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CASE SERIES - CORONARY ARTERY PERFORATIONS AND DIFFERENT METHODS OF MANAGEMENT.

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ABSTRACT:

Coronary artery perforation (CAP) is a potentially lethal complication of percutaneous coronary intervention. The risk of coronary perforation is associated with the complexity of the lesion. Severe coronary artery perforation is a rare but potentially life threatening complication which requires immediate intervention.

Keywords: coronaryarteryperforation; myocardial infarction.percutaneous coronaryintervention;

INTRODUCTION: Iatrogenic coronary artery perforation (CAP) is a rare complication of percutaneous coronary intervention (PCI).The imminent lethal outcome of CAP stems from the hemodynamic compromise of ensuing cardiac tamponade.With the advent of new devices and technologies, interventionalists and cardiac surgeons attempt more complex lesions including more calcified and tortuous vessels. We report three cases of severe coronary artery perforations and their management using three different techniques.

CASE 1: 60 year old gentleman with no comorbidities presented with Non ST elevation myocardial infarction(NSTEMI). Caronary angiogram showed significant double vessel disease- Type 3 tortuos LAD with mid segment 90% calcific stenosis. Dominant Right coronary artery (RCA) had critical focal stenosis in mid RCA with TIMI II flow. RCA PCI (percutaneous coronary intervention)was done with TIMI III flow. LAD PCI was staged. Right femoral 6French (F) arterial access was taken. The vessel was cannulated with Extra back up (EBU-Medtronic,Minneapolis, USA) 6 French catheter with 3.5 curve. The lesion was wired with 0.014 inch Balance middle weight (BMW) coronary wire. The lesion was predilated with 2.5 x 10 mm semi-compliant balloon at 14 atmospheres (atm). 3 x 36 mm sirolimus eluting stent (DES) was deployed at 12 atm. 3 x 10 mm 1:1, non-compliant balloon (Medtronic, Minneapolis, USA) was used for post dilatation at 20 atm. The control angiography after post dilatation showed Ellis type III perforation at the distal edge of the stent. The post- dilatation balloon which was in

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the guide catheter was reintroduced immediately to the site of perforation and balloon occlusion at 6 atmospheric pressure (atm) was done to seal the perforation. Echocardiography showed moderate pericardial effusion with right atrial diastolic collapse suggestive of tamponade. He had hemodynamic instability with fall in blood pressure in that short span of time. Urgent pericardiocentesis was done with auto-transfusion of blood into the femoral venous access site; hemodynamicsstabilised. Intermittent balloon occlusion at site of perforation was continued for 20 minutes(fig-1). ACT done was 200 seconds. Protamine sulphate to reverse heparin was not considered in view of its attendant risk of stent thrombosis and also because patient's hemodynamic had stabilised after pericardiocentesis and ballon occlusion. perfusion ballon catheter wasnot available.

Dual guide access strategy was planned as deflation of balloon for even a short span of time was causing fluctuation in hemodynamics. An alternate 7 French left femoral arterial access was taken. JL 7F guide was introduced. The existing EBU catheter was disengaged from left main coronary artery while the balloon was kept inflated in the lesion. JL 7F catheter was positioned parallel to the first catheter and was used to cannulate the left coronary artery. A floppy coronary 0.014 inch cougar guide wire was advanced until the proximal part of the inflated balloon. Just before it had to cross the site of perforation, the sealing balloon was deflated quickly. Guide wire was then crossed to the distal vessel. Balloon was re-inflated. 2.8 x 26 mm Graftmaster covered stent was then deployed at 17 atm. Check shoot showed sealing of perforation with TIMI III flow (fig-2).However he had thrombus in Ostial LAD and LCX. LCX was wired and thrombus aspiration done. Ostio-proximal LAD was dottered. Patient was stabilised in cardiac care unit. Dual antiplatelet therapy with aspirin and ticagrelor were continued. Check angiogram done on day 3 showed resolution of thrombus. Patient was discharged on day 6 in stable state and continues to be on regular follow up.

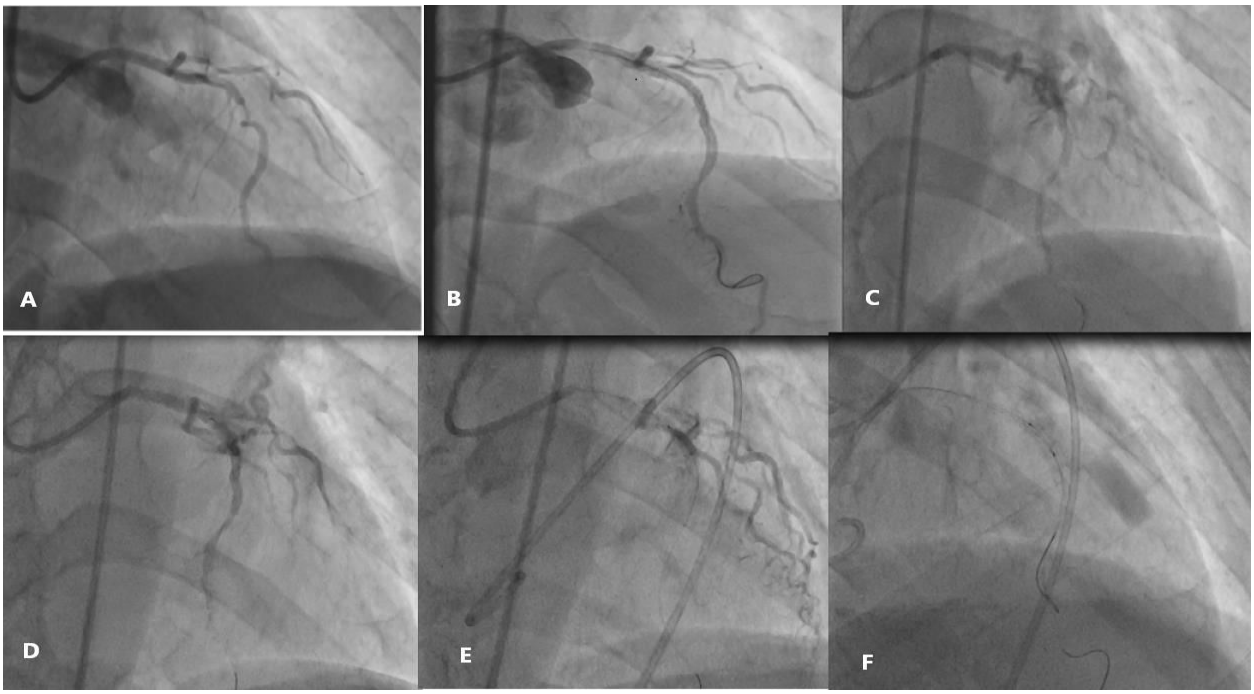

FIG-1. RAO cranial view of left coronary system showing long segment tortuous calcific mid lad with 90% stenosis. (A). Cranial view showing lad stent deployment.(B). Type III perforation at the mid mid lad after stent dialation with non compliant ballon.(C). Ballon tamponade of mid lad using the same non compliant ballon(D).Emergency pericardiocentesis was done using pigtail catheter(E). LAD was rewired with another PTCA wire after canulating LMCA with JL catheter(F).

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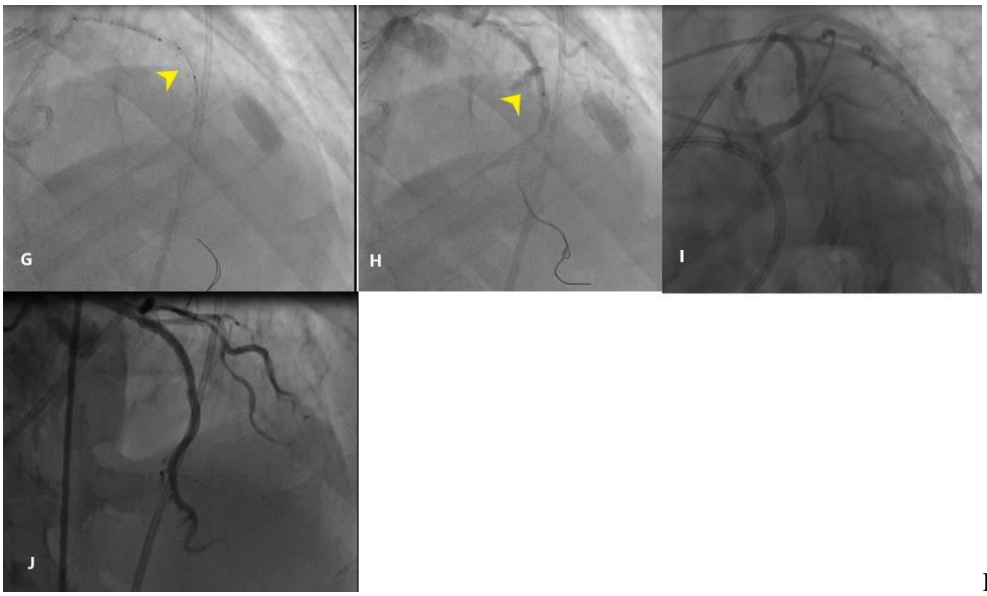
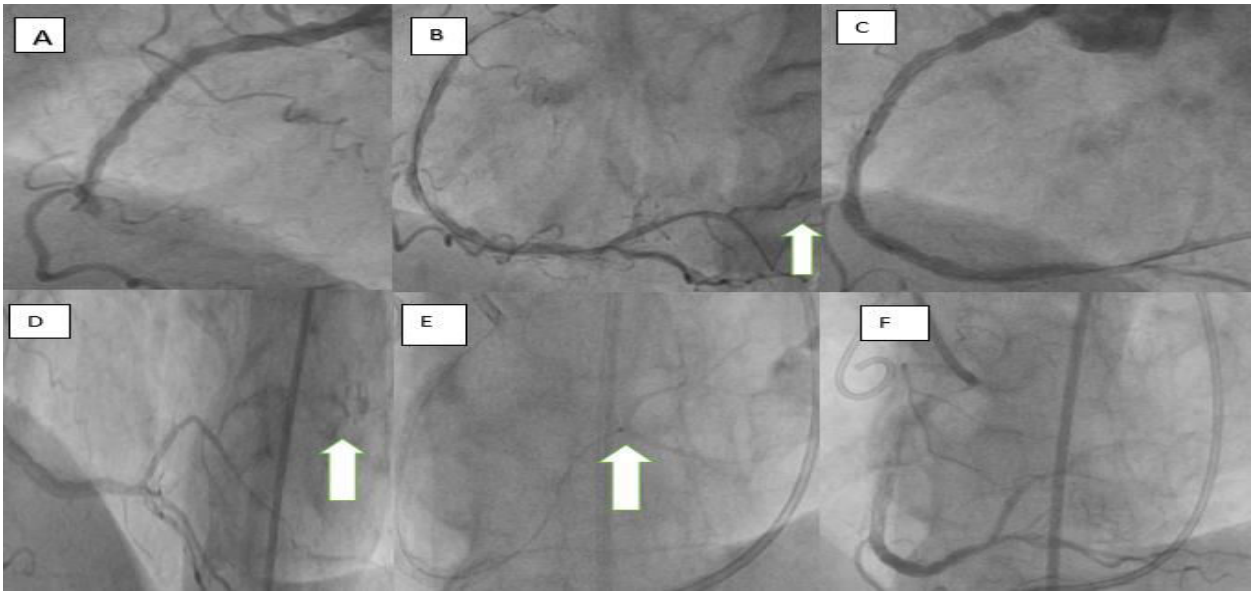


FIG 2. Arrow mark showing deflation of noncompliant ballon with simultaneous positioning of GRAFTMASTER stent through the second wire at the perforation site.(G).Deployment of GRAFTMASTER stent at the perforation site after removing first wire and NC ballon(H). LAO caudal view showing effective sealing of perforation site after the deployment of stent(I). Cranial view showing sealing off perforation with TIMI III flow(J).

CASE:2



An elderly lady presented with class 3 effort angina. Angiogram done showed Mid RCA (chronic total occlusion) CTO. Lesion was wired antegrade with hydrophilic wire (choice PT) lesion was adequately predilated with semi-compliant 1.25 x 10 mm at 16 atm, 2.5 x 10 mm at 14 atm and 2.75 x 10 m at 14 atm. Two overlapping stents from mid RCA (2.75 X 20 mm DES and 2.5 x 24 mm DES)were deployed and optimized with 2.75 x 10 mm non-compliant balloon at 20 atm. The final angiogram showed PLV distal bed excess myocardial staining. Wire induced distal perforation was suspected. Patient was observed on table for ten minutes and echo was done. No collection was noted. We anticipated that the perforation would seal by itself. Patient was kept in cath lab recovery room for additional time to diagnose early any late collection. Patient developed cardiac tamponade and brief cardiac arrest

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while being monitored. Emergency pericardiocentesis and autotransfusion was done and stabilized. Repeat angiogram showed an obvious distal leak this time from PLV branch. However, it was not easy to discern whether it came from upper or lower branch. It was decided that the terminal branch shall be embolized with gel foam. Microcatheter was taken on the coronary wire. It was kept prior to the bifurcation of terminal branch. A small injection from microcatheter demonstrated that the upper branch was the site of perforation. However, we decided to embolize at the bifurcation as the wire had traversed the lower branch as well, to occlude both the branches and keep the procedural time short. Gel foam particles emulsified in contrast was injected slowly. Repeat angiogram from guide showed sealing of perforation. Patient improved over the next 5 days and was discharged in a stable state.

FIG 3.LAO view showing CTO from the mid part of RCA(A).RCA was wired with ptca wire (B) followed by deployment of DES in mid to distal RCA(C).controlled CAG showing distal perforation from the branch of PLV(arrow mark)(D). Arrow mark showing Gel foam embolization to distal part of PLV branch using microcatheter(E). Effective sealing of perforation after gelfoam embolization(F).

CASE 3: An elderly frail gentleman was admitted with posterior wall MI. His angiogram showed triple vessel disease- LAD- short segment chronic total occlusion, filling retrogradely from hetero-collaterals. RCA showed proximal total occlusion. Ostio- proximal LCX showed 80% lesion with TIMI IIII flow. Patient was advised to undergo CABG. Patient and attenders refused stating his frailty and poor functional status. Culprit vessel angioplasty was planned to LCX. LCX was wired with 0.014''Cougar wire. Predilated with 2.5 x 12 mm balloon at 16 atm; stented with 3.5 x 24 mm Sirolimus eluting DES. Post dilatation was done with 3.5 x 10 mm balloon at 20 atm. Check angiogram after post dilatation showed type 3 coronary perforation. The balloon used for post dilatation which was in the guide catheter was immediately taken to the site of perforation and inflated to seal the perforation. Patient had hypotension. Pericardiocentesis was done and patient was put on assisted ventilation. Intermittent balloon occlusion was done for 15 minutes. Check angiogram after 15 minutes showed complete sealing of the perforation. Patient was stabilized and discharged after a week.

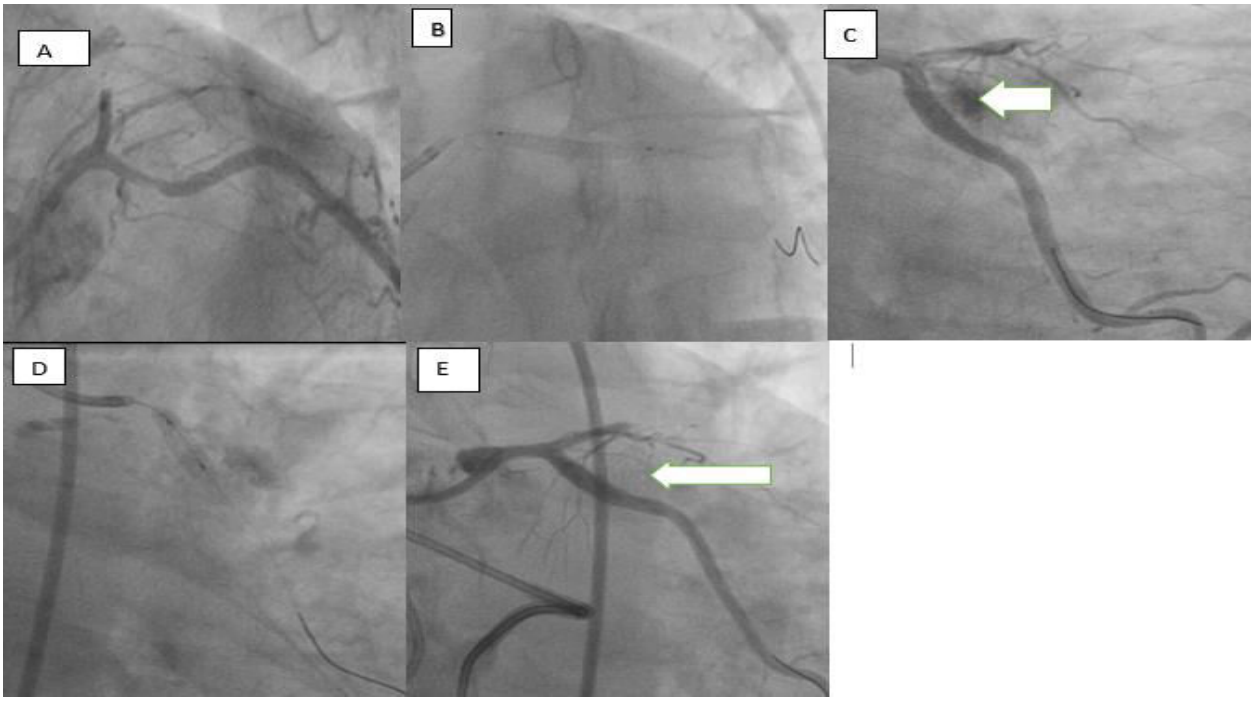

FIG 3. LAO caudal view showing total occlusion of LAD from the proximal part and significant stenosis at the proximal part of LCX (A). Deployment of stent in the proximal part of LCX(B). TYPE III perforation at the stented

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segment after NC ballon dialatation(C). Ballon tamponade of perforation site using the same NC ballon(D).Effective sealing of perforation after the ballon tamponade(E).

DISCUSSION: Coronary artery perforations are rare complications of PCI. Its incidences ranges from 0.3 to 3% in PCI,1.3% rotablator, 1.9% with excimer laser and rises to 2.9% in chronic total occlusions.[1,2].Certain risk factors are known to increase the incidence of perforations. These include chronic total occlusion, long lesions, angulated lesions,eccentric lesions and small vessels[3].Increased age, calcified vessel and prior CABG also increases the risk of perforations[4].

Ellis et al. classified coronary perforations based on their angiographic appearences. Type I is limited to vessel wall in the form of intramural crater without extravasation of dye. Type II perforation shows limited extravasation with pericardial or myocardial blushing on angiogram, whereas type III perforations include prominent dye extravasation from more than 1mm tear. It is the most serious form and is associated with the highest mortality rates, ranging from 7% to 44%. It is also associated with very high rates of cardiac tamponade (up to 40%) and with the need for emergent coronary artery by-pass grafting (CABG) in 20-40% of cases.Some authors include type 4 perforations where contrast flow can be seen from the perforation site to cardiac chambers or cavity. Muller et al proposed another type of perforation associated with usage of hydrophilic or stiff wires(type v) and these are usually distal perforation. Coronary artery perforations can occur with the use of guide catheters, oversized ballon and stents,cutting ballons,IVUS catheters or following ballon rupture[5,6].significant proportions of perforations occur with guidewires crossing the lesion with distal wire perforation[7].Hydrophilic coated wires have been found to be associated with coronary artery perforations in some series[8,9].Perforations occur more frequently with debulking techniques and atheroablative devices and often cause type III perforations.[10]

whether concomitant use of GP IIb/IIIa inhibitor increases the likelihood of CAP is controversial, since some of the studies show increased incidence while others donot.[11,12,13.]

Common treatment modalities for coronary perforations are discontinuation or reversal of the anticoagulation therapy, prolonged balloon inflation, coiling of the perforated vessel if it is a wire induced distal perforation, pericardiocentesis, and emergent CABG operation

In this context, the use of a dual guiding catheter is a helpful technique to reduce uncontrolled hemorrhage through the perforation since the time period without sealing is kept to a minimum. The most commonly used and preferred treatment approach for severe perforation is immediate sealing by prolonged balloon inflation followed by covered stent implantation. However, retrieving the balloon and inserting a covered stent may require some time and it is occasionally possible that the stent will not reach or cross the lesion as it is more bulky in nature. Covered stent are structurally two bare metal stents with a membrane in between- á metallic sandwich. It may not be easy to negotiate covered stent into all lesions (tortuous lesions, calcific lesions) because of its bulkier nature and limited flexibility. Hence, the perforation can remain without sealing for an unpredictably longer period of time and worsening patients hemodynamics. Use of perfusion balloons is helpful to bailout. When perfusion balloons are not available, dual guiding catheter approach (also called ping- pong approach) is a helpful technique in this context to reduce the duration of uncontrolled haemorrhage through the perforation . After placing a second guiding catheter and guide wire, through an alternate access, the covered stent can be advanced and placed immediately proximal to the sealing balloon. In a rapid manoeuvre, the sealing balloon can be retracted and the covered stent advanced and implanted. If initial delivery of the covered stent fails, re-insertion of the blocking balloon can be performed quickly which provides time. This whole technique can be performed in a controlled setting without haste and also helps in achieving favourable hemodynamic.

This technique was first described by Silver et alfor the treatment of type III coronary perforation, sealed with a stent coated with PTFE, which was released through a second guide catheter inserted into the contralateral femoral artery, while the perforation site was controlled and sealed with the angioplasty balloon.

This technique allows for the preparation and simultaneous parallel insertion of another system including guide catheter, guidewire, and covered stent, while the temporary sealing of the perforation is performed through the

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system used for the PCI that resulted in the coronary perforation . We used a 7F guide catheter for taking the covered stent. Covered stents are associated with higher risk of stent thrombosis both in short and long term. This could be because of excess metal layer or incomplete apposition. IVUS was not available with us. IVUS study after using covered stent could help in assessing stent apposition but it is associated with the risk of reintroduction of the catheter which may alter the geometry or configuration of the covered stent especially in complex anatomy.

In recent years new covered stents have been developed in order to improve the profile and trackability of these devices (e.g., Papyrus BK Biotronik or Bentley Innomed). These are formed by only one layer of membrane cover (polyurethane or micro-porous PTFE) in a backbone of cobalt-chromium stent. These features allow easier navigability through complex lesions and lower French catheter guide compatibility. However, even without this improved material, the technique is still of high utility in preventing bleeding while the covered stent is prepared and advanced to the target site.

Gelfoam embolization is another technique where distal perforations can be sealed off effectively. This is acompressed sponge in small pieces emulsified in dye. The exact mechanism of action is not known but some of the proposed mechanisms include 1. Slow/stop the blood flow, 2.clot formation, 3.platelet activation at the injected site, 4.provoide framework for cellular elements. There are some reports suggest that gelatin gets absorbed completely after 4 to 6 weeks

Alternative therapies include coil embolization, thrombogenic particles including polyvinyl alcohol, thrombin, embolic agents like N butylcyanoacrylate glue and autologous blood clot. Although potentially useful in emergency situations, these agents carry a risk of loss of the vessel lumen and subsequent infarction.

Ballon occlusion technique is another method where ballon is inflated for 5to 10 minutes at the perforation site. If the perforation cannot be sealedoff repeated inflations should be made. Distal ischemia is a concern in this method hence perfusion ballon should be used whenever available.Based on the duration and completeness of the occlusion, there are four balloon occlusion models: persistent complete occlusion, persistent partial occlusion, intermittent complete occlusion, and intermittent partial occlusion.

CONCLUSION : Successful treatment of this serious complication is associated with the rapid control of pericardial effusion, as mortality is closely linked to the development of cardiac tamponade . The double guide-catheter technique may be considered in severe coronary perforations with hemodynamic instability and also in situations where difficulty is expected to implant the covered stent, due to tortuosity, marked calcification, or previous stent in the proximal segment. This technique has a larger safety window and helps in stabilising hemodynamics better in a case of severe coronary perforation. Gelfoam embolization and ballon tamponade methods are also effective in selected cases.

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Conflicts of interest. There are no conflicts of interest.

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