vasa vasorum in the coronary arteries and molecular composition of atherosclerotic plaques.

MicroOCT (μOCT) method is one of the most interesting innovations. Unique resolution (1-2 μm) gives images rather similar to histological ones. Meanwhile, it is hard to say how difficult and surmountable are technological aspects of this technique for wide implementation.

Creation of hybrid catheters combining diagnostic transducers with interventional instruments as well as transducers of various modalities

The first device which actually combined two methods and gave a new level of information was IVS system combining IVUS with laser spectroscopy. It should be noted that for the comfort of data interpretation an overlay of

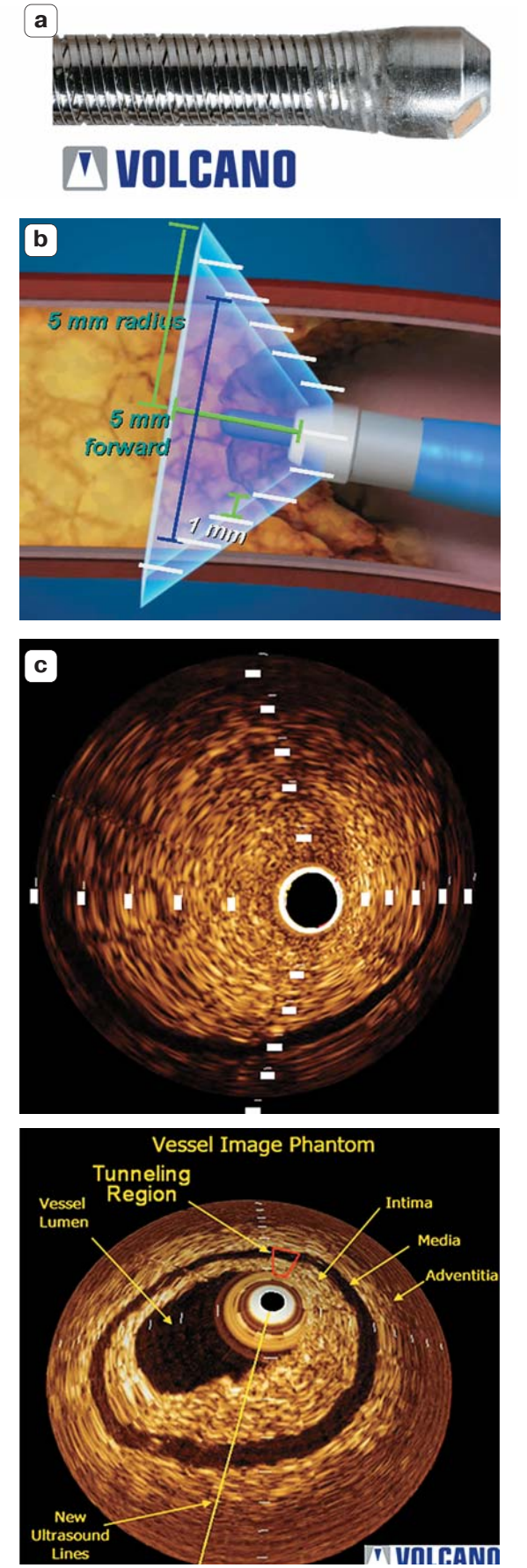


Figure 4. Prospective forward-looking Volcano transducer: a – appearance; b – principle diagram; c – examples of images.

hemogram on the longitudinal vessel reconstruction has been developed besides the circular hemogram of the vascular wall in the visualized section. Comparison of anatomy with the chemical composition of the vascular wall, detection of areas with high lipid content can assist in the prognosis of disease development, including the borderline plaque size. There are attempts of more obvious data representation in the form of 3D-image, including combination with CT-angiography data.

IVS system is of great importance since it was the first to demonstrate the possibility of successful positioning of two different transducers on one carrier catheter without compromising the latter. In the future this way, probably, will become one of the most prospective ones. Combination of IVUS and OCT is one of the most expected ones in this list. There are studies which demonstrated that combination of high informative value of OCT regarding intraluminal structures and IVUS regarding the layers of the vascular wall may be rather useful for diagnostics. However, these studies were based on rather time-consuming post-processing of images successively obtained via two devices. At this point, technological problems associated with optimal mutual positioning of transducers on one catheter while maintaining its rather low profile have not been solved. Unsolved patent issues, probably, also play their part. Nevertheless, potential of such combination is extremely high and, therefore, the issues will be solved. Other possible combinations which are also being developed are OCT and laser spectroscopy, IVUS and photoacoustic imaging.

Besides hybrid diagnostic devices, the efforts to create a combination of ultrasound catheter with various interventional tools have been sustained for many years. Among them one can name combination of IVUS transducers with tools for atherectomy, rotablation, laser recanalization, brachytherapy. All these variants turned out non-viable both due to technological problems and poor demand for the specified systems. The simplest out of such combinations – IVUS transducer and coronary balloon – is of much higher clinical interest. In systems with phase-electronic transducers (EndoSonics/Jomed/Volcano), this idea has been repeatedly discussed for many years. In early version of the system three types of balloon catheters with ultrasound transducers (Oracle, Focus, MegaSonics) have been used at once. Profile and convenience of these catheters were far

from ideal ones. Balloon MegaSonics Five 64 with much lower profile was introduced with appearance of In-Vision system and its later modifications. However, placement of transducer proximal to the balloon has been and remains a significant disadvantage in all generations of balloons. In practical work this meant that balloon had to be placed rather distally into the coronary vessel when using a catheter for control which could cause spasm, and sometimes it was even impossible due to a lack of space. New version of balloon for S5 system is called VIBE. Transducer on this catheter is also situated proximal to the balloon. However, if previous balloons were 20 mm long, VIBE balloons are shortened to 15 mm, and non-compliant NC VIBE balloons which should have been released do not exceed 8 mm at all. This, certainly, made the use of catheters more convenient and better adapted to the task of postdilation in the stent. Balloons were also notable for good profile exceeding the one in purely diagnostic catheters. Nevertheless, it was reported that this area of research was also suspended by the manufacturer and production of balloons was discontinued.

We believe that transducers located inside the balloon would be the most convenient in use and valuable in terms of information, but such designs have not gotten anywhere beyond experimental models yet.

One more idea which was successfully implemented by using phase-electronic transducers is 3 in 1 system JoSonics – a combination of ultrasound transducer and Jostent stent. This quite successful and viable combination, especially considering a rather big choice of stent sizes, ceased to exist after Jomed has sold its IVUS manufacturing to Volcano.

Finally, one more interesting combined device is called Pioneer catheter by Volcano. It implements combination of phase-electric ultrasound transducer with systems for subintimal recanalization. Ultrasound control allows maximal control of such recanalization. High profile of the device (7 F) is its limitation, it can be used only in the peripheral arteries. Moreover, the system is not registered for use in Russia.

Creation of hybrid stations combining several diagnostic modalities

Integration of IVUS into the angiographic complexes within the past years has become a widespread event, and versions of IVUS stations consisting of blocks, placed directly in front of the operator or in the control room, are compatible with almost all major angiographic apparatuses. At the same time, a tendency towards uniting a few diagnostic modalities within the scope of one station approves itself more and more. First of all, it concerns Volcano devices. Block for functional blood flow reserve measurement is already integrated into s5 station. It was also supposed to combine optical coherence tomography in a single console. Since it is already clear that IVUS and OCT are not mutually excluding techniques, and FFR can also provide very valuable additional information, such integration could provide a unique opportunity for almost complete invasive diagnostics without additional time consumption, especially considering the batching with both phase-electronic and mechanical catheters. Integration of OCT into a new version of s5 platform has also been reported at the PCR 2013 Congress, and, unfortunately, by the end of 2013 it was also not confirmed.

St. Jude Medical has become the second on the market and the first among manufacturers of the system for OCT who have integrated a unit for determining fractional blood flow reserve into its station. An interesting innovation of this system consists in the possibility of wireless communication with the unit to determine fractional blood flow reserve which makes it possible to work in a few operating rooms without the need for relocating the device itself.

In order to complete the overview of modern trends in development of devices for intravascular visualization, we should mention the point of view of Professor G. Mintz, who talked about the need to produce compatible products by the companies or to switch to the concept of open platforms. Such approach could significantly assist in the promotion of intravascular visualization methods, as it would expand possibilities of access to new techniques and new products without major costs for purchasing the new equipment.

References

1. Pandian N.G., Hsu T.L. Intravascular ultrasound and intracardiac echocardiography: concepts for the future. Am. J. Cardiol. 1992, 69, 20, 6H-17H.
2. Demin V.V. Clinical guidance on intravascular ultrasound investigation. Orenburg, 2005. 400 p.
3. Van der Steen A., Baldewsing R., Degertekin F. et al. IVUS beyond the horizon. EuroIntervention. 2006, 2: 132-142.

Comparative Evaluation of the Methods of Intravascular Ultrasound (IVUS) and Optical Coherence Tomography (OCT) for Visualizing Intravascular Structures

D.A. Asadov *

Moscow City Center of Interventional Cardioangiology, Russia

"IVUS can be compared to black-and-white TV, while OCT is like high-definition color"
Jeffrey A. Southard, MD, University of California Davis Medical Center

To date, endovascular methods of diagnostics and treatment of coronary heart disease (CHD) make it possible to perform not only the most complex therapeutic coronary interventions, but to conduct morphologic intravascular study as well to a high degree of accuracy. Possibility to assess the condition of vascular wall and intraluminal formations allows us to conduct various interventional manipulations more precisely and safely. Intravascular ultrasound (IVUS) and optical coherence tomography (OCT) maintain the leadership positions among the most spread methods of intravascular visualization. Since both methods are used in interventional cardiology for one purpose, it is advisable to compare their potentialities and disadvantages based on the analysis of literature data.

When analyzing advantages and disadvantages of two methods of intravascular visualization, it is advisable to begin with the physical aspects which form the basis for visualization of the scanned region. Since the principle of image formation by ultrasound is known well enough, we will review the coherence of light based on which the image is formed in the method of optical coherence tomography. In physics, light coherence is coherence of a few light waves in time manifesting during their interference. OCT effect is based on measuring the time of delay of a light beam reflected from the study tissue. Broadband superluminescent light emitting diode is a radiation source in modern OCT devices, and the light beam is delivered to the study region by an optical fiber cable. During the study the light impulse is dichotomized; moreover, one of its portions is reflected from the study object and the other (reference) portion – from a special reflecting mirror. Then the device summarizes reflected signals, thus causing the interference effect. The obtained information is processed using complex mathematical algorithm in the central processor and the scan of the study region is formed. The chief requirement in order to obtain an image is optical uniformity of the medium which is achieved by administering the contrast medium both into the system of transducer where the reflecting mirror is situated and into the vascular lumen.

Both systems (IVUS and OCT) make it possible to conduct anatomic assessment of the vessel. It has significantly higher definition, with 10-fold axial and lateral resolution. OCT has higher speed, and data collection takes only 2.5 seconds (scanning pitch is 54 mm). Many structural components of atherosclerosis and changes in the underlying tissues such as fibrous capsule of a plaque are inaccessible for IVUS, and neointimal hyperplasia is accessible only partially (1).

Resolution power of IVUS loses to OCT in all parameters, excluding the depth of penetration. Nevertheless, IVUS is a viable method of visualization which does not require additional administration of the contrast medium (which is topical for patients with renal problems), and also it is more precise in those areas where the adequate optical density cannot be obtained due to turbulent flux and fast blood flow (orifice of the trunk and the right coronary artery (RCA)) (10) (Table 1).

The vessel lumen, structure of the thrombus, dissections, protrusions of plaques through the

* *Address for correspondence:*
Dr Dzhamil Asadov
Moscow City Center of Interventional Cardioangiology
Sverchkov per, 5, Moscow, Russia, 101000
E-mail: asadov_djamil@mail.ru
Manuscript received on February 24, 2014
Accepted for publication on March 6, 2014

stent, intimal hyperplasia are better visualized by OCT; it is much easier to assess the lesion length, to visualize the fibrous capsule, the nature of hyperplasia, the plaque erosion and even calcinosis (9). It should be noted that ECG-synchronization is not required during OCT in order to obtain longitudinal scan of the proper quality. "Serrated" defect of longitudinal scanning intrinsic tor IVUS simply does not exist for OCT (8). However, despite the appeal of the method the main issue of investigators is as follows: what can be done with such big amount of new information?

In general public, OCT exists for over 7 years. During this period a lot of investigators have already gained the experience of its use in patients including those with myocardial infarction. The main objective of such studies was histological correlation between OCT and IVUS which was assessed using a native microslide of the scanned segment. Let's try to understand the information that we have. According to the data from the most early sources, namely Kume et al. (2005) who conducted autopsy of 166 corpses, OCT and IVUS are identically sensitive in assessment of fibrosis and calcinosis; however, OCT is significantly more sensitive in assessment of a lipid-containing plaque (Table 2) (2).

Table 1. Physical aspects and limitations of the methods

	IVUS	OCT
Frames per second, fps	30	100–200
Speed of traction, mm/sec	1	20–40
Wave length, μm	35–80	1.3
Axial resolution, μm	150	10–15
Lateral resolution, μm	250	40–90
Depth of penetration, mm	7	2–3
The size of catheter, mm	1	0.8
Administration of the medium	–	+

Example of comparative image of one segment using OCT and IVUS as well as their histological correlation are provided in Figure 1. As one can see, OCT the most accurately demonstrates intimal and subintimal formations and morphological changes. As a matter of fact, indeed, we can investigate histological processes in the vascular wall with high accuracy.

Such events inside the vessel as dissection (after transluminal angioplasty) and neointimal hyperplasia are also much better visualized by OCT which, as opposed to IVUS, can easily differentiate blood from dissecting intima or subintimal hemorrhage (Figure 2) (3).

It is obvious that during stent implantation OCT and IVUS are absolutely irreplaceable in specifying the degree of lesion, its length, nature, as well as in assessment of proper positioning, complete deployment and close adherence of the stent struts. Hence, the work of Rosenthal et al. who conducted comparative analysis of two visualization methods for assessment of stent positioning is of interest. 74 patients with 292 stented stenoses were included in the protocol. 236 IVUS images and 191 OCT images were obtained. Images were analyzed by three independent experts who overall reached consensus on 43 not completely deployed stents. Moreover, IVUS detected 17 out of 43, and OCT – 39 out of 43 such stents (see Table 3) [4].

And now, after reviewing the main advantages and disadvantages of two methods, we have closely approached the use of intravascular visualization in myocardial infarction. OCT method allows us not only to better detect intravascular thrombus, but even to differentiate it (Figure 3). Due to the great possibilities of OCT, this method will become extremely popular during the expansion of the practical use of

Table 2. Histological correlation between OCT and IVUS according to T. Kume et al.

		OCT, %	IVUS, %	P
Fibrosis	Sensitivity	79	88	n.s.
	Specificity	99	86	n.s.
Calcinosis	Sensitivity	96	98	n.s.
	Specificity	88	96	n.s.
Lipid plaque	Sensitivity	85	59	<0.05
	Specificity	94	97	n.s.

Table 3. Assessment of stent positioning according to OCT and IVUS data

	IVUS	OCT
Sensitivity	39.5 %	90.7 %
Specificity	99.2 %	100.0 %
Confidence interval	0.609 (95%CI 0.478–0.77)	0.096 (95%CI 0.038–0.24)

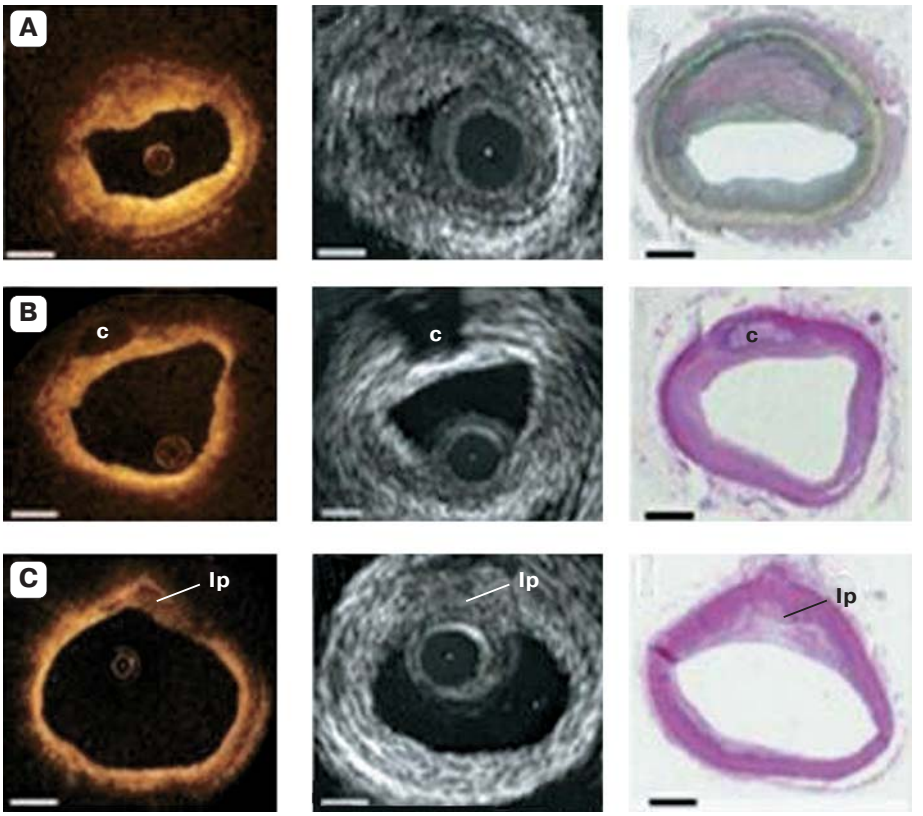


Figure 1. Histological correlation between OCT and IVUS (comment in the text). A – example of a fibrous plaque; B – example of a calcified plaque; C – example of a lipid-containing plaque.

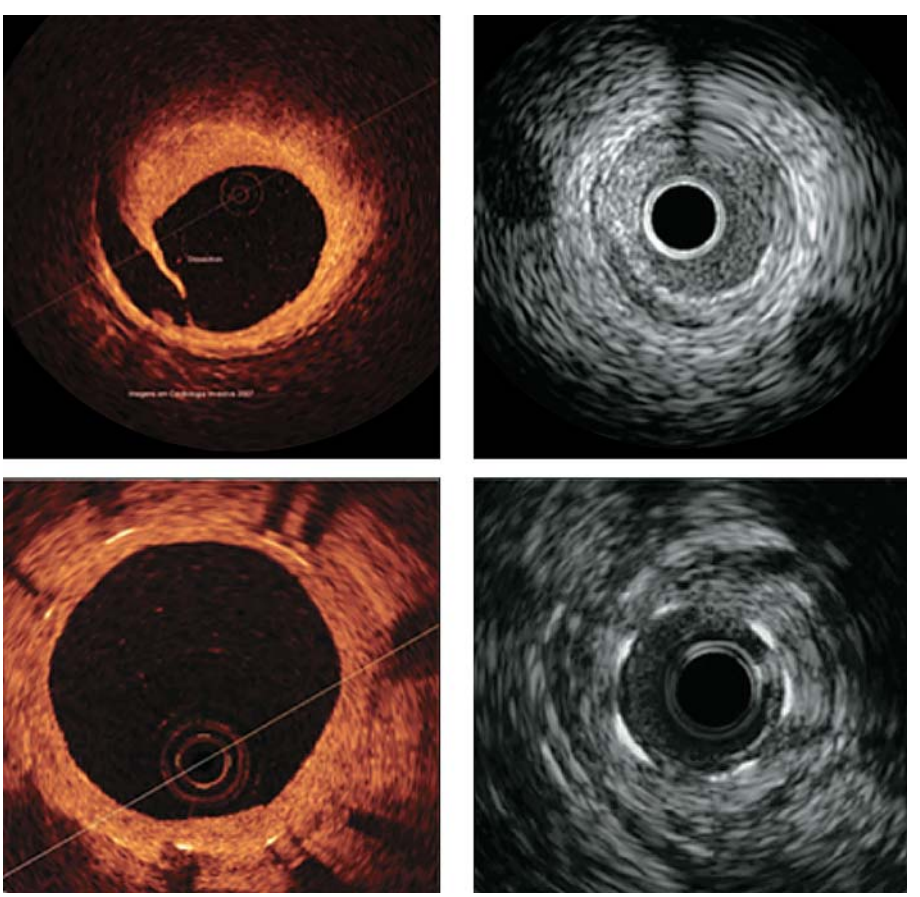


Figure 2. Dissection after transluminal angioplasty (above) and intimal hyperplasia in the stent (below) according to OCT and IVUS.

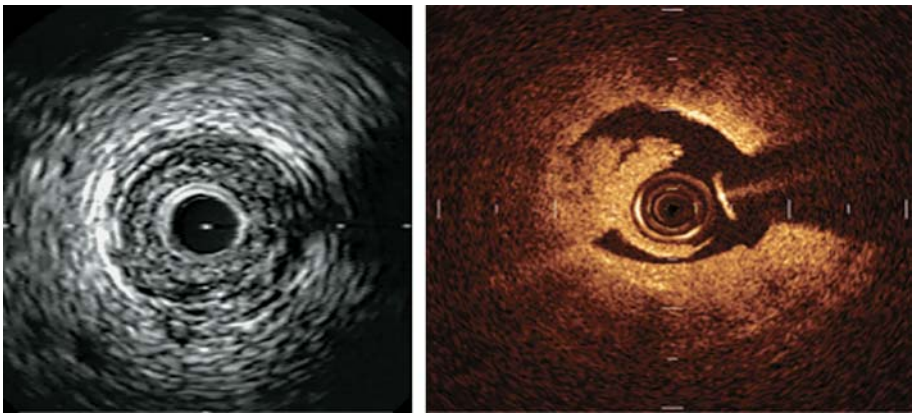


Figure 3. Thrombus in the vascular lumen according to IVUS and OCT data.

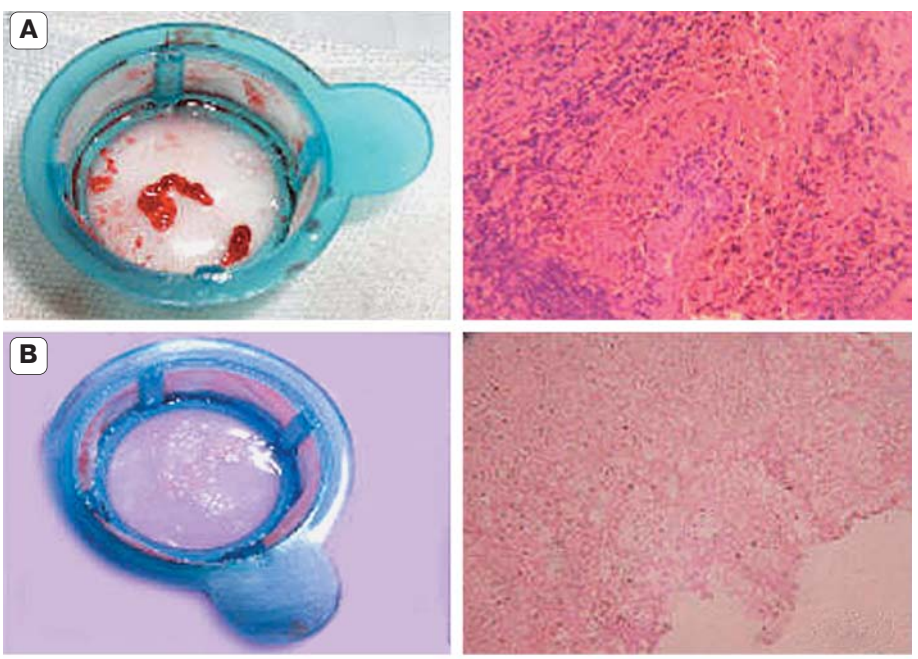


Figure 4. Histology of thrombectomy material from the coronary vessels.

biodegradable stents, as there is a possibility to control the degree of biomaterial absorption as well.

Thrombectomy in acute myocardial infarction (AMI) is widely developed; however, the importance of the thrombus structure itself is not recognized. Quadros et al. conducted a study on 113 patients with ST-segment elevation myocardial infarction with patent coronary vessels who did not undergo thrombolysis. A white thrombus was detected in one third of the cases (31%) and was associated with shorter time of ischemia until spontaneous reperfusion as compared to the red thrombus which was diagnosed in 69% of cases (5). These results demonstrate that assessment of intraluminal thrombus, factors responsible for its formation and structure may serve as useful prediction instrument, possibly even during thrombolytic therapy thus increasing its efficacy. In particular, completeness of thrombectomy or degree of lysis can be controlled.

Figure 4 presents thrombectomy material from the coronary vessels and histological image. The picture above (A) presents a so called red thrombus and its histological image. Red thrombus is an organized clot deprived of fibrin. The picture below (B) demonstrates a white thrombus rich in platelets and fibrin (12).

Thrombi are clearly visualized on OCT: a white thrombus rich in platelets and fibrin is easily differentiated due to homogenous scattering of reflected light and a low speed of scattering (Figure 5, 6). Meanwhile, a red thrombus poor in platelets and fibrin scatters the light heterogeneously and at a high speed (11). I.e. it

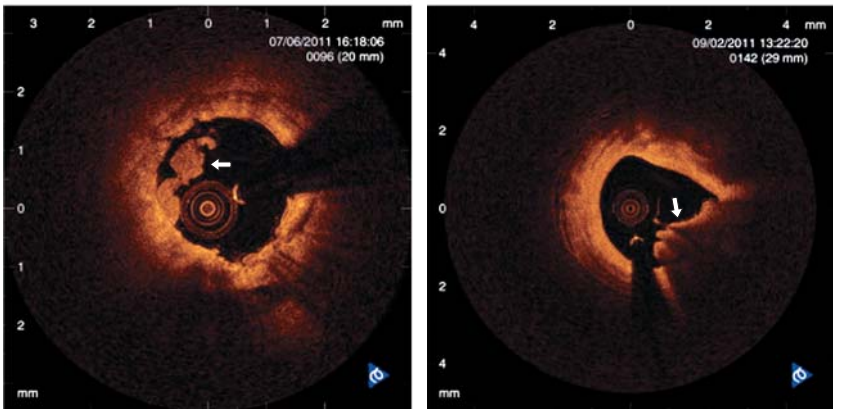


Figure 5. OCT of a white (on the left) and a red (on the right) thrombi (description in the text).

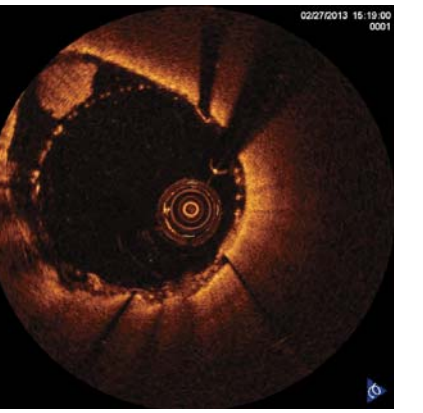


Figure 6. White thrombus in a "trap" under the implanted stent.

is clearly demonstrated that with the help of this method we can rather accurately conduct morphologic analysis of intraluminal thrombi.

Conclusions

1. OCT is a modern high-definition method of intravascular visualization which allows us to obtain data on the state of coronary vessels wall and intraluminal formations, and also to detect structures inaccessible for IVUS with higher reliability and speed.

2. IVUS is still irreplaceable in visualizing of vascular orifice lesions, as well as in patients with decreased renal function.

3. The use of OCT in patients with AMI gives reliable information on morphologic structure of the thrombus which is highly important in terms of research and practice.

4. Development of interventional technologies in the nearest future will require provision of anatomical (OCT) and physiological (fractional flow reserve, FFR) rationale for stent implantation into the marginal lesions, e.g. in case of effective thrombolysis and insignificant residual stenosis.

5. Taking into consideration the described above, such technique is unique not only for thrombus assessment, but, overall, it will be irreplaceable when proceeding to the practical use of biodegradable stents.

References

1. Bezzera H.G. et al. Assessment of coronary stent by optical coherence tomography, methodology and definitions. The Int J of Cardiovascular Imaging. February 201; 27: Issue 2, 259–269.
2. Kume T., Akasaka T., Kawamoto T. et al. Assessment of coronary intima—media thickness by optical coherence tomography: comparison with intravascular ultrasound. Circulation Journal 2005; 69, no. 8; 903–907.
3. Jeffrey A. Southard etc. The Use of OCT Compared with IVUS. Cath Lab Digest; Vol 20; Issue 3 March 2012.
4. Bezzera H.G., Costa M.A., Guagliumi G. et al. Intracoronary Optical Coherence Tomography: A Comprehensive Review. J Am Coll Cardiol Intv. 2009; 2 (11): 1035–1046.
5. Quadros A.S., Cambruzzi E., Sebben J. Red versus white thrombis in patients with ST-elevation myocardial infarction undergoing primary percutaneous coronary intervention: clinical and angiographic outcomes. Am Heart J 2012 Oct; 164(4): 553–560.
6. Murata A. et al. Accuracy of OCT in Evaluating Neointimal Thickness After Stent Implantation. J Am Coll Cardiol img 2010; 3: 76–84.
7. Templin C., Meyer M., Muller M.F. et al. Coronary optical frequency domain imaging (OFDI) for in vivo evaluation of stent healing: comparison with light and electron microscopy. Eur H Journal 2010; 31, 1792–1801.
8. Takahashi T., Honda Y., Russo R.J. et al. Intravascular ultrasound and quantitative coronary angiography. Cathet Cardiovasc Diagn 2002; 55:118–128.
9. Kato K., Yonetsu T., Kim S.J. , et al. Nonculprit plaques in patients with acute coronary syndromes have more vulnerable features compared with those with non-acute coronary syndromes : a 3-vessel optical coherense tomography study. Circ Cardiovasc Imaging 2012 ; 5 :433–440.
10. Wakabayashi K., Lindsay J., Laynez-Carnicero A., et al. Utility for Intravascular ultrasound guidans in patients undergoing percutaneus coronary intervention for type C lesions. J Interv Cardiol 2012; 25:452–459.
11. Finn A.V., Joner M., Nakazawa G et al. Pathological correlates of late drug-eluting stents thrombosis : strut coverage as a marker of endothelization. Circulation 2007 ; 115 :2435–2441.
12. Gualguimi G., Sirbu V., Musumeci G., et al. Examinations of the in vivo mechanisms of late drug-eluting stents: findings from optical coherense tomography and intravascular ultrasound imaging. JACC Cardiovasc Interv 2012; 5: 12–20.

Neuroendovascular Strategies for Posttraumatic Abdominal Pseudoaneurysms

Yu.L. Shevchenko, Yu.M. Stoyko, N.V. Bolomatov, V.A. Batrashov, A.L. Levchuk, S.V. Bruslik, V.A. Nazarov, A.G. Viller*

N.I. Pirogov National Medical Surgical Center, Moscow, Russia

Endovascular strategies for cerebral vascular pathology were developed in the second half of XX century. The neurosurgical strategies are known to be usually universal; they may be applied for other pathologies, particularly, for visceral arteries. The authors present clinical cases of neuroendovascular strategies used for posttraumatic abdominal pseudoaneurysms.

Key words: *hepatic pseudoaneurysm, splenic pseudoaneurysm, abdominal pseudoaneurysms, embolization, occlusive balloon, microcoils, glues.*

Cerebral vascular diseases are a complex neurosurgical pathology which is difficult to treat (2, 4, 5, 8, 13). In 1971, Russian neurosurgeon F.A. Serbinenko proposed a specific novel treatment option for cerebral vascular disease – endovascular balloon occlusion. The author developed and introduced into practice a detachable occlusive balloon; it is an inflatable round balloon, which may be repeatedly inflated and deflated or detached when inflated, if necessary (6). This technology is widely used for all types of neurovascular pathology. The suggested tool initiated a new area in the neurosurgery – endovascular management of cerebral vascular diseases. The second step in the development of these strategies was made by Kerber C. et al. in 1976; they used liquid embolic glue (isobutyl-2-cyanoacrylate) for treatment of vascular malformations of the brain. Due to its properties, this glue penetrates deep into the vessels and stroma of arteriovenous malformations resulting in full occlusion (12). The third innovation which permitted the breakthrough in vascular neurosurgery was the invention of electrically detachable coils which were developed and widely introduced into clinical practice by Guglielmi G. et al. in the mid-1980s. This strategy helped to introduce, to position and, if necessary, to remove the coils from vessels or aneurismal cavities quite quickly and easily (9). Wide introduction of these strategies into practice reduced complication incidence after brain interventions and mortality by 1.5-4 and 2-5 times, respectively, and significantly decreased temporary disability in patients after the intervention (4, 5, 8, 13).

It should be noted that, as a rule, the technologies used in neurosurgery are universal; they may be applied for other vascular pathologies, particularly for visceral arteries. According to the numerous authors, up to 10% of patients with abdominal trauma are at risk of fatal bleeding caused by hemobilia, arteriovenous fistula and arterial pseudoaneurysm. The other reasons for abdominal bleeding may be iatrogenic lesions (open and endoscopic surgeries, liver biopsy, drainage placement etc.). Such bleedings are recurrent and lead to death in up to 5% of cases (3, 7, 10, 11, 14, 15, 16). In some cases, selective angiography permits quick and minimally traumatic detection of the bleeding source; and endovascular techniques help to occlude the bleeding source without conversion to open surgery. An example of occlusion of the large vessel using Serbinenko detachable balloon is Patient S., 29 y.o. who was admitted to N.I. Pirogov Center of Surgery with complaints of epigastric pain, resolving after analgesics intake, and general weakness. It is known from the medical history that the patient had closed abdominal injury in 1998. In 2002, the patient was examined and treated in one of Moscow clinics, where a splenic cyst was diagnosed. In 2011, ultrasound examination revealed increase in the splenic cyst size. In May 2011, laparoscopic fenestration and coagulation of posttraumatic splenic cyst were performed in Pirogov center. The immediate postoperative period was unremarkable. Three months later, control abdominal US and CT examinations revealed cyst recurrence, and

* *Address for correspondence:*
Dr Nikolai Bolomatov
N.I. Pirogov National Medical Surgical Center, Moscow, Russia
70, Nizhnayay Pervomayskaya str., Moscow, 105203
Tel.: +7 (499) 464-49-54, +7 (495) 465-33-55,
fax: +7 (495) 465-09-52
E-mail: info@pirogov-center.ru
Manuscript received on February 4, 2014.
Accepted for publication March 12, 2014

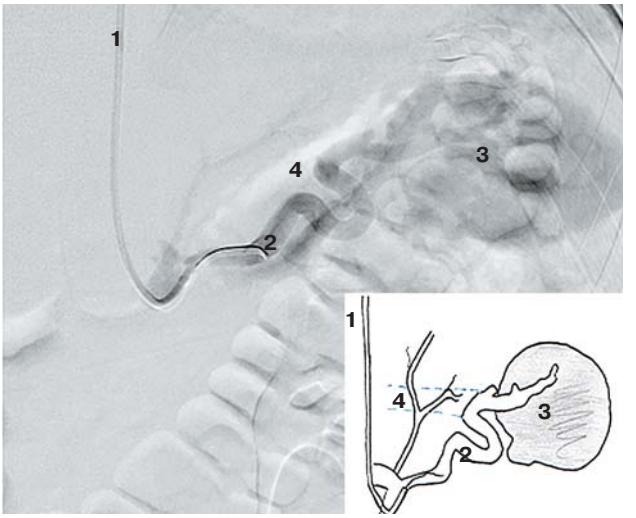


Figure 1. Celiacography. Splenic artery and cavity of pseudoaneurysm in the splenic bed. 1 – guiding catheter; 2 – splenic artery; 3 – pseudoaneurysm; 4 – splenic vein.

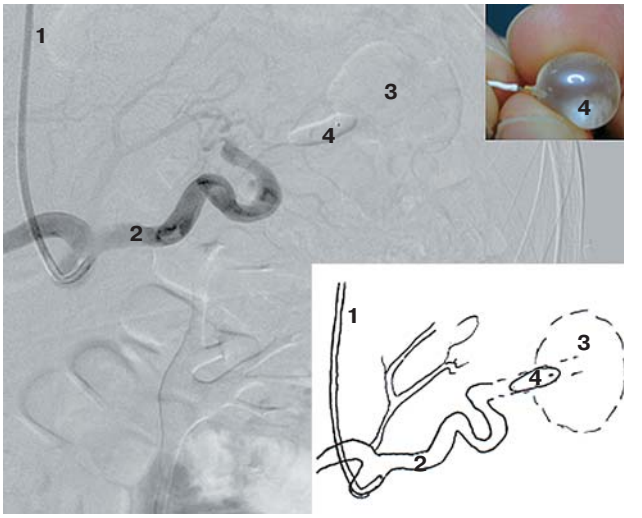


Figure 2. Control celiacography after occlusion of the splenic artery with the detachable balloon. 1 – guiding catheter; 2 – splenic artery; 3 – pseudoaneurysm; 4 – splenic vein.

laparoscopic splenectomy was performed on August 25, 2011. On September 07, 2011 control abdominal CT and US exams diagnosed the evidence of pseudoaneurysm with the shunt of arterial blood into the splenic vein. At that time, the patient underwent abdominal aortography and celiacography which visualized the splenic artery along its whole length, a pseudoaneurysm (63 × 48 × 32 mm) in the splenic bed region, and the shunting of opacified blood into the splenic vein during the arterial phase. Conclusion: splenic pseudoaneurysm with the formation of arteriovenous fistula (Fig.1).

The patient underwent endovascular intervention: embolization of the splenic pseudoaneurysm with the detachable balloon (Fig. 2). The duration of intervention was 20 min.

Abdominal US revealed positive dynamics (signs of thrombosed hematoma). On September 30, 2011, the patient was discharged in satisfactory condition and with clinical improvement under the supervision of specialists at his place of residence.

Another example of combined application of detachable coils and cyanoacrylate adhesives for abdominal pathology is Patient M., 20 y.o. who had a stab penetrating abdominal wound associated with the damage of the right hepatic lobe complicated by intra-abdominal bleeding on November 07, 2010. On the same day, an emergency surgery at place of his residence was performed: closure of the liver wound. On November 30, 2010, the patient developed gastrointestinal bleeding. EGDS detected no bleeding source. Therefore, the surgeons decided to perform open surgery: gastroduodenotomy, stomach and duodenum revision. The surgery revealed the major duodenal papilla as the bleeding source. During the operation, abdominal ultrasound examination was performed and posttraumatic pseudoaneurysm was detected in the right hepatic lobe, segment VIII. On December 15, 2010, the patient gastrointestinal bleeding and hemobilia recurred (confirmed by EGDS). The patient was prescribed with medical (hemostatic and replacement) therapy and on December 17, 2010, he was transferred to Pirogov Center of Surgery for further treatment. On admission, the patient reported episodic pulling pain in the right hypochondrium and episodic pain in the upper parts of the abdomen, as well as retrosternal pain; these were getting stronger after maximum inspiration and expiration. Clinical status presented signs of severe anemia (hemoglobin up to 84 g/L, hematocrit up to 25%), and no evidence of icterus (total bilirubin – 15.3 μmol/L). The computed tomography performed on the same day detected the increase of previously diagnosed pseudoaneurysm. Therefore, the diagnosis of posttraumatic arterio-venous-biliar fistula with forming pseudoaneurysm of the right hepatic lobe complicated with recurrent hemobilia was established. The patients also had moderately severe posttraumatic anemia. On the same day the patient underwent urgent abdominal aortography and selective angiography of the hepatic artery and its branches (Fig. 3), which confirmed pseudoaneurysm located at segment VIII without bile ducts opacification (the territory supplied by the right hepatic artery).

The patient underwent urgent endovascular intervention: combined embolization of the

Figure 3. Selective angiography of the right hepatic artery dated December 17, 2010. < Extravasation of contrast media in hepatic segment VIII (pseudoaneurysm).

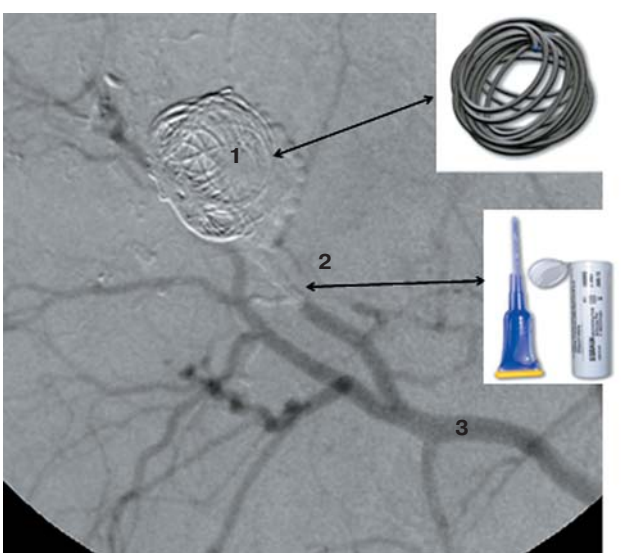


Figure 4. Selective angiography of the right hepatic artery performed on December 19, 2010 after endovascular embolization, total occlusion of the segmental artery using glue adhesive. 1 – microcoils, 2 – glue adhesive, 3 – right hepatic artery.

posttraumatic pseudoaneurysm using microcoils and glue adhesive: initially, the aneurism cavity was filled with 6 detachable microcoils (microcoils Matrix2, Axium), then the damaged artery embolization was performed with mixture of histoacryl and lipiodol (Fig. 4). Control angiography revealed no signs of pseudoaneurysm opacification. In total the intervention lasted for 36 min.

At control angiography, performed on December 20, 2010, the pseudoaneurysm was not opacified. It should be noted that the positive effect has been obtained only after total occlusion of the large segmental arterial branch; no signs of hemobilia were observed and anemia did not increase. On December 29, 2010 the patient was discharged in fair condition under medical supervision at his place of residence. Therefore, endovascular strategies led to quick and minimally traumatic intrahepatic bleeding cessation.

From the above mentioned clinical cases it is apparent that strategies and tools used in brain interventions made it possible to quickly occlude the bleeding source in the visceral arteries without conversion to open surgeries.

References

1. Borisov A.E., Kotkas I.E., Mukhiddinov N.D. Liver artery embolization for hemobilia and bleeding after liver injury, spontaneous tumor rupture, and relapsed bleedings “Modern strategies in surgery” Sbornik nauchnykh trudov (Collection of proceedings). SPb., 2006, pp. 55–58.
2. Vorobeva P.A. Stroke. Regulatory documents. Moscow, Newdiamed publsh., pp. 129-165, 480.
3. Ermolov A.S., Abakumov M.M., Vladimirova E.S. Liver injury. Moscow, Meditsina publsh., 2003.
4. Krylov V.V. Surgery of brain aneurisms in 3 volumes. IP “T.A. Alekseeva” publsh., 2011, 1, 12–42.
5. Kuznetsov A.N. Cerebral embolism: past, present, future problems. Nevrol. journ. 2004, 9, 4–11.
6. Serbinenko F.A. Catheterization and occlusion of the major brain vessels and prospects of vascular neurosurgery development. Voprosy neurokhirurgii (Problems of Neurosurgery), 1971, 5, 17–27.
7. Shapkin V.S., Grinenko Zh.A. Closed and open liver injuries. Moscow, Meditsina publsh., 1977.
8. Shevchenko Yu.L., Kuznetsov A.N., Vinogradov O.I. Surgical treatment options for secondary prevention of lacunar infarction. Vestnik N.I. Pirogova NMHC (Herald of N.I. Pirogov NMSC). 2009, 4, 13–22.
9. Guglielmi G., Vinuela F., Dion J. et.al. Electrothrombosis of saccularaneurysms via endovascular approach. Part 2: preliminary clinical experience. J. Neurosurg. 1991, 75, 8–14.
10. Hermine C., Ernst O., Delemazure O. et al. Arterial complications of percutaneous transhepatic biliary drainage. Cardiovasc. Intervent. Radiol. 1996, 19, 160–164.
11. Jander H., Laws H., Kogutt M. et al. Emergency embolization in blunt hepatic trauma. Am. J. Roentgenol. 1977, 129, 249–252.
12. Kerber C. Balloon catheter with a calibrated leak. A new system for superselective angiography and occlusive catheter therapy. Radiology. 1976, 120, 547–550.
13. Koenigsberg R., Bianco B., Faro S. et al. Textbook of Clinical Neurology. Saunders Elsevier, 2007.
14. Nicholson T., Travis S., Ettles D. et al. Hepatic angiography and embolization for hemobilia following laparoscopic cholecystectomy. Cardiovasc. Intervent. Radiol. 1999, 22, 20–24.
15. Richardson J., Franklin G., Lukan J. et al. Evolution in the management of hepatic trauma. Ann. Surg. 2000, 232, 324–330.
16. Walter J., Paaso B., Cannon W. Successful transcatheter embolic control of massive hematobilia secondary to liver biopsy. Am. J. Roentgenol. 1976, 127, 847–849.

The Results of Uterine Arteries Embolization in Benign Uterine Diseases (experience of City Clinical Hospital N64)

V.V. Mayskov[1], I.Yu. Mayskova[1], S.P. Semitko[2]**

[1] *City Clinical Hospital No. 64, Chair of Endovascular Methods of Diagnosis and Treatment, Faculty of Advanced Training for Physicians*

[2] *Pirogov Russian State Medical University, Moscow, Russia*

Surgical treatment remains a method of choice in females with symptomatic hysteromyoma including its combination with adenomyosis. Big size of nodules and their number, localization in the area of vascular bundle, traumatic approach associated with the entrance into the uterine cavity significantly limit the possibilities of myomectomy. Hysterectomy (HE) inevitably results in the loss of female reproductive function and development of post-hysterectomy syndrome (PHS) manifesting in psycho-emotional and neurovegetative disorders. However, percentage of HE in surgical treatment of hysteromyoma remains significant and constitutes 46% in the USA, 48% in Sweden, 35% in the United Kingdom, 48% in the Russian Federation (Kulakov V.I., Adamyan L.V., 1999).

Over the last years attention of medical society was drawn to new organ preservation methods of hysteromyoma treatment using the newest technologies, which have become one of the top-priority strategies of modern gynecology, radiology and nuclear medicine, and radiodiagnostics. This is caused not only by the increasing need of females to use their childbearing potential in an older age, but also by obtaining data about the increased incidence of cardiovascular diseases by 18% among women who underwent HE at the age younger than 50 [2].

Modern achievements of radiosurgery allow us to suggest an alternative minimally invasive organ preservation method of hysteromyoma treatment – uterine artery embolization (UAE). The first report on UAE was made by J. Oliver et al. [4] who successfully used this technique in emergency situations to arrest postpartum hemorrhage and postoperative bleeding. Their undertakings were continued in the works of French gynecologist J. Ravina who in 1991 started performing UAE as preoperative management before elective HE in females with large myomas. It appeared that UAE not only minimized the blood loss, but in a number of cases made it possible to perform myomectomy [5]. With accumulation of surgical experience, development of endovascular instruments and positive long-term results of treatment, UAE became widely recommended and considered as an independent method of hysteromyoma treatment which does not require subsequent myomectomy. In Russia, UAE was performed for the first time by Professor A.S. Belenky in 2002 [6], and already in 2011 a group of enthusiasts was awarded the Russian Federation Government Prize "…for development and implementation of endovascular surgery methods to preserve and restore female reproductive health".

Despite the apparent advantages of the technique and rapid increase in a number of followers of organ preservation treatment, it is highly demanded in Russia as its availability is limited. Department of Radiosurgical Diagnostic and Treatment Methods in the State-Funded Healthcare Institution City Clinical Hospital No. 64 of Moscow Healthcare Department started functioning since September 2012. One of the top-priority areas of practical and scientific work of radiosurgical service is to provide help to the patients with acute coronary circulation disorder. Integration of radiosurgical service into the treatment process of a multi-specialty emergency care hospital, including Gynecology Department, is a prospective course of the service development.

Objective of the study: to assess first immediate and mid-term results of uterine artery

* *Address for correspondence:*
Dr. Viktor Mayskov
City Clinical Hospital №64,
61, ul. Vavilova, Moscow, 117292, Russia
E-mail: maiskov-angio@yandex.ru
Manuscript received on February 21, 2014.
Accepted for publication on April 22, 2014.

embolization in treatment of women with hysteromyoma.

Materials and methods

We analyzed first immediate and mid-term results of uterine artery embolization in 26 females with symptomatic hysteromyoma. The age of female patients ranged from 33 to 52 years old, mean age was 43.6 ± 2.7 years old. Gynecological history and a history of somatic complaints did not significantly differ between women. The body weight index was over 35 kg/m^2 in two patients. Mean disease duration was 3.2 ± 1.3 years. A majority of patients (86%) had multiple nodules, their number varied from 2 to 9 with a mean of 3.7 ± 1.28 per patient, and their dimensions ranged from 17 to 118 mm. In seven patients (26.9%) myoma was accompanied by diffuse adenomyosis. Submucous localization of nodules was detected in four patients (15.4%), cervicoisthmical localization – in three patients (11.5%).

The indications for surgical treatment were as follows: menometrorrhagias, pain syndrome, large myoma (Table 1).

At the moment of UAE, menstural function in all females was preserved and they were strongly inclined to undergo organ preservation surgical treatment. Characteristic of myomatous nodules is presented in Table 2.

We considered UAE both as independent treatment method and as preoperative management for subsequent myomectomy. Elective patients were examined in the outpatient settings in the Consultative and Diagnostic Department by gynecologist within the scope of standard preparation for the surgical intervention with mandatory ultrasound duplex scanning of uterine arteries in the nodules or MRI with subsequent discussion of the results by a board of doctors including a radiosurgeon. Urgent patients were discussed for the purpose of UAE conduction after diagnostic curettage and inefficacy of conservative treatment.

Procedure was performed using a routine technique via right-sided femoral approach with Roberts 5F (Cook) catheter, PVA particles (Cook), embospheres (Biosphere). 500 μm PVA particles were preferable in hysteromyoma without adenomyosis. For combination of pathological conditions, 350 μm PVA particles were used at the beginning with subsequent administration of 500 μm PVA particles. Stasis of contrasted blood in the trunks of uterine arteries for five cardiac cycles, the absence of opacification in the peri-fibroid plexus were considered as angiographic endpoints. If optimal final angiographic result was not achieved in females with giant nodules, 700 μm PVA particles were additionally administered. A possibility of conducting superselective embolization using microcatheters was discussed in case of anatomic variants of uterine blood supply.

All patients underwent complex therapy during the early postoperative period including programmed anesthesia with narcotic and nonsteroid drugs, infusion therapy, wide-spectrum antibiotics, prophylaxis of venous embolic complications.

The control ultrasound examination with dopplerometry and/or MRI were conducted in 1, 3, 6 months after UAE. Changes in sizes of uterus and myomatous nodules, the presence and type of blood flow in the radial and arcuate uterine arteries were assessed over time.

Results

The immediate success assessed as bilateral embolization with achievement of angiographic endpoints was 95% (Figure 1).

It was technically impossible to perform embolization in one patient due to anatomic variant of uterine blood supply by the dominant left ovarian artery (Figure 2). It was decided to abstain from superselective embolization with microcatheter due to significant tortuosity of the artery and a high risk of unscheduled ischemic ovarian injury in a patient of late reproductive age.

UAE as an isolated method of treatment was performed in 23 patients; we observed expul-

Table 1. Indications for surgical treatment

Symptom	n (%)
Menometrorrhagia	23 (88.5)
Pain syndrome	2 (7.7)
Large myoma	3 (11.5)

Table 2. Changes in volume of uterus and myomatous nodules after UAE over time (n = 15)

Parameter, m	Baseline	In 1 month	In 3 months	In 6 months
Volume of the uterus, cm^3	342,1 ± 4,4	335,3 ± 3,1 (–1,9%)	306,2 ± 3,2 (–10,5%)	244,9 ± 2,8 (–28,4%)
Volume of the largest myomatous nodule, cm^3	65,6 ± 4,1	64,8 ± 2,3 (–1,2%)	55,6 ± 2,2 (–15,2%)	39,6 ± 1,8 (–39,6%)

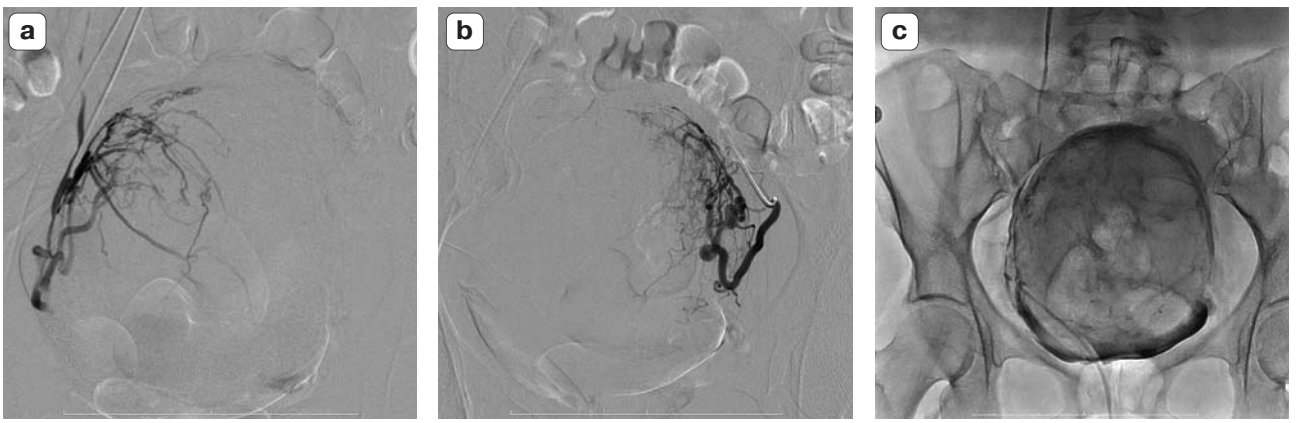


Figure 1. a – embolization of the right uterine artery; b – embolization of the left uterine artery; c – result of bilateral embolization of a large hysteromyoma.

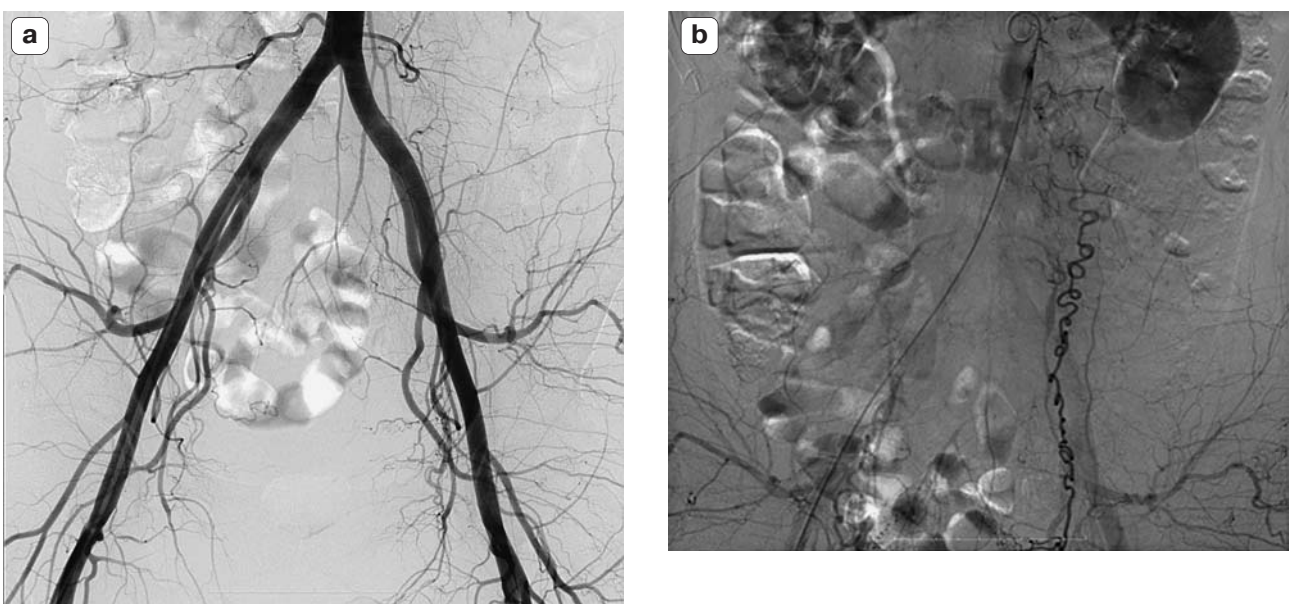


Figure 2. a – abdominal aortography; uterine arteries are not visualized; b – variant of uterine blood supply by the dominant left ovarian artery.

sion of myomatous nodules within 7 to 30 days in two patients with submucous localization of the nodules (8.7%) (Figure 3).

UAE was performed in three patients with large hysteromyoma (14-16 weeks of pregnancy) as preoperative management prior to subsequent myomectomy. As a result of subsequent laparoscopic myomectomy conducted within up to 7 days after UAE, 9, 5 and 6 nodules, respectively, were removed ranged from 30 to 110 mm with a blood loss in each patient not exceeding 200 mL. Figure 4 shows stages of uterine immobilization and removed myomatous nodules in a 42-year-old patient who had surgery on Day 2 after UAE (Figure 3).

Control ultrasound (US) investigations performed in 3 and 6 months revealed significant reduction of uterus and myomatous nodules over time (Table 2).

In 6 months after the procedure 85.2% of patients experienced a total relief of symptoms which bothered them prior to UAE.

Conclusion

According to domestic and foreign clinicians, UAE is safe, clinically and cost-effective method of hysteromyoma treatment. The risk of development of any complications is 10 times lower than after the surgical treatment and does not exceed 1%. Allergic reactions and local vascular complications related to puncture and catheterization of femoral artery are the most common complications of UAE [9].

Indications for UAE procedure are almost unlimited and include all symptomatic myomas accompanied by menometrorrhagia, pain, feeling of heaviness, frequent urination, dyspareunia etc., as well as growing and large myomas [10].

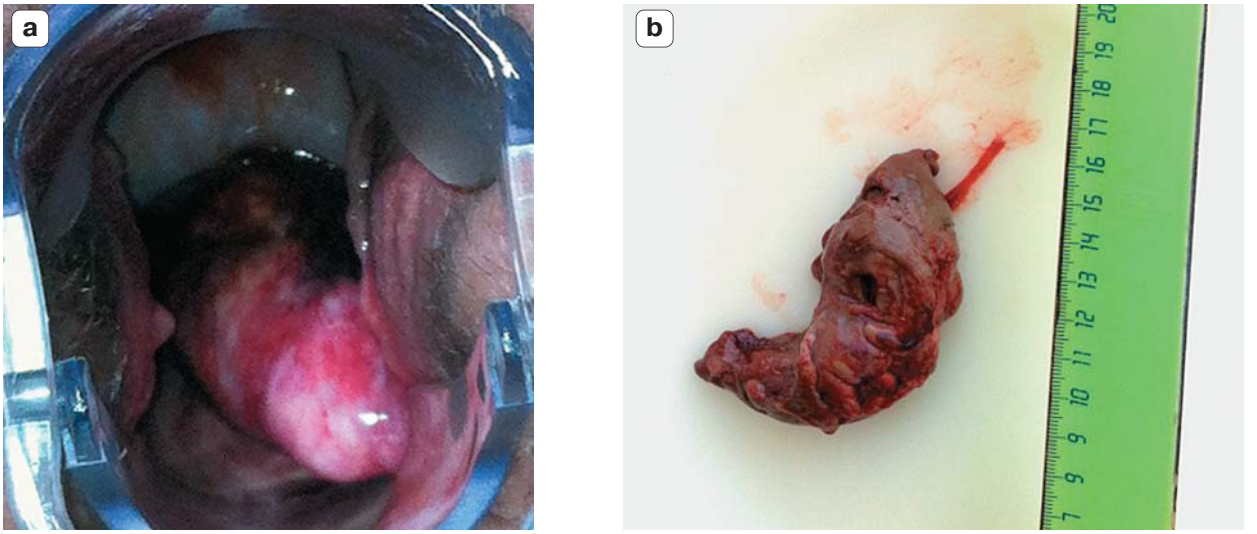


Figure 3. Delivered myomatous nodule. a – examination via specula; b – gross specimen.

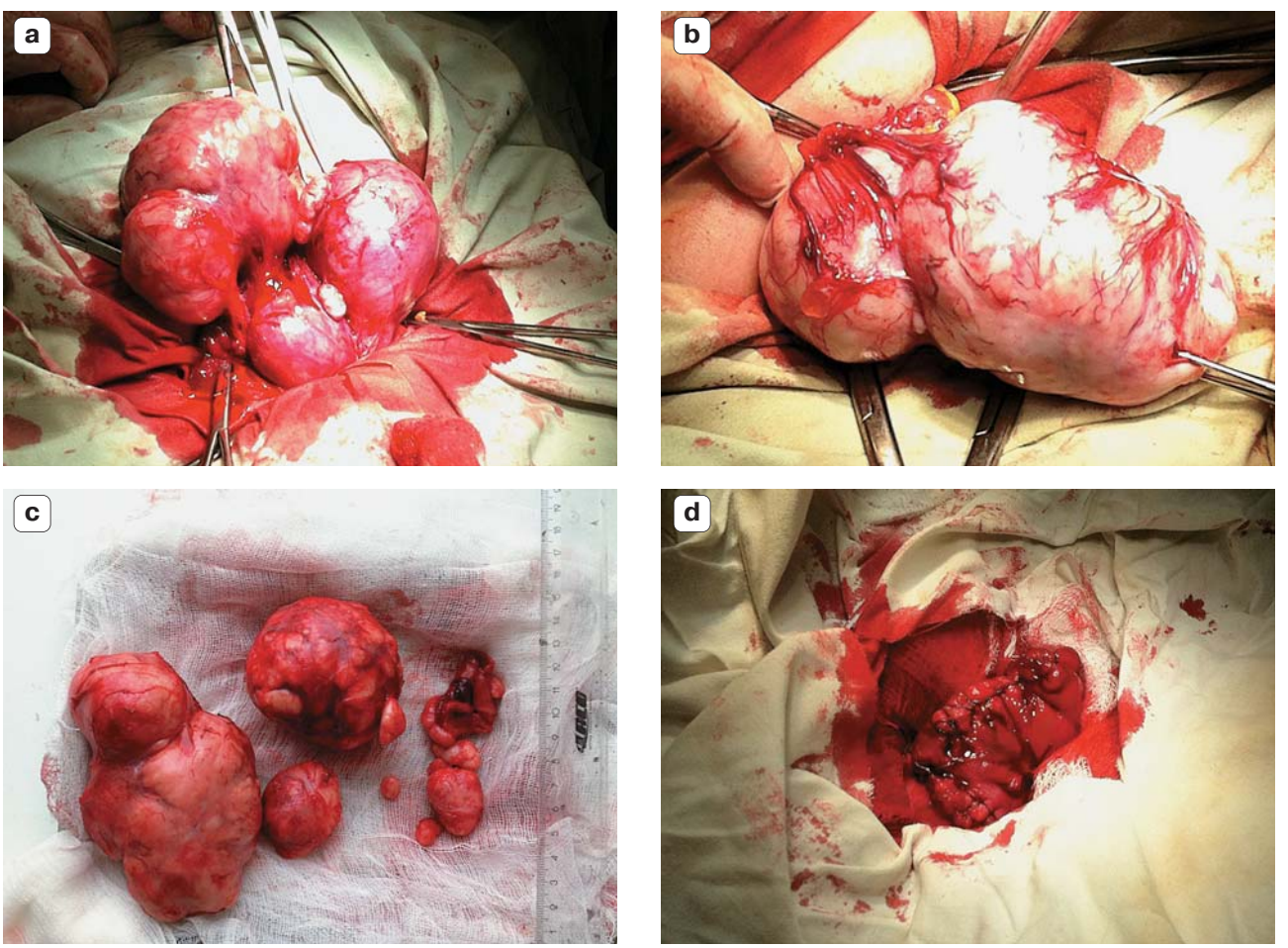


Figure 4. a, b – stages of uterus immobilization; c – removed myomatous nodules; d – uterus after uterorrhaphy.

Results of successful use of this method in giant myomas were published in the studies of foreign authors [11]. Acute inflammatory diseases, menopause are contraindications for UAE.

Success of uterine artery embolization in treatment of hysteromyoma and adenomyosis marks the beginning of partnership between gynecologists and specialists in radioendovascular diagnostics for treatment of women with this disease. Unlike massive surgery, UAE does not close the doors to all other methods of treatment.

Interdisciplinary cooperation and education ensure more efficient analysis of existing pathology in a patient and determination of a strategy of appropriate treatment.

Preoperative management must include thorough gynecologic and physical examination, pelvic US with dopplerometry and/or MRI (which is preferable), biopsy of endometrium. Gynecologist and radiosurgeon both have to be engaged in the course of procedure, assessment of therapy results, postoperative management.

Method of treatment of benign uterine diseases should be individual, clinically feasible, effect from its use should not worsen the existing situation.

References

1. Podzolkova N.M., Podzolkov V.I., Nikitina T.I. et al. Hysterectomy syndrome with unilateral adnexectomy during metabolite and antihypertensive treatment.Ros. vestnik ak.-ginek. (Russian Bulletin of Obstetrician-Gynecologist). 2005, 1, 26–31 (in Russian).
2. Parker W.H., Broder M.S. Chang E. et al. Ovarian conservation at the time of hysterectomy and long-term health outcomes in the Nurses' Health study. Obstetrics and Gynecology. 2009, 113, 5, 1027–1037
3. Phipps J. Laparoscopic- assisted vaginal hysterectomy a series of 114 cases. Abstracts of the 4-th Bennial Meeting of the International Society for Gynecologic Endoscopy. Qxford. 1995, p.29.
4. Oliver J., Lance J. Selective embolization to control massive hemorrhage following pelvic surgery. Am. J. Obstet. Gynecol. 1979, 135, 431–432.
5. Ravina L.I.T., Merland J., Flcrbi clean D el al. Preoperative embolization of uterine fibroma. Preliminary results (10 eases). Pres.Med. 1994, 23, 1540–1548.
6. Kapranov S.A., Belenkiy A.S., Bobrov B.Yu. et al. Uterine artery embolization (UAE) in the treatment of hysteromyoma: 126 observations. Bulletin of Bakoulev Scientific Center for Cardiovascular Surgery, Russian Academy of Medical Sciences "Cardiovascular diseases". 2003, 4, 11, 219. (in Russian)
7. Dobrokhotova Yu.E., Kapranov S.A., Alieva A.A. et al. Embolization of Uterine Arteries in Complex Management of Uterine Myoma. Rossiyskiy vestnik akushera-ginekologa (Russian Bulletin of Obstetrician-Gynecologist). 2006, 6, 1. 57–59. (in Russian)
8. Breusenko V.G., Krasnova I.A., Kapranov S.A. et al. Some debating issues of uterine artery embolization in hysteromyoma. Akush. i gin. (Obstetrics and Gynecology). 2006, 3, 26–30. (in Russian)
9. Hirst A., Dutton S., Wu O. et al. Multi-centre retrospective cohort study comparing the efficacy, safety and cost-effectiveness of hysterectomy and uterine artery embolisation for the treatment of symptomatic uterine fibroids. The HOPEFUL study. Health Technol Assess. 2008, 12, 5, 1–248.
10. Savelieva G.M., Breusenko V.G., Kapranov S.A. et al. Uterine artery embolization (UAE) in the treatment of hysteromyoma: achievements and perspectives. Akush. i gin. (Obstetrics and Gynecology). 2007, 5, 54–59 (in Russian)
11. Goodwin S., McLucas B., Lee M. et al. Uterine artery embolization for the treatment of uterine leiomyomata midterm results. J. Vasc. Intervent. Radiol. 1999, 10, 1159–1165.

Simultaneous Combined Endovascular Stenting of the Left Main Coronary Artery (LCA) and Transcatheter Aortic Valve Implantation (TAVI) in a Female Patient at High Risk for Open-Heart Surgery

D.G. Iosseliani, E.E. Kovaleva, O.E. Sukhorukov, D.A. Asadov, I.S. Arabadzhyan, I.V. Isaeva, A.N. Rogatova, V.A. Kryukov

Moscow City Centre of Interventional Cardioangiology, Russia

Introduction

It is known that atherosclerotic process tends to progress with age, thus worsening the clinical presentation of a disease depending on which organ is involved in the pathologic process. To the full extent this also refers to the human cardiovascular system. With age, stenotic-occlusive process in cardiac coronary arteries exacerbates and their calcinosis becomes more expressed. The same can be said about the aortic valve which is rather often subject to stenotic-calcifying atherosclerotic lesion in elderly and old age. These processes negatively affect the clinical course and prognosis of the disease. In particular, severe clinical course and prognosis are typical for patients with combined stenotic-occlusive lesion of the coronary arteries and cardiac aortic valve. The incidence of combined atherosclerotic lesion is rather high in elderly and old patients. It suffices to say that coronary heart disease (CHD) is registered in more than 50% of patients older than 70 with marked aortic valve stenosis (Dewey et al., 2010). As it was already noted earlier, such patients have extremely severe clinical course and prognosis of the disease. This in particular refers to the patients with the left main coronary artery (main LCA) involved in the stenotic-occlusive process. Such presentation is seen in approximately 2.5–4% of patients with coronary heart disease (Park S.J., et al., 2003). Today an open heart surgery involving aortic valve implantation and direct myocardial revascularization is the most effective treatment method of combined atherosclerotic lesions of cardiac structures. However, in many elderly and old patients bypass surgeries are associated with a high risk of dangerous complications and lethal outcome, or are contraindicated at all. Therefore, endovascular procedures correcting both coronary blood supply and aortic valve function are more often used in this category of patients. This refers to the coronary artery stenting and transcatheter aortic valve implantation (TAVI). A lot of such combined endovascular procedures including both coronary stenting and TAVI have already been performed. Nevertheless, to date there is no single strategy and commonly accepted guidelines on the sequence and order of these procedures. A majority of investigators prefer to conduct these procedures separately with a certain time interval. Others prefer using hybrid interventions, i.e. combination of endovascular procedures and bypass surgery. There are very few observations regarding simultaneous endovascular procedures of coronary artery stenting and transcatheter aortic valve implantation This specifically concerns patients with lesion of the main LCA. Most likely, each of the strategies used in "age-specific" patients with combined lesion of aortic valve and coronary arteries has its pros and cons, and only further accumulation of experience in this area will allow us to work out the most optimal strategy regarding these patients. It cannot be ruled out that the strategy will not be universal and will differ depending on the clinical state of a patient, peculiarities of cardiovascular system involvement, the severity of concomitant diseases, the skills of surgical teams in performing combined procedures etc.

* *Address for correspondence:*
Prof. David Iosseliani
Moscow City Center of Interventional Cardioangiology
Russia, 101000, Moscow, Sverchkov per., 5
E-mail: davidgi@mail.ru
Manuscript received on March 24, 2014.
Accepted for publication on April 21, 2014.

Taking into account the necessity to accumulate experience and to comparatively analyze observations of different clinics, we considered it necessary to share the experience of Moscow City Centre of Interventional Cardioangiology in simultaneous combined endovascular treatment of aortic stenosis and coronary heart disease in elderly and old patients at high risk or with contraindications for open heart surgeries. Our experience includes 19 patients with combined endovascular procedures on the coronary arteries and aortic valve; in 12 cases endovascular procedures were performed simultaneously, in other 7 cases – at different stages (in one patient 8 months after the valve implantation). There were no in-hospital deaths.

This report presents a clinical case of successful simultaneous endovascular procedure of multiple coronary artery stenting, including stenting of the main LCA, and TAVI in a female patient with critical aortic stenosis and coronary heart disease.

Case study

A female patient V., 75 years old, was admitted to the Moscow City Centre of Interventional Cardioangiology with complaints of attacks typical for exertional angina, dyspnea on slight exertion.

For a few years she had episodes of increased blood pressure up to 170/100 mmHg; she is adapted to 130/80 mmHg. Since 2010 the patient started experiencing angina attacks on moderate exertion, and since 2012 – dyspnea while walking. In May 2012 she was diagnosed (according to Echo-CG data) with aortic valve stenosis (mean gradient = 47 mmHg, peak gradient = 86 mmHg). No history of rheumatism was registered, therefore atherosclerotic origin of defect could be assumed. During 2013 the patient noted deterioration of dyspnea on exertion along with gradually decreased exercise tolerance.

The patient underwent clinical and instrumental examination. On electrocardiography sinus rhythm of 56 beats per minute was registered. There were signs of marked left ventricular myocardial hypertrophy. *ST*-segment depression and inverted T waves in I, aVL, V4–V6 leads were registered.

Cardiac cavities were not enlarged according to echocardiography data. The left atrium (LA) area was 16 cm^2 (anterior-posterior size of the LA = 3.2 mm), and the right atrium (RA) area – 14 cm^2. Left ventricular ejection fraction was 73%. End-diastolic dimension (EDD) = 4.4 cm, end-systolic dimension (ESD) = 2.6 cm, end-diastolic volume (EEV) = 97 cm^3 and end-systolic volume (ESV) = 25 cm^3. Interventricular septum thickness in diastole was 13 mm; posterior wall thickness in diastole – 12 mm, i.e. symmetric left ventricular myocardial hypertrophy was registered. Aorta was sclerotic, ascending aorta was 39 mm, diameter of aortic valve annulus was 21 mm. Degree 2–3 calcinosis of aortic valve cusps was observed. On Doppler echography (Figure 1): systolic flow rate in the aortic valve orifice was 5.1 m/sec, peak gradient = 114 mmHg, mean gradient = 73 mmHg, calculated aortic valve orifice area was 0.37 cm^2; marked stenosis of aortic valve orifice as well as degree I regurgitation from aorta to the left ventricle were diagnosed. Mitral valve: the cusps moved in different directions, degree 1 regurgitation was observed in the LA, mean diastolic gradient on the mitral valve was 1.78 mmHg. Tricuspid valve: the cusps moved in different directions, degree 1 regurgitation in the RA was registered, mean pulmonary artery pressure was 34 mmHg. Multispiral computed tomography confirmed marked calcinosis of aortic valve cusps without involvement of fibrous annulus (Figure 2).

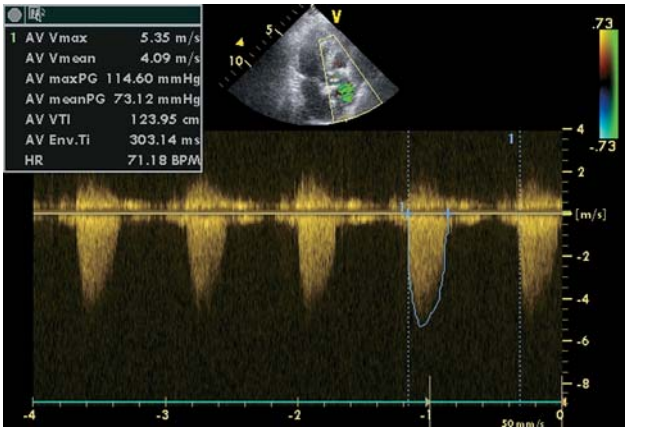


Figure 1. Patient V., 75 years old, transthoracic echocardiography (prior to TAVI). Continuous wave Doppler study, apical approach. Aortic valve (AV) systolic pressure gradient measurement. Peak gradient between the left ventricle and aorta is 114 mmHg, mean – 73 mmHg.

Selective coronary angiography (Figure 3) detected up to 70% stenosis of the main LCA in the bifurcation area. The left anterior descending artery (LAD LCA) had moderate diffuse changes along its whole length with segmented stenosis up to 70% in the proximal part. Up to 80% stenosis of the left circumflex artery (LCX LCA) in the middle segment and up to 70% stenosis of the obtuse marginal branch of the left coronary artery (OMB LCA) were also registered. The right coronary artery was without changes.

As a result of conducted investigation the following clinical diagnosis was set: Acquired heart disease; significant stenosis of aortic valve; coronary heart disease; functional class (FC) 2 exertional angina; NYHA FC 2–3; stenotic atherosclerosis of aorta and coronary arteries; up to 70% stenosis of the main LCA in the bifurcation area; up to 70%

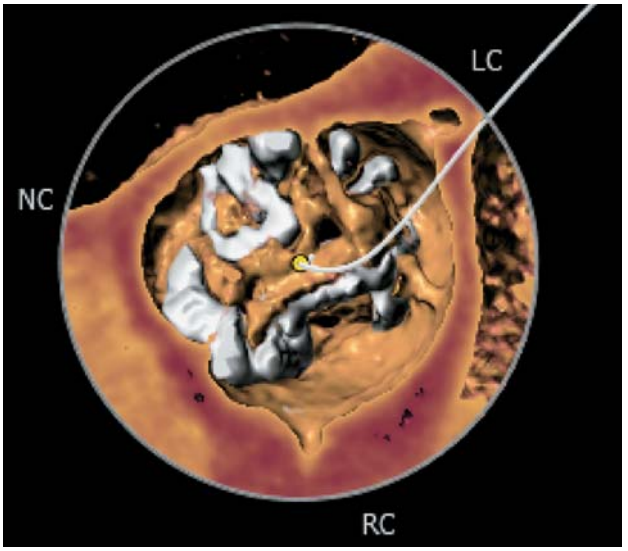


Figure 2. 3D reconstruction using multispiral computed tomography. VRT-section at the level of aortic valve annulus in the axial plane. Degree 2–3 marked calcinosis of aortic valve cusps is observed.

stenosis of the LAD LCA in the proximal part; up to 80% stenosis of the LCX LCA in the middle segment; up to 70% stenosis of the OMB LCA; essential hypertension, stage II; dyslipidemia 2A.

Concomitant diagnosis: nodular goiter; chronic hypothyreosis; renal cysts; chronic gastritis, stage of remission; discirculatory encephalopathy, grade 2; vestibulopathy; asthenoneurotic syndrome.

Considering the diagnosis and the tendency towards disease progression, it was decided to perform simultaneous combined procedure – stenting of the coronary arteries and TAVI.

At first, according to the generally accepted technique, direct stenting of a middle segment of the LCX LCA (Resolute Integrity 3.5 × 9), stenting of the main LCA involving the LCX LCA (Resolute Integrity 3.5 × 22), kissing ballooning of the LAD LCA and the LCX LCA through debulking of the stent in the main LCA, stenting of the proximal segment of the LAD LCX (Resolute Integrity 3 × 9) were performed (Figure 4).

After endovascular myocardial revascularization under general anesthesia, aortic valve implantation was performed using Edwards Sapien XT 23 mm prosthesis. Right common femoral artery was surgically isolated, introducer sheath 18 Fr was placed in it through the puncture. Introducer sheath 6 Fr was placed through the puncture in the left common femoral artery, pig tail graduated catheter was introduced through it into aortic root. The second pig tail catheter was administered into the left ventricular cavity to measure the pressure in it. Mean pressure gradient between the left ventricle and aorta at the moment of procedure was 65 mmHg. Introducer 6 Fr was placed into the right jugular vein through the puncture as well, electrode for temporary pacing was introduced through it into the right ventricular cavity. Then, valvuplasty of aortic valve using dilation

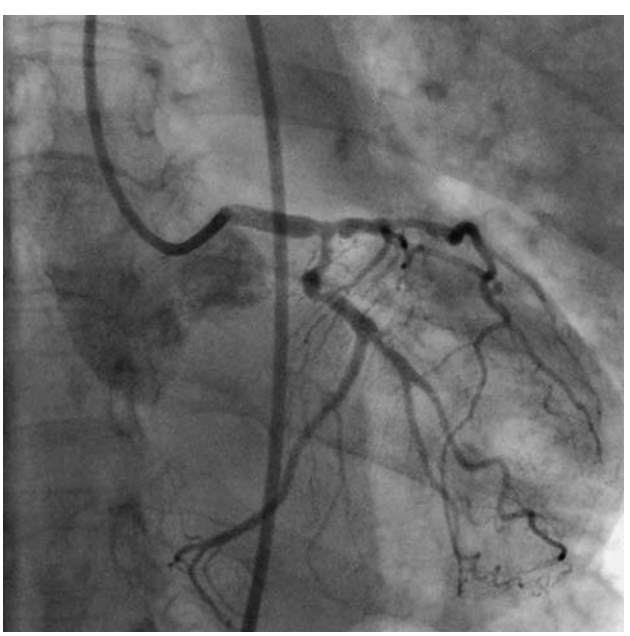


Figure 3. Coronary angiogram of the left coronary artery (LCA). Bifurcation stenotic lesion of the main LCA, as well as stenoses of proximal departments of the left anterior descending artery and the left circumflex coronary artery.

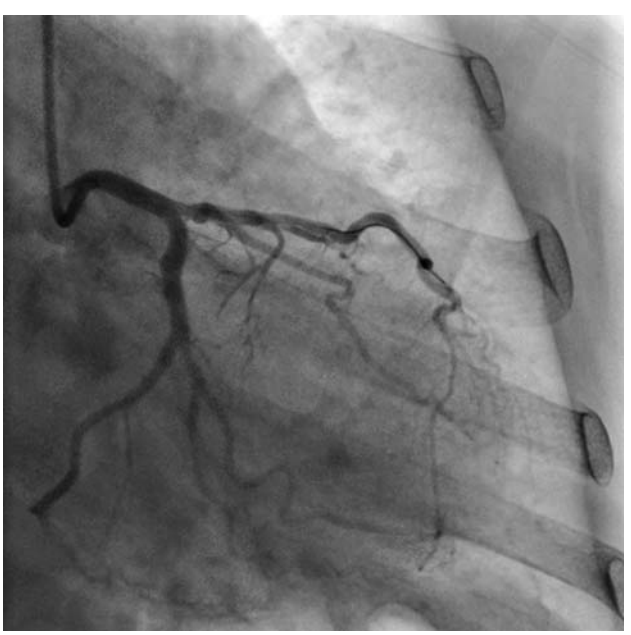


Figure 4. Coronary angiogram of the same patient after endovascular procedures: direct stenting of a middle segment of the LCX LCA (Resolute Integrity 3.5 × 9 mm), stenting of the main LCA involving the LCX LCA (Resolute Integrity 3.5 × 22 mm), kissing ballooning of the LAD LCA and the LCX LCA through debulking of the stent in the main LCA, stenting of the proximal segment of the LAD LCX (Resolute Integrity 3 × 9 mm).

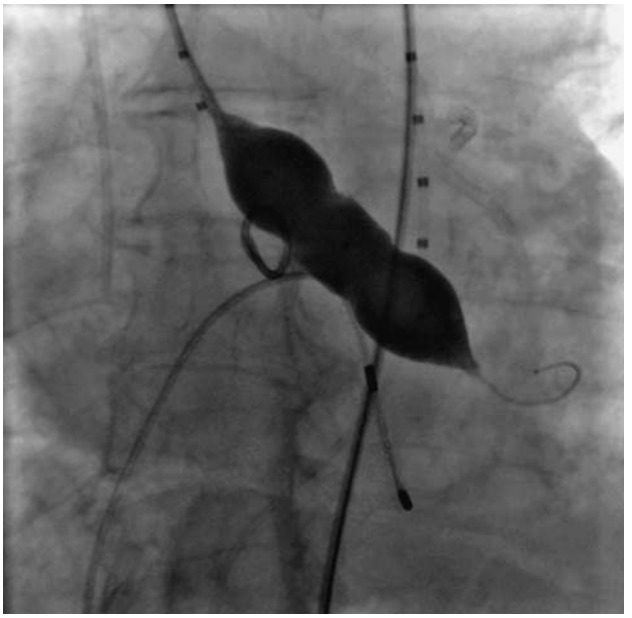


Figure 5. Balloon aortic valvuloplasty.

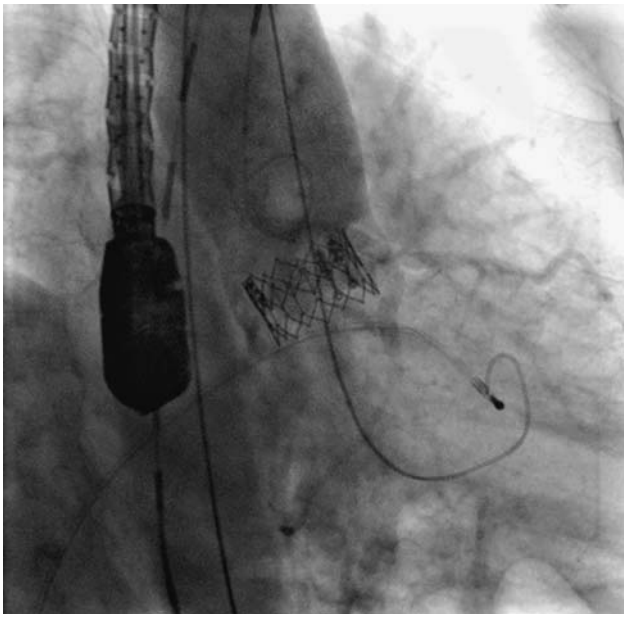


Figure 6. Edwards Sapien XT 23 mm aortic valve prosthesis implantation.

balloon 21 mm in diameter was performed under generally accepted technique with electrocardiostimulation at the frequency of 180 impulses/minute (Figure 5). Then, Edwards Sapien XT 23 mm prosthesis was inserted on the delivery device in the area of aortic valve and implanted (Figure 6). No aortic regurgitation was observed during the control aortography. Mean pressure gradient between the left ventricle and aorta was 10 mmHg. According to the data of intraoperative transesophageal echocardiography, prosthesis of aortic valve with insignificant paraprosthetic regurgitation was visualized. The prosthesis function was assessed as satisfactory. Peak gradient on the aortic valve was 14 mmHg (Figure 7). There was no fluid in the pericardial cavity. Thereon, the procedure was completed. Total duration of procedure was 120 minutes; fluoroscopy time was 43.2 minutes, amount of contrast medium – 400 mL.

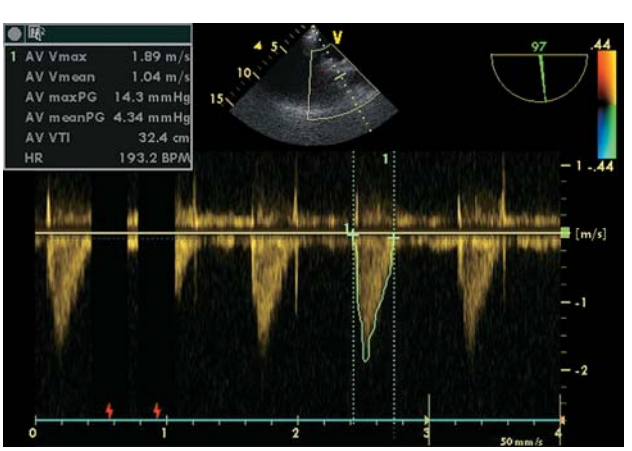


Figure 7. Transesophageal echocardiography (intraoperatively) in the same patient. Continuous wave Doppler study. AV systolic pressure gradient measurement. Peak systolic gradient on the aortic valve after prosthesis implantation is 14 mmHg, mean – 4.3 mmHg.

Discussion

Aortic stenosis is the most common disease in a group of acquired heart defects in elderly patients. In 80-85% of cases stenosis of aortic orifice develops due to atherosclerotic and degenerative changes of aortic valve cusps. It is known that a majority of patients with significant aortic stenosis have coronary heart disease. Combination of surgical aortic valve replacement and coronary artery bypass grafting (CABG) is a gold standard for treatment of patients with aortic stenosis and concomitant CHD; however, in elderly and old patients this surgery is associated with high surgical and perioperative risk (Iung B, 2008; Dimarakis I. et al., 2011) and is even contraindicated in some patients.

Patients with combination of aortic valve stenosis and stenotic lesion of the main LCA are the most difficult category of patients with high probability of disappointing immediate prognosis after establishing the diagnosis and a risk of sudden cardiac arrest. Until recently direct myocardial revascularization with aortic valve replacement was practically the only treatment method for this patient population. Although it should be noted that it is accompanied by higher incidence of intra- and perioperative complications and lethality.

As for alternative endovascular treatment of stenotic lesion of the main LCA, earlier reports on the results were disappointing due to technical difficulties, the absence of adequate expendable materials etc. Further enhancement of this procedure technique and development of more comfortable expendable materials improved immediate and long-term results of endovascular procedures in patients with the main LCA lesion, and stenting of the main LCA is widely used now in treatment of CHD patients. Meanwhile, there are only single reports on simultaneous endovascular treatment of aortic valve and main LCA stenoses. Ronen J. et al. report about combination of TAVI and percutaneous coronary intervention on the main LCA as an alternative strategy in patients at high surgical risk. They examined 10 inoperable patients who underwent stenting of the main LCA in 7 cases prior to TAVI and in 3 cases prior to balloon valvuloplasty. Moreover, endovascular procedure on aortic valve and the main LCA was performed simultaneously in 4 patients, in other 6 patients it was postponed until 2–4 weeks after the coronary artery stenting. None of the patients had complications. Mortality rate in one month was 10%.

Before making any conclusions regarding simultaneous procedures of TAVI and stenting of the main LCA, it should be noted that to date there is no common opinion on advisability and necessity to perform simultaneous procedures of TAVI and stenting of the coronary arteries. A majority of authors consider that endovascular correction of coronary blood flow should be performed in the first place, and only then after a certain time aortic valve replacement can be conducted. Their point of view is based on the fact that it can be difficult to perform a coronary procedure after valve replacement due to complicated access to the coronary orifices caused by prosthesis frame. Initial coronary artery stenting may also facilitate the second stage of treatment – endovascular aortic valve replacement due to improved myocardial vascularization of the left ventricle. Therefore, restoration of coronary blood flow in the first place is considered advisable and does not require special discussion. Only the issue on time interval between these procedures is debatable, i.e. whether to perform replacement immediately after the coronary stenting or to wait for a certain time. A majority of investigators tend towards a compliance with certain time interval; however, we consider simultaneous procedure of endovascular coronary and aortic correction more attractive due to a number of facts, the most important of which is that a patient is less loaded emotionally: (it is preferable to undergo endovascular surgery once rather than twice), also in-hospital stay duration is reduced, the drug load is reduced (two-fold reduction of a number of drugs which must be used during any endovascular procedures) etc. Of course, all of the above may be canceled in case if simultaneous procedure constitutes a life-threatening event for a patient or may cause dangerous complications. Thus, each separate case requires an individual approach in order to make a decision on treatment strategy, considering multiple factors regarding the patient himself/herself, his/her condition, the presence of serious concomitant diseases etc., as well as the choice of medical institution where this procedure will be performed: readiness of the team to simultaneously perform rather complex procedures of coronary stenting and endoprosthetic replacement of aortic valve.

In this case study we also wanted to demonstrate that successful conduction of simultaneous combined procedure of multiple coronary artery stenting and TAVI without serious complications is possible even in such complex and serious pathology of coronary arteries as combined lesions of the main LCA, circumflex branch of the LCA and left anterior descending branch of the LCA and severe atherosclerotic stenosis of aortic valve. First of all, during such procedures we should beware of renal failure caused by the contrast medium load, neurologic disorders due to anesthesia in elder patients, greater radiation exposure due to duration of the procedure and combination of two independent procedures. Meanwhile, biochemical blood parameters reflecting renal function were within normal range (creatinine 81 μmol/L, urea 6. mmol/L) in our clinical cases after procedure and in the coming days; also, no clinical manifestations of renal failure (anuria, oliguria) were observed. No significant clinical manifestations of neurologic disorders were reported. Examination of neurologist also did not reveal any dynamic deviations in the neurologic status of the patient. Total time of fluoroscopy was 43.2 minutes which is also not considered as significant deviation from the norms of single radiation exposure. Postoperative period was without complications and on Day 7 the patient was transferred to the Rehabilitation Department of the Center; she was discharged from it in a fair condition on Day 21 after conducted endovascular procedures.

Conclusion

Therefore, simultaneous conduction of TAVI and multiple coronary artery stenting including the main LCA in a female patient with critical aortic stenosis and CHD is possible, effective and safe. However, for more substantiated conclusions and guidelines, it is necessary to further accumulate experience and to thoroughly conduct comparative analysis of treatment results obtained from similar patients after various types of combined endovascular treatment.

References

1. Dewey T.M., Brown D.L., Herbert M.A. et al. Effect of concomitant coronary artery disease on procedural and late outcomes of transcatheter aortic valve implantation. Ann Thorac. Surg. 2010, 89 (3), 758–767.
2. Park S.J., Park S.W., Hong M. et al.Long-term (three-year) outcomes after stenting of unprotected left main coronary artery stenosis in patients with normal left ventricular function. Am. J. Cardiol., 2003, 91, 12–16
3. Kandzari D.E., Colombo A., Park S.J., Tomasso C.L., Ellis S.G., Guzman L.A. et al. Revascularization for unprotected left main disease: evolution of the evidence basis to redefine treatment standards. J Am Coll. Cardiol. 2009, 54, 1576–1588
4. Conradi L., Seiffert M., Franzen O. et al. First experience with transcatheter aortic valve implantation and concomitant percutaneous coronary intervention. Clin. Res. Cardiol. 2011, 100 (40), 311–316
5. Otto C.M., O'Brien K.D. Why is there discordance between calcific aortic srenosis and coronary artery disease? Heart. 2001, 85, 601–602
6. Iung B. Management of the elderly patient with aortic stenosis. Heart. 2008, 94, 519–524
7. Dimarakis I., Rehman S.M., Grant S.W. et al. Conventional aortic valve replacement for high-risk aortic stenosis patient not suitable for transcatheter aortic valva implantation: feasibility and outcomes. Eur. J. Cardiothorac. Surg. 2011, 40 (30), 743–748
8. Ronen J., Finkelstein A., Basil S. Lewis, Victor Guetta, Nader Khader, et al. Stenting of the unprotected left main coronary artery in patients with severe aortic stenosis prior to percutaneous valve interventions. Cardiovasc. Revascul. Med. 2012, 13, 90–94.

Russian Society of Interventional Cardioangiology WE ARE 15!

David Iosseliani,
the founder and the first President of RSICA
(1999–2005)
Corresponding Member of Russian Academy of Sciences, Professor, Director of Moscow City Center of Interventional Cardioangiology, Head of the Chair of Endovascular Methods of Diagnosis and Treatment of Pirogov Russian State Medical University, Head specialist of Moscow for Endovascular Diagnosis and Treatment, Moscow

Alexander Osiev,
elected president of RSICA in 2014.
Professor, head of the Center of Endovascular Surgery and X-ray Diagnosis of Meshalkin Research Institute of Circulation Pathology, Novosibirsk

"Russian Society of Interventional Cardioangiology" was founded in 1999, on the initiative of one of the leaving interventional cardiologists of Russia, the Director of Moscow City Center Interventional Cardioangiology David Iosseliani. The main task of the Society consists in unification of creative effort of the members for the stimulation of the development and maximal realization of the achievements of medical science and practice, the reinforcement of professional connections between the specialists in interventional cardioangiology and in the adjacent fields. From the time of foundation and up to 2005, David Iosseliani had been elected president of the board of RSICA. During this period regional offices of the Society were created in most regions of Russia, a Board and other working structures of the Society have been created. Five Russian congresses of interventional cardioangiology with broad participation of numerous outstanding foreign specialists have been held since the

Vladimir Ivanov,
President of RSICA in 2005–2008
Professor, Head of the Department of Endovascular Methods of Diagnosis and Treatment of Vishnevsky 3rd Central Military Clinical Hospital, Krasnogorsk

Zaza Kavteladze,
President of RSICA in 2008–2011
Professor, Head of the Department of Endovascular Methods of Diagnosis and Treatment of City Clinical Hospital №71, Moscow

Leonid Kokov,
President of RSICA in 2011–2014
Corresponding Member of Russian Academy of Sciences, Professor, Head of the Department of Endovascular Methods of Diagnosis and Treatment of Sklifosovsky Research Institute of Emergency Medicine, Head of the Chair of X-ray Diagnosis of Sechenov 1st Moscow State Medical University, Moscow

foundation of the Society. All Congresses were highly successful and evoked a wide response in medical circles in Russia and abroad. Numerous conferences, symposia, workshops, etc., were carried out. The annual International Course "Modern trends in the treatment of STEMI – from guidelines to everyday practice" is being held from 2013. From 2002, the Society publishes a bi-lingual "INterbational Journal of interventional cardioangiology" (Editor-in-Chief – D. Iosseliani). At present the Society unifies the physicians from many cities of Russia. In 2005, Vladimir Ivanov (from Krasnogorsk) has been elected President of the Society. In 2008, he has been superseded by Zaza Kavteladze (Moscow), in 2011, the Presidency went to Leonid Kokov (Moscow), and in March 2014, during the 5th Congress of RSICA, the Board has elected the new President of RSICA – Professor Alexander Osiev from Novosibirsk.

5th Russian Congress of Interventional Cardioangiology Information message

In 2014, Russian Society of Interventional Cardioangiology celebrates its jubilee – 15 years since the foundation. The main event of this jubilee was the 5th Russian Congress of Interventional Cardioangiology, which was held on March 26–28 in Moscow World Trade Center. The Congress was organized by Russian Society of Interventional Cardioangiology (RSICA) with the support of Russian Scientific Society of Cardiology and Moscow City Center of Interventional Cardioangiology. Over 500 delegates from all regions of Russia, from the countries of Former Soviet Union and beyond participated in the Congress. The geography of Russian participants is really impressive: Irkutsk, Novokuznetsk, Surgut, Lipetsk, Orenburg, Cheboksary, Toliatti, Krasnodar, Omsk, Ulan-Ude, Kurgan, Severodvinsk, Chita, Penza, Krasnoyarsk, Khanty-Mansisk, Samara, Tomsk, Volgograd, Ufa, Archangelsk, St. Petersburg, Barnaul, Cherepovets, Naberezhnye Chelny, Saratov, Petrozavodsk, Kostroma, Nalchik, Vladimir, Nijny Novgorod, Tiumen, Novosibirsk, Khabarovsk, Uhta, Belgorod, Maykop, Magadan, Yekaterinburg, Yaroslavl, Lipetsk, Yoshkar-Ola, Voronezh, Veliky Novgorod, Vladikavkaz, Miass, Makhachkala, Kursk, Kaluga, Niagan, Perm, Kazan, Tula, Cheliabinsk.

The work of the Congress started with the greeting speech of the President of RSICA, Corresponding Member of Russian Academy of Sciences, professor Leonid Kokov, dedicated to the history of RSICA. The highly topical program of the Congress included 6 Plenary and 32 Sectional sessions, as well as 16 Symposia, during which over 200 presentations and lectures have been offered to the audience. All fields of contemporary cardioangiology have been elucidated, including several domains of medicine where the methods of endovascular surgery are being actively used. Most symposia were dedicated to innovative research and the introduction of their results into the clinical practice by the leaders of world industry. Not only the specialists in endovascular diagnosis and treatment of cardiovascular diseases, but also cardiologists, vascular surgeons, oncologists, gynecologists, specialists in x-ray diagnosis have shown interest in the work of Congress.

The lectures of eminent foreign experts – Alec Vahanian (France), Bernhard Meier (Switzerland), Christoph Nienaber (Germany), George Sianos (Greece), Maciej Lesiak (Poland), Gabriel Bartal (Israel) – attracted the most interest of the audience.

One cannot overlook the memorial lecture of Professor Yury Volynsky dedicated to the 90th anniversary of the renowned physician and researcher, one of the pioneers of our profession in Russia Yury Petrossian. After the lecture, the Board of RSICA has announced its decision to institute a memorial Petrossian medal "For the contribution to the development of the profession". This medal shall be awarded to our colleagues for their best achievements in clinical and research activities.

The Congress ended by the meeting of RSICA Board held to hear reports and elect new officials. The President of the Society Professor L. Kokov presented his substantive report. The Board gave a high appreciation to the work of the Society officials and President and expressed its gratitude to the Organizing Committee for the high level of the Congress organization. In accordance with the statute, the composition of the Board has been revised. After that, the renewed Board has elected Professor Alexander Osiev as the President of RSICA.

The Organizing Committee of the Congress would like to express its deepest and most sincere gratitude to all the participants, speakers and lecturers, to the sponsors for their substantial support, to all our colleagues who have devoted their energies to the holding of the 5th Jubilee Congress. We congratulate the new President Alexander Osiev and wish the Society to conduct an interesting and fruitful work under his guidance.

The Organizing Committee