

Self-practice Program For Beating Minimally Invasive Coronary Anastomosis Using Homemade Low Fidelity Simulator

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Introduction

- Minimally invasive CABG (MICS) provides a safe alternative approach to sternotomy^{1,2}
- MICS is technically more demanding and has a steep learning curve to overcome.³
- We believe that a specialised cardiothoracic procedure like MICS can be trained as early as during residential training.
- Minimally invasive Off-pump Modular Anastomosis Drill (MOMAD) is an intensive, graduated, self practice program using homemade low fidelity simulator.
- A blinded pilot study was done looking into MOMAD’s efficacy as a MICS training tool.

Minimally invasive Off-pump Modular Anastomosis Drill (MOMAD)

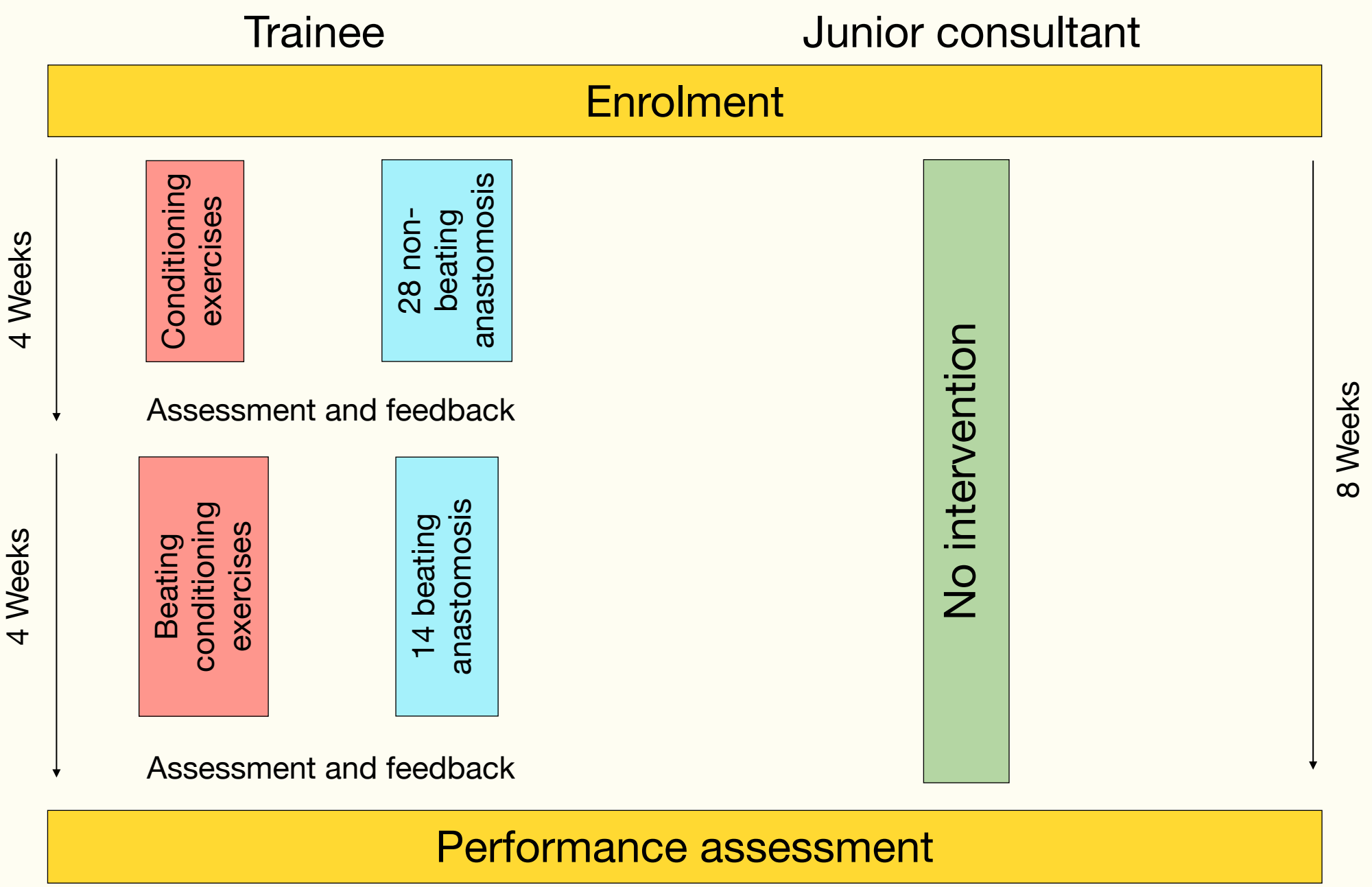


Figure 1: Flow of MOMAD curriculum versus control

Materials and methods

- Studied subject:** A trainee with minimal distal coronary anastomosis (n<10) experience.
- Control:** A junior consultant with minimal off-pump CABG (OPCAB) or MICS experience
- Intervention:** The program curriculum comprises specific exercises and 4-weekly assessments using objective structured assessment of technical skills (OSATS) scoring.⁴ (Figure 1)
- Assessment:** Both were tasked to perform 2 coronary anastomoses on OPCAB and MICS simulator. Blinded assessments of these anastomoses were carried out by 3 senior consultants.
- Primary outcomes:** Time to complete each anastomosis and the modified OSAT score for each anastomosis during the performance assessment.
- Secondary outcomes:** Progression in the anastomotic time throughout the program and progression of OSAT score during interval assessments. Independent evaluation of MOMAD simulator using a 6 statements 1 to 5 points Likert-scale questionnaire.

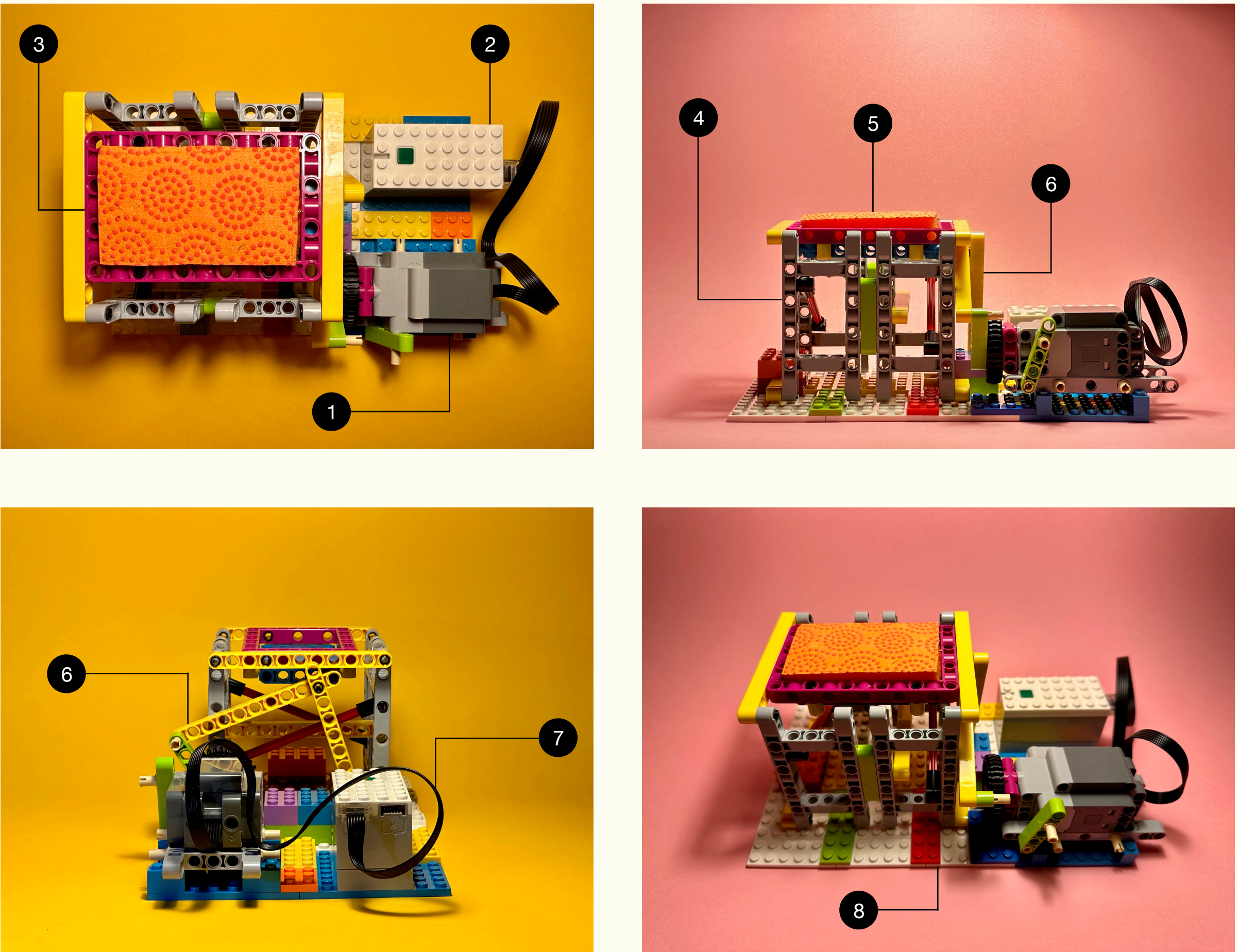


Figure 2: MOMAD simulator. 1. Motor, 2. Wireless hub, 3. Modular tray, 4. Frame, 5. Module, 6. Four bar crank system, 7. Cable, 8. Base plate.

MOMAD simulator

- Modular benchtop beating heart simulator. (Figure 2)
- Oscillatory motion design
- Multiple modules: conditioning exercises, coronary shunt placement, beating coronary anastomosis, and beating anastomotic repair. (Figure 6)
- Main construction using Lego® (Lego A/S, Billund, Denmark).
- Motor powered and wirelessly controlled by smartphone via a programmed application.
- Function: rate selection, auditory feedback, housing for OPCAB and MICS.
- Total simulator cost: **US\$ 174.87**.
- Consumables cost: **US\$ 4.29/40 cycles**.

Results

- Overall performance of the trainee approaches the performance of the junior consultant. (Table 1)
- OPCAB anastomosis:** The trainee outperformed the junior consultant. Time (**489s** vs 605s) Modified OSATS score (**21** vs 20.7).
- MICS anastomosis:** The trainee’s performance approaches that of the junior consultant. Time (**712s** vs 652s). Modified OSAT score (**19** vs 20.6).
- Throughout the program, there were inverse correlations between anastomosis time and number of practice by 0.833 for non beating and 0.632 for beating (Figure 4 and 5). There was also an **improvement** in terms of **OSATS** scoring by **26.6%**.
- Independent assessment revealed mean score of **3.98** out of 5 from the questionnaire.

Performance assessment

	OPCAB Consultant	OPCAB Trainee	MICS Consultant	MICS Trainee
Modified OSATS score	20.7	21	20.6	19
Time	605s	489s	652s	712s

Table 1: Performance assessment post MOMAD program using modified OSATS scoring. Trainee’s performance approaches that of a consultant

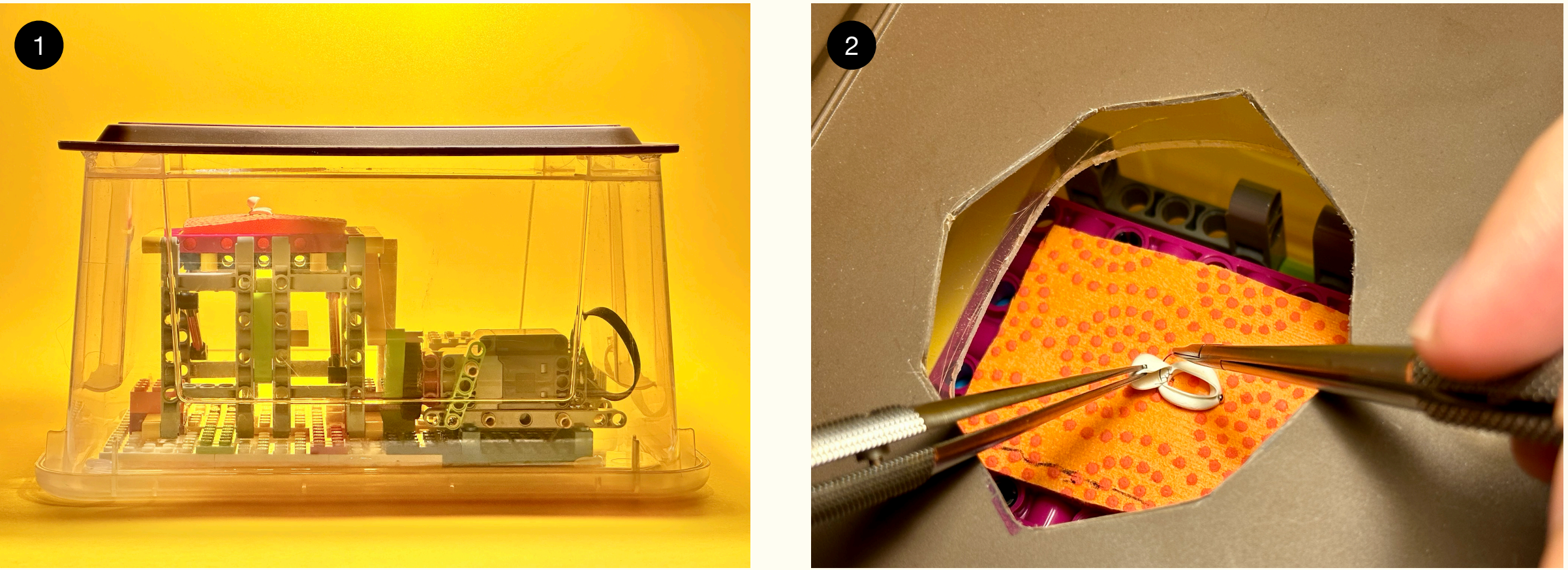


Figure 3: 1. Simulator housing. 2. Advanced conditioning practice in MICS housing

Non-beating coronary anastomosis

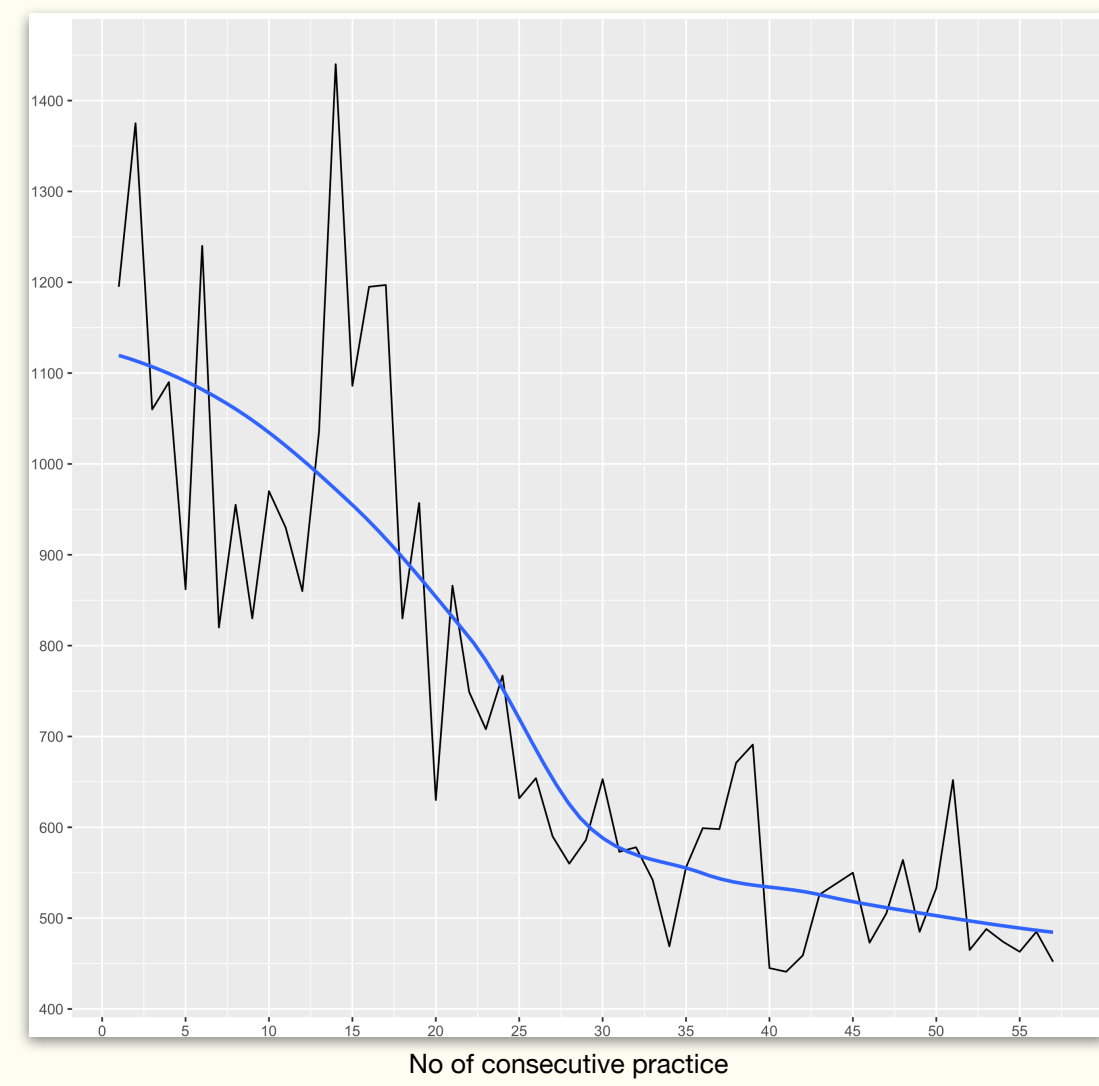


Figure 4: ‘Plateau effect’ achieved after 30th consecutive practice.

Beating coronary anastomosis

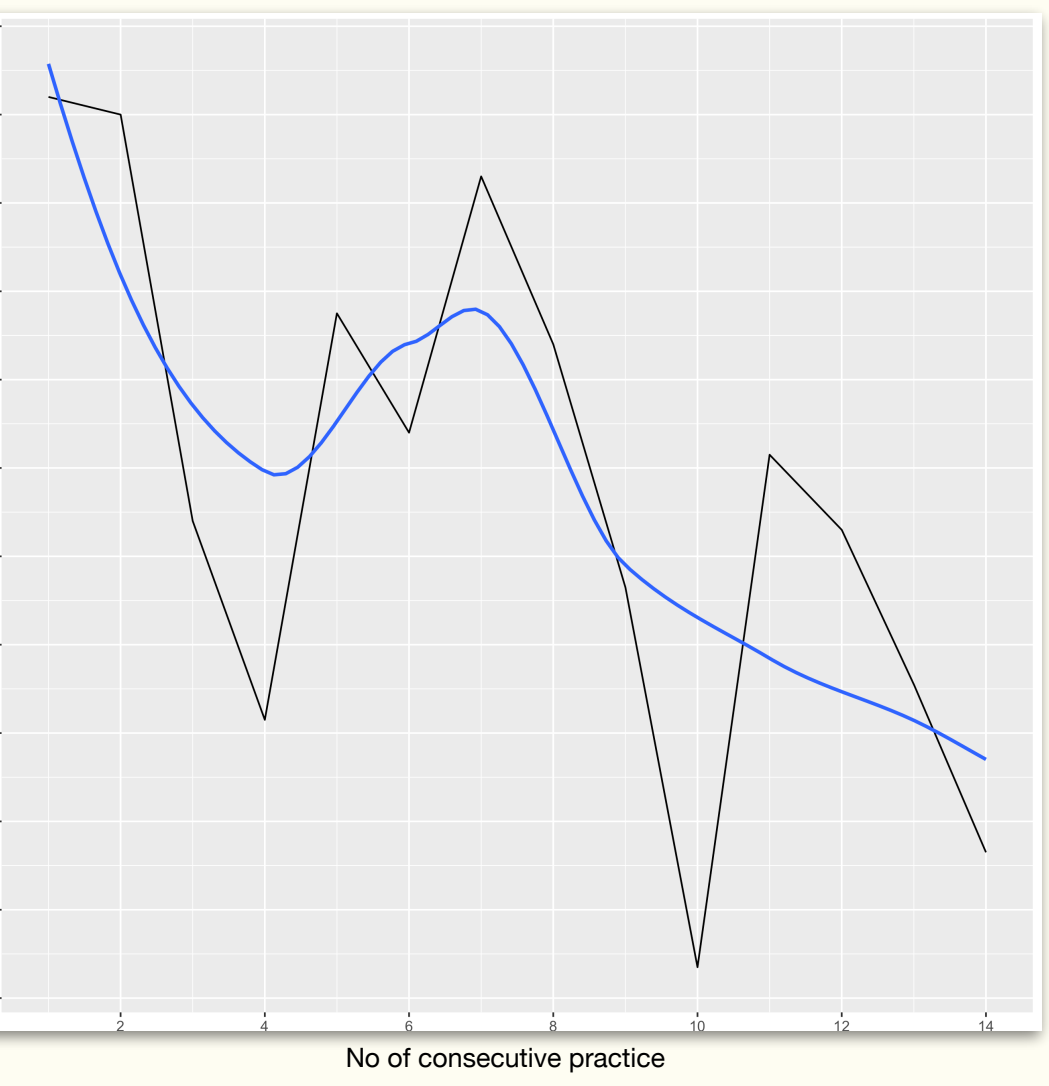


Figure 5: ‘Plateau effect’ was not achieved likely due to smaller number of consecutive practice.

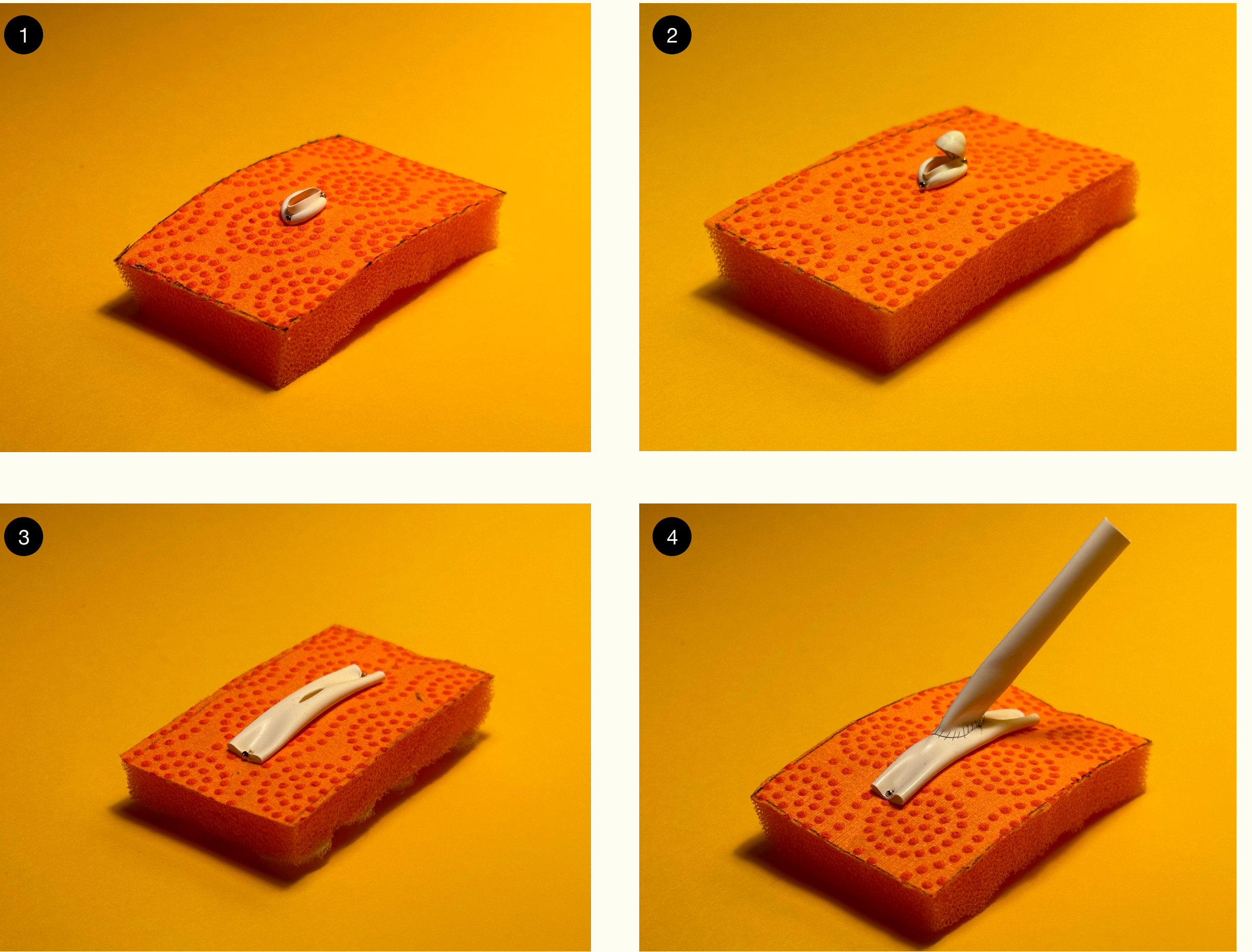


Figure 3: Simulated Modules. 1. Basic conditioning module, 2. Advanced conditioning module, 3. Coronary for anastomosis or shunt practice, 4. Completed anastomosis which can be used for anastomotic repair practice.

Conclusion

- MOMAD program was able to help an intermediary trainee to reach plateau effect of the MICS learning curve quicker. This should be introduced earlier into training.
- Fellows or junior consultants will gain from simulation training by involving deliberate practice of higher complexity skills.
- The simulator used for the simulation training must be easily accessible, affordable, enables graduated practice, and not necessarily high in fidelity.⁵ These remove the barrier to practice.
- We have structured a framework for a randomised control trial to evaluate how MOMAD translates into clinical practice.

Reference

- Marin-Cuatas M, Sá MP, Torregrossa G, Davierwala PM. Minimally invasive coronary artery surgery: Robotic and nonrobotic minimally invasive direct coronary artery bypass techniques. *JTCVS Tech.* 2021;10:170-177.
- Ruel M, Shariff MA, Lapierre H, et al. Results of the Minimally Invasive Coronary Artery Bypass Grafting Angiographic Patency Study. *J Thorac Cardiovasc Surg.* 2014;147(1):203-208
- Ruel M. Nonsternotomy multivessel coronary artery bypass grafting: A key development in cardiac surgery. *JTCVS Tech.* 2021;10:162-167.
- Fann JI, Caffarelli AD, Georgette G, et al. Improvement in coronary anastomosis with cardiac surgery simulation. *J Thorac Cardiovasc Surg.* 2008;136(6):1486-1491.
- Norman G, Dore K, Grierson L. The minimal relationship between simulation fidelity and transfer of learning. *Medical education.* 2012;46(7):636-47.