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CASE REPORT

Simple Solutions to Common Cath Lab Challenges: Overcoming Damping, Stent Movement, Support Issues, and Distal Stent Delivery

Imran Khan
Ayub Medical Teaching institute, Abbottabad-Pakistan.

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sidharat1@gmail.com

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Abstract

Background: Cardiac catheterization for percutaneous coronary intervention (PCI) can present various technical challenges that require innovative solutions to ensure successful outcomes. This report highlights four unique cases that demonstrate distinct problems encountered during PCI and the strategies employed to navigate them.

Case Presentation: This report examines four distinct cases encountered during percutaneous coronary interventions (PCIs), each highlighting unique technical challenges and innovative solutions. In the first case, a 60-year-old man undergoing RCA intervention experienced pressure damping due to selective guide engagement. The team addressed this by wiring the acute marginal branch, which allowed for coaxial support while maintaining hemodynamic stability. The second case involved a 30-year-old man with a tight ostial LAD lesion, where stent movement posed a challenge. High-rate pacing was utilized to stabilize the stent during deployment, similar to a washing machine's spin cycle. In the third case, a 65-year-old man with critical proximal left circumflex stenosis struggled with stent delivery due to inadequate guide support. The anchor balloon technique provided the necessary stability for successful stent advancement. Finally, a 55-year-old man with a mid-left circumflex lesion faced difficulties in distal stent delivery. The team employed the Buddy-in-Jail technique, which involved jailing a buddy wire to facilitate the positioning of the distal stent.

Results: Each case illustrates the successful application of innovative problem-solving strategies that not only resolved specific technical challenges but also contributed to improved procedural outcomes. The techniques employed ranging from coaxial support and high-rate pacing to the anchor balloon and Buddy-in-Jail methods demonstrated their effectiveness in navigating complex anatomical scenarios, ultimately leading to successful interventions and enhanced patient safety.

Conclusion: These case studies highlight the critical need for tailored, adaptive approaches in addressing the diverse technical challenges faced during percutaneous coronary interventions (PCI).

Keywords

Percutaneous Coronary Intervention, Coronary Artery Disease, Stents, Interventional Cardiology, Catheterization.

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Introduction

Cardiac catheterization, a critical procedure for diagnosing and treating coronary artery disease, often presents interventional cardiologists with complex technical challenges. These difficulties can arise from a variety of factors such as patient anatomy, lesion characteristics, and the tools used during percutaneous coronary intervention (PCI). Common issues include pressure damping during guide catheter engagement, uncontrolled movement of stents (often referred to as "to-and-fro" stent motion), insufficient guide catheter support, and challenges in advancing stents distally within tortuous or calcified vessels. These technical obstacles, if not addressed effectively, can compromise procedural success and increase the risk of complications.

This article presents four unique case studies that illustrate common problems encountered during PCI and highlights the innovative strategies used to navigate these challenges. Each case demonstrates a different scenario from selective guide engagement leading to pressure damping, to difficulty in pushing a stent distally in a tortuous vessel showcasing the problem-solving approaches that can make a significant difference in the outcome of these procedures. These case studies not only provide insight into the technical nuances of PCI but also serve as a guide for clinicians facing similar challenges in the catheterization lab. By understanding the mechanics of these issues and the corresponding solutions, interventionalists can improve procedural efficiency and patient outcomes.

Case 1: Pressure Damping with Selective Guide Engagement

60-year-old man presented for elective PCI to the right coronary artery (RCA) for Class III angina despite optimal medical management. Selective engagement of the guide catheter caused pressure damping, compromising support and guide coaxial position for wiring (Figure 1 & 2).

Case 1: Diagnostic Assessment

The patient presented with subtotal occlusion of the right coronary artery (RCA), which posed a significant technical challenge in manipulating the wire through the occlusion. An additional challenge arose with the selective engagement of the guide catheter, leading to pressure damping a phenomenon where the pressure waveform flattens due to catheter malposition or arterial compromise, increasing the risk of myocardial ischemia. Immediate intervention was required to navigate through this issue without further compromising blood flow (Figure 3).

Case 1: Therapeutic Intervention

Several options were considered to provide sufficient support for wire manipulation without exacerbating pressure damping:

- This guide would offer strong support to facilitate wire passage. However, it worsened pressure damping and was deemed less suitable due to difficulty with disengagement, particularly in aorto-ostial PCI cases where coaxial alignment is crucial.
- A catheter with side holes was considered because it would give a reassuring appearance of normal pressure waveforms. However, the blood flow could still be compromised despite the misleading normal waveform.
- Another option was to leave the wire floating in the aortic root to prevent further damping. Unfortunately, this approach would not resolve the issue of maintaining coaxial guide engagement, which is critical for proper manipulation of the wire. (1)

The Chosen Solution – Wiring of the Acute Marginal Branch:

To overcome the problem, the team first decided to wire the acute marginal artery (Figure 4). This approach allowed the guide catheter to remain coaxial while disengaged, providing the necessary support to manipulate the wire through the subtotal RCA occlusion. This partially disengaged state maintained proper blood flow while allowing further wire adjustments (Figure 5).

Case 1: Follow-Up and Outcomes

Once the acute marginal branch was wired, the catheter remained stable in a coaxial position. This provided enough support to introduce a second wire, which successfully traversed the mid-RCA occlusion (Figure 5). After the main artery was wired, the rest of the procedure proceeded smoothly, leading to the successful revascularization of the occluded artery. The final angiographic result demonstrated restored blood flow with no further complications (Figure 6). The patient's post-procedural course was uneventful, and follow-up revealed normal coronary flow without signs of ischemia. This case highlights the importance of strategic catheter and wire manipulation to overcome technical challenges during PCI, particularly in complex coronary anatomies.

Case 2: The See-Sawing Stent

A 30-year-old man underwent a coronary angiogram after being thrombolysed for an anterior STEMI, revealing a tight ostial LAD lesion (Figure 6 & 7). The stent exhibited a to-and-fro movement, making deployment challenging.

Case 2: Diagnostic Assessment

The patient presented with a challenging percutaneous coronary intervention (PCI) involving the deployment of a stent just distal to the left main coronary artery. The stent could not be cleanly deployed at the ostium, which posed a significant risk to both the stability of the stent and the integrity of the left main. Without adequate support, there was a high probability of improper stent placement, which could lead to suboptimal outcomes or complications such as geographical miss.

Case 2: Therapeutic Intervention

Several potential strategies were considered to ensure proper stent deployment at this critical anatomical location:

- One option was to deeply seat the guide catheter into the vessel to stabilize the stent during deployment. However, this approach posed a risk of damaging the left main artery due to excessive catheter engagement and could lead to further complications.
- Another strategy involved partially inflating the stent balloon and then pulling back the stent into position. While this approach could potentially reposition the stent, it carried a high risk of geographical miss or the stent becoming dislodged from the balloon, leading to an incomplete or failed deployment.

The Chosen Solution – The Washing Machine Dryer Analogy:

The team ultimately opted for a pacing technique, frequently used during transcatheter aortic valve implantation (TAVI) procedures, to stabilize the stent. By pacing the heart at a high rate, the rapid contraction minimized the to-and-fro movement of the stent during placement. This effect can be compared to a washing machine dryer: when the dryer first starts, it vibrates, but as the spinning frequency increases, the vibrations stabilize. (2) Similarly, high-rate pacing stabilized the vessel and allowed for precise positioning of the stent (Figure 8 & 9).

Case 2: Follow-Up And Outcomes

Once the heart rate was paced and stabilized, the stent was positioned just distal to the left main and successfully deployed without incident (Figure 10, 11 & 12). The forward movement of the stent during pacing ensured its proper alignment with the ostium, and the final angiographic result showed a well-deployed stent with restored vessel patency.

The patient's recovery was uneventful, and follow-up imaging confirmed that the stent was securely in place, with no signs of stent migration or restenosis. This case highlights the effectiveness of pacing techniques in stabilizing coronary stents during challenging deployments, particularly in anatomically complex regions like the left main artery.

Case 3: Lack Of Support for Stent Delivery

A 65-year-old man, admitted with NSTEMI, had a history of complex PCI to the LAD/Diagonal artery. A coronary angiogram revealed a critical proximal left circumflex stenosis, but it was impossible to insert the stent due to poor support (Figure 13).

Case 3: Diagnostic Assessment

The patient required a percutaneous coronary intervention (PCI) with stent placement in the left circumflex artery. However, the procedure was complicated by difficulty in pushing the stent across a proximal bend, primarily due to poor support from the guide catheter. The lesion had been adequately prepared, but the anatomical configuration of the vessel, combined with insufficient catheter support, hindered successful stent delivery.

Case 3: Therapeutic Intervention

Several options were considered to improve the support and overcome the bend:

- Predilatation was considered, but the issue was not inadequate lesion preparation; it was primarily related to the lack of guide catheter support and the difficult proximal bend.
- The use of a buddy wire can be helpful in these situations, as a second wire could straighten the proximal bend and provide additional support for the stent delivery. However, in this case, the buddy wire technique was attempted but proved unsuccessful, as it did not enable the passage of the stent across the bend. (3)
- A guide extension catheter, such as a Guideliner (4), could have been a valuable tool to provide enhanced support and facilitate stent advancement. However, this option was unavailable at the time of the procedure.
- Deeply seating the guide catheter was considered as an option. While this technique can increase support, it carries risks such as vessel dissection. Additionally, the proximal bend made it impossible to achieve effective deep seating in this case.
- The wiggle wire technique, useful in calcified or tortuous vessels, could help guide the stent past a calcified plaque or anatomical barrier (5). Unfortunately, a wiggle wire was not available during this procedure.

The Solution – Anchor Balloon Technique:
Ultimately, the anchor balloon technique (Figure 14) was chosen to overcome the issue of poor catheter support. A wire was inserted into a distal obtuse marginal branch, and a small 1.5 x 12 mm semicompliant balloon was inflated within this vessel. This provided the necessary additional support for the guide catheter. With the anchor balloon in place, the stent was successfully advanced across the proximal bend and deployed in the left circumflex artery.

Case 3: Follow-Up And Outcomes

After the successful deployment of the stent (Figure 15, 16 & 17), the angiographic result was excellent. The balloon anchoring in the obtuse marginal branch provided sufficient support to allow the smooth delivery of the stent. Post-deployment, the patient experienced no complications, and the stent was well-positioned within the vessel.
The follow-up confirmed that the stent remained patent, with no signs of restenosis. This case highlights the utility of the anchor balloon technique in challenging anatomical cases where traditional support mechanisms fail, enabling successful stent deployment in difficult-to-reach areas.

Case 4: Difficulty In Distal Stent Delivery

A 55-year-old man presented with disabling angina, and a coronary angiogram revealed a mid-left circumflex lesion (Figure 17 & 18). Despite predilatation, a stent could not be inserted distally due to poor guide support and proximal calcification.

Case 4: Diagnostic Assessment

The patient presented with a challenging case during a percutaneous coronary intervention (PCI), where it was not possible to insert a 2.75 x 28 mm Resolute Integrity stent into the distal segment of the artery. The primary issue stemmed from poor guide catheter support and significant proximal calcification, which prevented successful stent delivery.

Case 4: Therapeutic Intervention

Several strategies were considered to overcome the problem, but each had its limitations:

- Deep seating of the guide catheter was attempted to provide additional support (Figure 19-22). However, this technique proved ineffective in this particular case.
- The use of a guide extension catheter, such as a Guideliner, would have been ideal to enhance support and facilitate stent delivery. Unfortunately, a Guideliner was not available at the time.
- Although the anchor balloon technique could have been useful, the 6 French EBU guide catheter used did not permit simultaneous insertion of both a balloon and a stent, making this technique impossible.
- A buddy wire technique was attempted to provide extra support by straightening the vessel. However, this approach was also unsuccessful in advancing the stent to the desired position.

The Solution – Buddy-in-Jail Technique:
Given the challenges with the above techniques, the team opted for the "Buddy-in-Jail" technique (Figure 23). This approach involved the following steps:

- A buddy wire was inserted alongside the main wire, and a proximal stent was deployed while the buddy wire was intentionally jailed between the stent and the vessel wall (6).
- After the proximal stent was deployed, a gentle tug was applied to the jailed buddy wire. This action provided additional support and traction, allowing the distal stent to be pushed along the non-buddy wire, through the previously deployed proximal stent, and into the desired position distally.

Case 4: Follow-Up And Outcomes

Following the successful deployment of both the proximal and distal stents using the Buddy-in-Jail technique, the final angiographic result showed excellent stent positioning. The calcification and lack of support were effectively overcome by the buddy wire providing additional traction, enabling the distal stent to reach its target location.

The patient experienced no complications during or after the procedure, and follow-up assessments confirmed that the stents remained patent, with no signs of restenosis. This case demonstrates the value of the Buddy-in-Jail technique in overcoming complex anatomical challenges that prevent distal stent delivery.

Discussion

The four cases presented in this article illustrate the range of technical challenges that can arise during percutaneous coronary intervention (PCI), from pressure damping to stent movement, poor guide catheter support, and difficulties in stent delivery through calcified or tortuous vessels. These scenarios require not only a deep understanding of coronary anatomy and hemodynamics but also innovative approaches to problem-solving in real time. By adapting established techniques and occasionally improvising solutions, these cases demonstrate how careful planning and creativity can overcome even the most difficult procedural obstacles.

In Case 1, pressure damping was the primary challenge. Engaging the right coronary artery (RCA) with the catheter led to loss of normal pressure waves, risking potential harm. Several possible solutions were considered, such as using a catheter with side holes or changing to an

Amplatz (AU) guide catheter for better support. However, these options presented their own risks, including exacerbating the damping or risking damage to the vessel. The final solution of wiring the acute marginal artery first allowed the guide to disengage slightly, which provided both support and the necessary alignment for the intervention. This highlights the importance of guide catheter manipulation and maintaining hemodynamic stability during complex coronary procedures.

Case 2 dealt with the challenge of stent movement, specifically the difficulty in positioning the stent at the ostium of the left anterior descending (LAD) artery just distal to the left main. Deep seating the guide catheter risked injury to the left main, and partial inflation of the stent balloon could lead to geographical miss or the stent dislodging from the balloon. The innovative solution here was to pace the heart at a high rate, mimicking the stability achieved in a washing machine dryer during the high-speed spin cycle. This stabilized the vessel, minimizing the to-and-fro motion and allowing precise stent deployment. This case underscores how pacing, typically used during transcatheter aortic valve implantation (TAVI), can be repurposed in other coronary interventions to enhance procedural control.

In Case 3, the inability to deliver the stent across a proximal bend due to poor support from the guide catheter posed a significant challenge. Various options, such as using a buddy wire to provide additional support or employing a guide extension catheter (Guideliner), were either unavailable or unsuccessful in this case. Ultimately, the anchor balloon technique provided the necessary additional support. By inflating a small balloon in a distal obtuse marginal branch, the team created the support needed to deliver and deploy the stent in the proximal left circumflex artery. This case illustrates how anchoring techniques can be a critical tool for navigating difficult anatomy, particularly when other common strategies fail.

Case 4 presented a combination of poor guide catheter support and severe calcification, making it impossible to deliver the stent distally. After multiple unsuccessful attempts, including deep seating the guide and using a buddy wire, the team employed the Buddy-in-Jail technique. This method involved jailing the buddy wire with a proximally deployed stent, then using the tension on the buddy wire to provide enough support to advance the distal stent into position. This creative solution is a prime example of how combining multiple techniques can overcome seemingly insurmountable challenges. The Buddy-in-Jail technique, in particular, offers a strategic approach when standard methods, like guide extension or deep seating, are not feasible or effective.

Across these cases, a few key themes emerge. First, guide catheter support is crucial in complex PCI, and when traditional approaches such as deep seating or using a Guideliner are not available, techniques like the anchor balloon or Buddy-in-Jail can be valuable alternatives. Second, stent manipulation requires careful consideration of vessel dynamics, especially in tortuous or calcified vessels, where solutions such as buddy wires or specialized pacing can provide the stability needed for precise stent placement. Third, pressure damping remains a potentially dangerous issue during coronary interventions, and innovative solutions like disengaging the guide while wiring side branches can help maintain hemodynamic stability without sacrificing support.

In summary, these cases highlight the importance of both established techniques and creative problem-solving in overcoming the technical challenges inherent in PCI. Techniques like pacing the heart, anchoring balloons, and the Buddy-in-Jail method, when used judiciously, can significantly enhance procedural success. These methods are particularly valuable in situations where conventional techniques fall short, providing interventionalists with additional tools to navigate complex coronary anatomy and ensure optimal patient outcomes.

Conclusion

The challenges encountered during percutaneous coronary intervention (PCI) can often be effectively addressed through innovative strategies customized to the patient's unique coronary anatomy and the available interventional tools. These case studies provide valuable insights for interventional cardiologists, equipping them with practical solutions for navigating complex situations in the catheterization lab.

Learning points

- When selective guide engagement leads to pressure damping, wiring a side branch can provide the necessary coaxial support while maintaining hemodynamic stability.
- High-rate pacing can effectively stabilize stent movement during deployment in cases where excessive motion is observed.
- This technique is an effective strategy for providing additional support during the delivery of stents in complex anatomical scenarios.
- This innovative approach can facilitate the positioning of a distal stent through a proximal stent when traditional methods are insufficient.

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Figure/Video

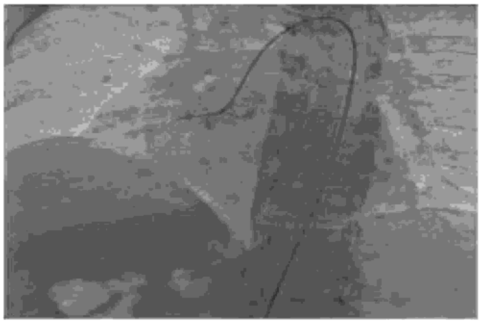

Figure 1: Selective Engagement of RCA

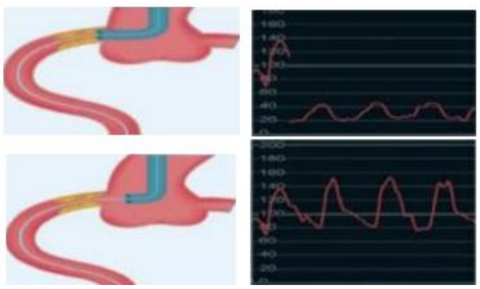

Figure 2: Illustrative Representation of Damping

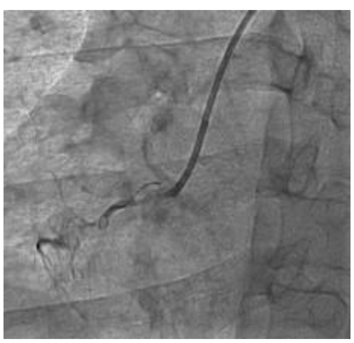

Figure 3: Subtotal RCA Occlusion

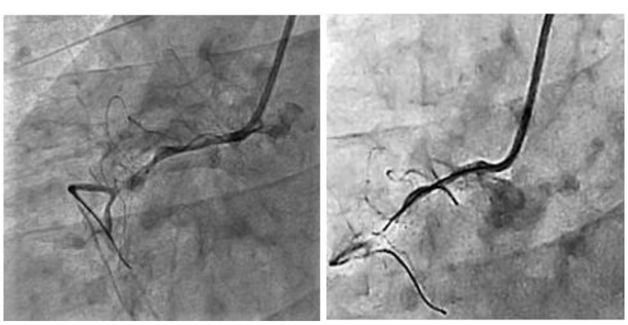

Figure 4: Wiring of Acute Marginal enabling disengagement of the guide Catheter.

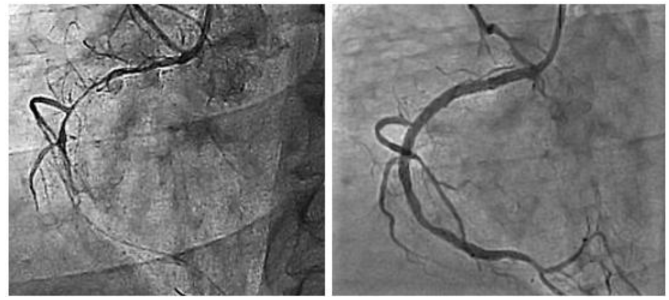

Figure 5: Wiring of the main vessel and the final result

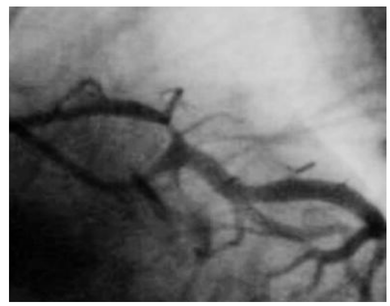

Figure 6: Proximal LAD Stenosis-LAO

Figure 7: Proximal LAD Stenosis-RAO Caudal

Figure 8: Backward movement of the stent.

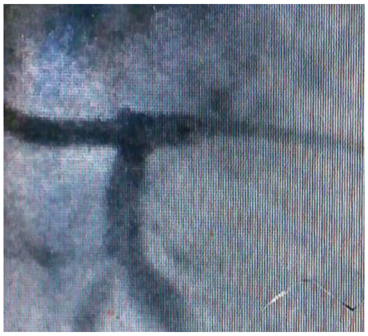

Figure 9: Forward movement of the stent

Figure 10: Stent positioning just distal to the ostium

Figure 11: Stent Deployment.

Figure 12: The Final Result

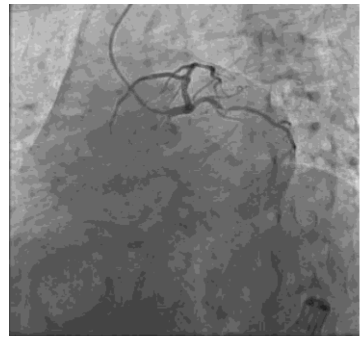

Figure 13: Proximal Lt Circumflex

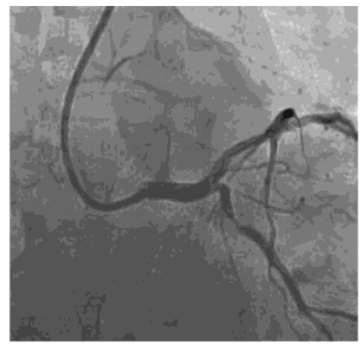

Figure 14: LAO Caudal View

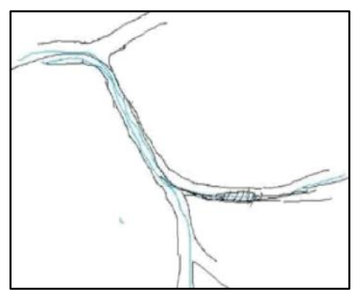

Figure 15: Balloon Anchoring Technique

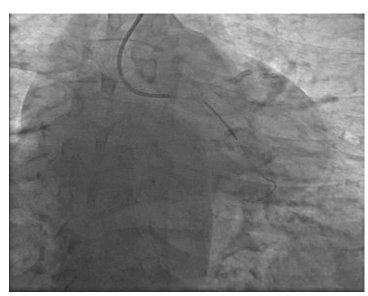

Figure 16: Stent Placement

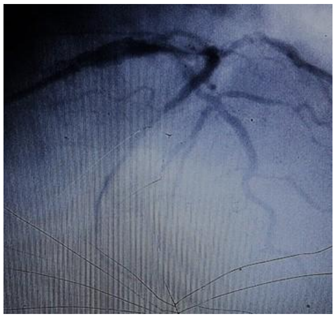
Figure 17: Mid Left Circumflex stenosis


Figure 18: After predilatation

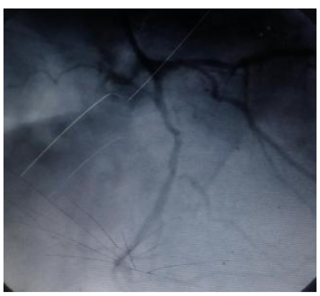
Figure 19: Deep seated guide was unsuccessful


Figure 20: Proximal stent deployed

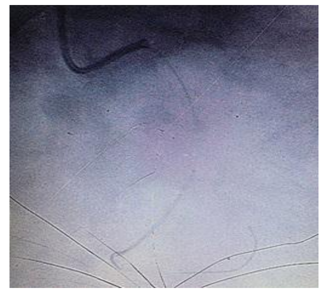
Figure 21: Distal stent in desired position


Figure 22: The final result

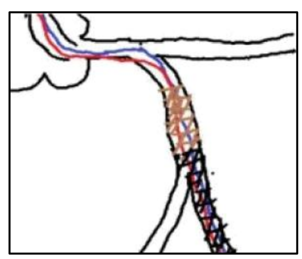
Figure 23: The Buddy in Jail technique