ST-elevation myocardial infarction secondary to paradoxical coronary emboli in a patient with massive pulmonary embolism and essential thrombocythemia: A case report

Fahad S. Almeahmadi, Albayda M. Mehdar, Kumar Sridhar, Patrick Teefy

ABSTRACT

Introduction: Essential thrombocythemia (ET) is a myeloproliferative disorder with higher incidence of thrombotic events. To our knowledge, we present the first case of ST-segment elevation myocardial infarction (STEMI) secondary to paradoxical right coronary artery (RCA) embolus through a patent foramen ovale (PFO) in a patient with essential thrombocythemia and pulmonary embolism.

Case Report: A 67-year old female with a history of ET presented to the emergency room with dyspnea. Physical examination revealed an elevated JVP, an S1Q3T3 pattern on her presenting ECG, and an elevated D-dimer. V/Q scan showed a high probability for pulmonary embolism as well as unusual evidence of right-to-left cardiac shunting. After starting low molecular weight heparin, she developed new-onset chest pain and her ECG showed ST-elevation in the inferior leads. Emergency left and right heart catheterization showed an acutely occluded RCA with heavy thrombus burden. This was managed successfully with thrombus aspiration only. Massive bilateral pulmonary embolism was seen on thoracic computed tomography (CT) scan, which was managed by systemic thrombolysis. A Transesophageal echocardiogram was performed, which confirmed a patent PFO with right-to-left shunting. The patient was treated medically with dual antiplatelets, anticoagulation with heparin and hydroxyurea. Given the degree of thrombotic burden PFO closure was not performed and the patient was managed conservatively with lifelong anticoagulation. The patient has been followed closely, and three years post-event, she has done remarkably well on warfarin with no evidence of further thromboembolism.

Conclusion: We describe the first case of paradoxical coronary artery embolism through a PFO in a patient with ET and massive PE. Our patient was managed conservatively on oral anticoagulation without further thromboembolic events at three years post-event.

International Journal of Case Reports and Images (IJCRI)

International Journal of Case Reports and Images (IJCRI) is an international, peer reviewed, monthly, open access, online journal, publishing high-quality, articles in all areas of basic medical sciences and clinical specialties.

Aim of IJCRI is to encourage the publication of new information by providing a platform for reporting of unique, unusual and rare cases which enhance understanding of disease process, its diagnosis, management and clinico-pathologic correlations.

IJCRI publishes Review Articles, Case Series, Case Reports, Case in Images, Clinical Images and Letters to Editor.

Website: www.ijcasereportsandimages.com

CASE REPORT

PEER REVIEWED | OPEN ACCESS

ST-elevation myocardial infarction secondary to paradoxical coronary emboli in a patient with massive pulmonary embolism and essential thrombocytosis: A case report

Fahad S. Almehmadi, Albayda M. Mehdar, Kumar Sridhar, Patrick Teefy

ABSTRACT

Introduction: Essential thrombocytosis (ET) is a myeloproliferative disorder with higher incidence of thrombotic events. To our knowledge, we present the first case of ST-segment elevation myocardial infarction (STEMI) secondary to paradoxical right coronary artery (RCA) embolus through a patent foramen ovale (PFO) in a patient with essential thrombocytosis and pulmonary embolus. **Case Report:** A 67-year old female with a history of ET presented to the emergency room with dyspnea. Physical examination revealed an elevated JVP, an S1Q3T3 pattern on her presenting ECG, and an elevated D-dimer. V/Q scan showed a high probability for pulmonary embolism as well as unusual evidence of right-to-left cardiac shunting. After starting low molecular weight heparin, she developed new-onset chest

pain and her ECG showed ST-elevation in the inferior leads. Emergency left and right heart catheterization showed an acutely occluded RCA with heavy thrombus burden. This was managed successfully with thrombus aspiration only. Massive bilateral pulmonary embolism was seen on thoracic computed tomography (CT) scan, which was managed by systemic thrombolysis. A Transesophageal echocardiogram was performed, which confirmed a patent PFO with right-to-left shunting. The patient was treated medically with dual antiplatelets, anticoagulation with heparin and hydroxyurea. Given the degree of thrombotic burden PFO closure was not performed and the patient was managed conservatively with lifelong anticoagulation. The patient has been followed closely, and three years post-event, she has done remarkably well on warfarin with no evidence of further thromboembolism. **Conclusion:** We describe the first case of paradoxical coronary artery embolism through a PFO in a patient with ET and massive PE. Our patient was managed conservatively on oral anticoagulation without further thromboembolic events at three years post-event.

Keywords: Essential thrombocytosis, Myocardial infarction, Paradoxical embolism, Patent foramen ovale, Pulmonary embolism

How to cite this article

Almehmadi FS, Mehdar AM, Sridhar K, Teefy P. ST-elevation myocardial infarction secondary to paradoxical coronary emboli in a patient with massive pulmonary embolism and essential thrombocytosis: A case report. Int J Case Rep Images 2015;6(3):149–155.

Fahad S. Almehmadi¹, Albayda M. Mehdar², Kumar Sridhar³, Patrick Teefy⁴

Affiliations: ¹MBBS, FRCPC, Adult Cardiology Resident, Department of Medicine, University of Toronto, Toronto, Ontario, Canada, Adult Cardiology Scholar at King Saud Bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia; ²MBBS, Internal Medicine Resident, Department of Medicine, University of Toronto, Toronto, Ontario, Canada; ³MD, FRCPC, Associate Professor, Department of Medicine, University of Western Ontario, London, Ontario, Canada; ⁴MD, FRCPC, Associate Cardiology Professor, Department of Medicine, University of Western Ontario, London, Ontario, Canada.

Corresponding Author: Dr. Fahad Saleh Almehmadi, Adult Cardiology Program, University of Toronto, 2305-1055 Bay Street, Toronto, Ontario, M5S 3A3, Canada; Tel: 416-567-5516; Email: falmehma@gmail.com

Received: 13 October 2014
Accepted: 19 November 2014
Published: 01 March 2015

doi:10.5348/ijcri-201528-CR-10489

INTRODUCTION

Essential thrombocytosis (ET) is a myeloproliferative disorder characterized by pathological clonal proliferation of megakaryocytes and thrombocythemia [1]. Essential thrombocytosis can be complicated by both thrombotic and/or hemorrhagic sequelae. De Novo coronary thrombus is rare, but has been described in literature [2–11]. We present a patient with ET and an unusual presentation of inferior myocardial infarction secondary to paradoxical embolus through a patent foramen ovale (PFO) in the setting of acute pulmonary embolism.

CASE REPORT

A 67-year-old female presented to the emergency department with rapidly progressing dyspnea and epigastric pain. Her past medical history was significant for ET, hypertension, atrial fibrillation, and osteoporosis. Her ET was diagnosed six years ago based on persistent thrombocythemia ($1100 \times 10^9/\text{dL}$). Her medications included aspirin 81 mg and hydroxyurea 1000/500 mg on alternate days. On presentation, she was tachycardic, tachypneic and hypoxic. Physical examination revealed an elevated JVP and bilateral lower limb edema. Initial blood work showed a white blood cell count $7.1 \times 10^9/\text{dL}$, hemoglobin 14.9 g/dL, platelet count $412 \times 10^9/\text{dL}$, D-dimer >4000, creatine kinase 59, and troponin-T 0.03. Presenting ECG showed a typical S1Q3T3 pattern and symmetric T-wave inversion in anterior precordial leads (Figure 1). Her chest X-ray was unremarkable. Acute pulmonary embolus was suspected and a V/Q scan revealed high probability of pulmonary embolism. V/Q scan unexpectedly revealed uptake of radiotracer in the kidneys, suspicious for a right-to-left cardiac shunt. (Figure 2) Transthoracic echocardiogram showed severe right ventricular dilation with septal shift and left-to-right intra-atrial shunting, suggestive of a PFO. The patient was started on subcutaneous low molecular weight heparin for a presumed pulmonary embolism.

She remained clinically stable for eight hours, and then suddenly developed worsening chest pain, hypotension, and worsening hypoxia. Repeat ECG revealed ST-segment elevation in leads II, III and aVF consistent with STEMI (Figure 3). She was immediately intubated, started on dopamine and taken for cardiac catheterization. Left and right heart catheterization showed normal left main, left anterior descending, and left circumflex arteries, and a completely occluded right coronary artery (RCA) (Figure 4). Thrombectomy to the RCA was performed with a 6 F Export® thrombectomy catheter with concomitant administration of intra-coronary abciximab. TIMI 3 flow

in RCA was established though distal embolization to the posterior descending and posterior-lateral arteries was apparent (Figure 5) that subsequently cleared when additional unfractionated heparin was bloused (Figure 6). Right heart catheterization showed an elevated RV pressure of 70/18 mmHg. Oxygen saturation analysis of the right-sided chambers did not reveal a “step-up” to suggest a large left-to-right shunt. Moreover, trans-septal puncture and left sided chamber oxygen saturation measurements also did not reveal a significant step down from femoral artery’s readings.

The patient was started on an abciximab infusion for 12 hours and admitted to the intensive care unit. She continued to deteriorate hemodynamically and recombinant tissue plasminogen activator (tPA) was given. Transesophageal echocardiography showed a markedly dilated and hypokinetic right ventricle, a redundant and hypermobile inter-atrial septum with an 8-mm connection suggestive of a PFO (Figure 7). Bubble study showed intense and immediate opacification of the left atrium, confirming right-to-left shunting (Figure 8). There was no evidence of left atrial or left ventricular thrombi. The computed tomography (CT) pulmonary angiography confirmed the diagnosis of massive bilateral pulmonary emboli. The patient did well post coronary thrombectomy and systemic thrombolysis with no further thrombotic sequelae or hemorrhagic complications. She was started on unfractionated heparin and transferred to the cardiology ward one week later. She was transitioned to warfarin with a target INR between 2 and 3, and

Figure 1: Electrocardiography at presentation, S1Q3T3 pattern and symmetric T wave inversion in anterior precordial leads indicating right ventricular strain.

Figure 2: Perfusion images of V/Q scan showing high probability for pulmonary embolism, but also show an unexpected radiotracer uptake in kidneys.

also maintained on hydroxyurea 1000 mg/500 mg on alternate days. She continued to improve clinically and was eventually discharged home. The decision was not to close her PFO and resume therapeutic anticoagulation. The patient was done well on medical therapy, symptom free at three-year follow-up

DISCUSSION

Essential thrombocytosis (ET) is a rare myeloproliferative disorder characterized by megakaryocytic lineage expansion leading to sustained thrombocythemia and increased risk of bleeding and thrombosis. Essential thrombocytosis affects 0.5–2.5/100,000 patients with higher predisposition in

Figure 3: Electrocardiography after eight hours of admission showing ST-segment elevation in II, III and aVF indicating inferior injury with ST-segment depression in V2-V3 pointing to posterior extension.

Figure 4: Left anterior oblique view of right coronary artery angiogram showing a complete occlusion at mid-segment with TIMI-0 flows.

Figure 5: Left anterior oblique view of the right coronary artery angiogram post-thrombectomy with distal embolization to posterior lateral and posterior descending artery. Note the smooth lining within the right coronary artery.

Figure 6: Left anterior oblique view of the right coronary artery after thrombectomy, IIb/IIIa and heparin showing no residual clot in right coronary artery, posterior descending artery or posterior-lateral artery.

females [1]. Thrombosis can involve any vascular bed and is associated with a higher morbidity and mortality than bleeding, which is typically limited to the skin and mucous membranes [1]. Deep venous thrombosis and pulmonary

Figure 7: Transesophageal echo bi-caval view with color flow Doppler showing right to left shunt.

Figure 8: Transesophageal echo bi-caval view with bubble study showing immediate left atrial opacification through the patent foramen ovale.

embolism are the most common thrombotic manifestation [12]. The incidence of ET related thrombotic events is 15–26.4% and in western studies [3]. Factors predisposing to thrombosis are age >60, previous thrombotic event, higher cardiac risk factors, and leukocytosis >15,000 [1, 13]. Platelet counts do not predict thrombotic events, as 10–20% of severe thrombotic complications occur in patients with platelets counts of $<60 \times 10^9/L$ [14, 15]. Our case also represents an example of life-threatening thrombosis with normal platelets counts.

Typical ECG changes in setting of pulmonary embolism include sinus tachycardia, S1Q3/S1Q3T3 pattern, right axis deviation, transient complete or incomplete right bundle branch block, and T-wave inversions in the right pericardial lead. All of these findings, except sinus tachycardia were seen on our first

ECG. The patients ECG also had symmetrical T-Wave inversion in leads V1–V4, which is a marker for worse prognosis in hospitalized patients with pulmonary embolism [16]. ST-segment elevation has been described in the setting of pulmonary embolism [17, 18]. It is presumed to be secondary to pressure overload and subendocardial ischemia involving the right ventricle, but paradoxical embolism with subsequent coronary occlusion has also been postulated [17, 19]. STEMI is a rare but well described complication of ET both as an initial manifestation and during follow-up. Approximately, 20 cases of STEMI occurring in the setting of ET have been described. Left main and left anterior descending (LAD) occlusions represent the majority of cases [8, 11] and only five cases have right coronary artery (RCA) involvement [5–7, 20, 21], and no isolated circumflex involvement has been described. To our knowledge, our case is the first published report of RCA occlusion secondary to paradoxical coronary embolism in a patient with ET and massive bilateral pulmonary embolism.

As per criteria suggested by Johnson et al., a paradoxical embolism (PDE) can be presumed when there is evidence of arterial embolization in the absence of a source in the left heart, or when there is a venous source of embolism and an abnormal communication between the venous and the arterial circulation is demonstrated [22]. All three criteria are applicable to our case [22].

Most cases of paradoxical embolism are associated with PFO, while ASD, pulmonary AV malformation, or VSD have been described less frequently [23]. Paradoxical embolism to the coronary tree is rare and constitutes 5–10% of all paradoxical emboli [22]. Paradoxical emboli are further supported if pressure gradients support right-to-left shunting. Pulmonary embolism is associated with 60% of the cases of paradoxical embolism in patients with a PFO and right-to-left shunting [23].

We decided to treat the coronary emboli with manual aspiration and intracoronary abciximab without stenting given the absence of residual disease post-aspiration. Manual thrombectomy has been shown to be beneficial in patients with STEMI in the setting of primary PCI [24]. Murhtay et al. described a successful aspiration of LAD emboli using Export® catheter with eptifibatide infusion in treating PDE resulting from an underlying DVT [22]. Kujime et al. described successful use of Thrombuster® aspiration catheter in treating paradoxical RCA clot [25]. Wilson et al. successfully used Export® catheter in conjunction with heparin and eptifibatide in treating an occluded obtuse marginal coronary embolus [26]. Glycoprotein IIb/IIIa infusion post-catheterization has been used in conjunction with thrombectomy to treat high thrombus burden in ET related coronary emboli. Murthay et al. described the use of eptifibatide infusion for 18 hours post-procedure in a similar case [22]. Michaels et al. described the utility of abciximab as an effective sole therapy for decreasing the thrombus burden. In a 50-year-old male with ET and STEMI, angiogram showed extensive clot to left coronary system and total occlusion

of RCA. He was successfully treated with thrombectomy to the RCA alone with abciximab infusion for 24 hours [6].

We decided not to close the patient's PFO. The thrombotic potential of the closure device may have negated any potential benefit from closure. Three relatively recent randomized controlled trials, CLOSURE I [27], PC [28], and PROSPECT [29], failed to prove any benefit of percutaneous closure over medical therapy in patients with paradoxical embolism secondary to PFO. Also a recent meta-analysis by Ntaios et al. showed the same results [30]. Our patient is unique, as her paradoxical embolic event was a STEMI. She has remained stable with rigorous maintenance of therapeutic anticoagulation with warfarin.

CONCLUSION

Essential thrombocytosis is a disorder of dysfunctional platelet overproduction leading a high risk of catastrophic thrombotic events even with normal platelets count. This case shows a rare presentation of paradoxical coronary embolism through a patent foramen ovale in patients with massive pulmonary embolism. Coronary embolism itself is rare, and should always be considered in venous thromboembolism patients with cardiac deterioration. There is no clear treatment consensus in such patients, but combination therapy of thrombectomy and a GPIIb/IIIa inhibitor in the acute setting with chronic anticoagulation was successfully employed in our case. Patent foramen ovale closure may be considered to prevent further embolism, however, our patient did well conservatively, with anticoagulation only.

Author Contributions

Fahad S. Almehmadi – Conception and design, Drafting the article, Critical revision of the article, Final approval of the version to be published

Albayda M. Mehdar – Conception and design, Drafting the article, Critical revision of the article, Final approval of the version to be published

Kumar Sridhar – Analysis and interpretation of data, Drafting the article, Critical revision of the article, Final approval of the version to be published

Patrick Teefy – Acquisition of data, Analysis and interpretation of data, Drafting the article, Critical revision of the article, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

Copyright

© 2015 Fahad S. Almehmadi et al. This article is distributed under the terms of Creative Commons Attribution License which permits unrestricted use, distribution and reproduction in any medium provided the original author(s) and original publisher are properly credited. Please see the copyright policy on the journal website for more information.

REFERENCES

1. Briere JB. Essential thrombocythemia. *Orphanet J Rare Dis* 2007 Jan 8;2:3.
2. Bildirici U, Celikyurt U, Ural E. Essential thrombocythemia: A case of acute st-segment elevation myocardial infarction in a young female. *Clin Cardiol* 2009 Feb;32(2):104–5.
3. Cheng CW, Hung MJ. Coronary spasm-related acute myocardial infarction in a patient with essential thrombocythemia. *World J Cardiol* 2011 Aug 26;3(8):278–80.
4. Daya SK, Gowda RM, Landis WA, Khan IA. Essential thrombocythemia-related acute st-segment elevation myocardial infarction. A case report and literature review. *Angiology* 2004 May-Jun;55(3):319–23.
5. Hamada Y, Matsuda Y, Fujii B, et al. Multiple coronary thrombosis in a patient with thrombocytosis. *Clin Cardiol* 1989 Dec;12(12):723–4.
6. Michaels AD, Whisenant B, MacGregor JS. Multivessel coronary thrombosis treated with abciximab (reopro) in a patient with essential thrombocythemia. *Clin Cardiol* 1998 Feb;21(2):134–8.
7. Mizuta E, Takeda S, Sasaki N, et al. Acute myocardial infarction in a patient with essential thrombocythemia: Successful treatment with percutaneous transluminal coronary recanalization. *Circ J* 2005 Aug;69(8):1000–2.
8. Ozben B, Ekmekci A, Bugra Z, Umman S, Meric M. Multiple coronary thrombosis and stent implantation to the subtotally occluded right renal artery in a patient with essential thrombocytosis: A case report with review. *J Thromb Thrombolysis* 2006 Aug;22(1):79–84.
9. Singla A, Jagasia D, Garg M, Lowry PA, Stapleton D. Acute st-segment elevation myocardial infarction: A rare initial presentation of previously undiagnosed essential thrombocythemia. *Platelets* 2012;23(6):463–6.
10. Turgut T, Harjai KJ, Edupuganti R, et al. Acute coronary occlusion and in-stent thrombosis in a patient with essential thrombocythemia. *Cathet Cardiovasc Diagn* 1998 Dec;45(4):428–33.
11. Watanabe T, Fujinaga H, Ikeda Y, et al. Acute myocardial infarction in a patient with essential thrombocythemia who underwent successful stenting—a case report. *Angiology* 2005 Nov-Dec;56(6):771–4.
12. Mitus AJ, Schafer AI. Thrombocytosis and thrombocythemia. *Hematol Oncol Clin North Am* 1990 Feb;4(1):157–78.
13. Wolanskyj AP, Schwager SM, McClure RF, Larson DR, Tefferi A. Essential thrombocythemia beyond the first decade: Life expectancy, long-term complication

- rates, and prognostic factors. *Mayo Clin Proc* 2006 Feb;81(2):159–66.
14. Colombi M, Radaelli F, Zocchi L, Maiolo AT. Thrombotic and hemorrhagic complications in essential thrombocythemia. A retrospective study of 103 patients. *Cancer* 1991 Jun 1;67(11):2926–30.
 15. Regev A, Stark P, Blickstein D, Lahav M. Thrombotic complications in essential thrombocythemia with relatively low platelet counts. *Am J Hematol* 1997 Nov;56(3):168–72.
 16. Falterman TJ, Martinez JA, Daberkow D, Weiss LD. Pulmonary embolism with st segment elevation in leads v1 to v4: Case report and review of the literature regarding electrocardiographic changes in acute pulmonary embolism. *J Emerg Med* 2001 Oct;21(3):255–61.
 17. Cheng TO. Mechanism of st-elevation in precordial leads v(1)-v(4) in acute pulmonary embolism. *Int J Cardiol* 2009 Aug 21;136(3):251–2.
 18. Goslar T, Podbregar M. Acute ecg st-segment elevation mimicking myocardial infarction in a patient with pulmonary embolism. *Cardiovasc Ultrasound* 2010 Nov 24;8:50.
 19. Uchida S, Yamamoto M, Masaoka Y, Mikouchi H, Nishizaki Y. A case of acute pulmonary embolism and acute myocardial infarction with suspected paradoxical embolism after laparoscopic surgery. *Heart Vessels* 1999;14(4):197–200.
 20. Koh KK, Cho SK, Kim SS, Oh BH, Lee YW. Coronary vasospasm, multiple coronary thrombosis, unstable angina and essential thrombocytosis. *Int J Cardiol* 1993 Sep;41(2):168–70.
 21. Saffitz JE, Phillips ER, Temeszy-Armos PN, Roberts WC. Thrombocytosis and fatal coronary heart disease. *Am J Cardiol* 1983 Sep 1;52(5):651–2.
 22. Murthy A, Shea M, Karnati PK, El-Hajjar M. Rare case of paradoxical embolism causing myocardial infarction: Successfully aborted by aspiration alone. *J Cardiol* 2009 Dec;54(3):503–6.
 23. Ahmed S, Sadiq A, Siddiqui AK, Borgen E, Mattana J. Paradoxical arterial emboli causing acute limb ischemia in a patient with essential thrombocytosis. *Am J Med Sci* 2003 Sep;326(3):156–8.
 24. Burzotta F, De Vita M, Gu YL, 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 Sep;30(18):2193–203.
 25. Kujime S, Hara H, Enomoto Y, et al. A case of paradoxical embolic st-segment elevation myocardial infarction triggered by sleep apnea. *Intern Med* 2012;51(14):1851–5.
 26. Wilson AM, Ardehali R, Brinton TJ, Yeung AC, Vagelos R. Successful removal of a paradoxical coronary embolus using an aspiration catheter. *Nat Clin Pract Cardiovasc Med* 2006 Nov;3(11):633–6.
 27. Furlan AJ, Reisman M, Massaro J, et al. Closure or medical therapy for cryptogenic stroke with patent foramen ovale. *N Engl J Med* 2012 Mar 15;366(11):991–9.
 28. Meier B, Kalesan B, Mattle HP, et al. Percutaneous closure of patent foramen ovale in cryptogenic embolism. *N Engl J Med* 2013 Mar 21;368(12):1083–91.
 29. Carroll JD, Saver JL, Thaler DE, et al. Closure of patent foramen ovale versus medical therapy after cryptogenic stroke. *N Engl J Med* 2013 Mar 21;368(12):1092–100.
 30. Ntaios G, Papavasileiou V, Makaritsis K, Michel P. PFO closure vs. Medical therapy in cryptogenic stroke or transient ischemic attack: A systematic review and meta-analysis. *Int J Cardiol* 2013 Oct 30;169(2):101–5.

ABOUT THE AUTHORS

Article citation: Almehmadi FS, Mehdar AM, Sridhar K, Teefy P. ST-elevation myocardial infarction secondary to paradoxical coronary emboli in a patient with massive pulmonary embolism and essential thrombocytosis: A case report. *Int J Case Rep Images* 2015;6(3):149–155.

Fahad S. Almehmadi is a second year Adult Cardiology Resident at University of Toronto in Canada. He earned his medical degree with distinction from Umm Alqura University in Makkah, Saudi Arabia. He intends to pursue an academic career in cardiology and cardiac electrophysiology.

Albayda M. Mehdar is a second year Internal Medicine Resident at University of Toronto in Canada. She earned her medical degree with distinction from King Abdulaziz University in Jeddah, Saudi Arabia.

Kumar Sridhar is Associate Professor at Western University – Department of Medicine and University Hospital and Interventional Cardiologist and Director of CCU at London Health Sciences Centre. Dr. Sridhar completed his medical training at Western University, London, Ontario and his interventional cardiology fellowship at Western University and Thomas Jefferson University Hospital in Philadelphia, Pennsylvania. He has a number of publications in peer-reviewed journals, book chapters and research interests specific to novel treatment coronary interventions and treatment strategies.

Patrick Teefy is Director of the Cardiac Catheterization Laboratories at London Health Sciences Centre, London, Ontario Canada and Associate Professor, University of Western Ontario. His research interests include interventional cardiology and trans-catheter aortic valve implantation.

Access full text article on
other devices

Access PDF of article on
other devices

Edorium Journals: An introduction

Edorium Journals Team

About Edorium Journals

Edorium Journals is a publisher of high-quality, open access, international scholarly journals covering subjects in basic sciences and clinical specialties and subspecialties.

Invitation for article submission

We sincerely invite you to submit your valuable research for publication to Edorium Journals.

But why should you publish with Edorium Journals?

In less than 10 words - we give you what no one does.

Vision of being the best

We have the vision of making our journals the best and the most authoritative journals in their respective specialties. We are working towards this goal every day of every week of every month of every year.

Exceptional services

We care for you, your work and your time. Our efficient, personalized and courteous services are a testimony to this.

Editorial Review

All manuscripts submitted to Edorium Journals undergo pre-processing review, first editorial review, peer review, second editorial review and finally third editorial review.

Peer Review

All manuscripts submitted to Edorium Journals undergo anonymous, double-blind, external peer review.

Early View version

Early View version of your manuscript will be published in the journal within 72 hours of final acceptance.

Manuscript status

From submission to publication of your article you will get regular updates (minimum six times) about status of your manuscripts directly in your email.

Our Commitment

Six weeks

You will get first decision on your manuscript within six weeks (42 days) of submission. If we fail to honor this by even one day, we will publish your manuscript free of charge.

Four weeks

After we receive page proofs, your manuscript will be published in the journal within four weeks (31 days). If we fail to honor this by even one day, we will publish your manuscript free of charge and refund you the full article publication charges you paid for your manuscript.

Mentored Review Articles (MRA)

Our academic program "Mentored Review Article" (MRA) gives you a unique opportunity to publish papers under mentorship of international faculty. These articles are published free of charges.

Favored Author program

One email is all it takes to become our favored author. You will not only get fee waivers but also get information and insights about scholarly publishing.

Institutional Membership program

Join our Institutional Memberships program and help scholars from your institute make their research accessible to all and save thousands of dollars in fees make their research accessible to all.

Our presence

We have some of the best designed publication formats. Our websites are very user friendly and enable you to do your work very easily with no hassle.

Something more...

We request you to have a look at our website to know more about us and our services.

We welcome you to interact with us, share with us, join us and of course publish with us.

Edorium Journals: On Web

Browse Journals

CONNECT WITH US