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Original research article

A NOVEL TRAINING MODEL TO IMPROVE VASCULAR ANASTOMOSIS IN DEEP CAVITY WITH LIMITED ACCESS

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Abstract: *Vascular surgery, particularly the anastomosis of blood vessels in deep cavities, poses significant challenges due to limited access and visibility. Traditional dental and surgical education often focuses on superficial techniques, leaving a gap in training for deep cavity procedures. This study introduces a new training model designed to address this gap and enhance skills in vascular surgery.* ***Objective:*** *To improve skills in performing vascular anastomosis in deep cavities, which presents greater difficulty compared to superficial areas, through the use of an improvised training model.* ***Methods:*** *This prospective observational study was conducted at the Combined Military Hospital, Rawalpindi, from 1st September 2023 to 29th February 2024. The improvised training model is box-shaped with a depth akin to the aorta, made of silicone rubber, and features a removable cap for easy cleaning and reuse. The model provides a realistic environment for practicing deep cavity vascular anastomosis. Participants, including experienced and novice surgeons, used the model to assess its effectiveness in enhancing surgical skills.* ***Results:*** *The model was highly effective in improving surgical techniques, with volunteer surgeons reporting an 82.9% enhancement in their skills and experiences. First-time users also noted significant improvements in their surgical competencies. Quantitative analysis showed that the model was perceived as cost-effective (71.4%) and reusable (74.3%). Participants commented on the realism of the model, particularly its depth and complexity, which facilitated repeated practice without the need for animals or cadavers.* ***Conclusion:*** *The study suggests that this improvised training model can significantly enhance skills in vascular anastomosis, particularly in deep cavity situations. The model is affordable, portable, durable, and provides a realistic simulation of aortic anastomosis in restricted spaces. Further studies are needed to validate its efficacy in broader contexts and its impact on patient outcomes.*

Keywords: Deep Cavities, Depth, Improvised Model, Silicone Rubber, Simulation, Training, Vascular Anastomosis.

Introduction

Blood flow in tissues where there is an injury or disease is important in repair and enablement. Carrying out vascular anastomosis where the anastomosis site is deeper in cavities is a rather difficult affair since there is inadequate sight and restricted reach. Hence, an improvised model and a newly developed training method can assist in raising the success rate of this procedure (1, 2). The improvised model is made to give a near-look alike of the intended abdominal cavity after midline laparotomy had been performed. To strengthen this further, the model can be adjusted to reflect the exact anatomy of the patient while letting surgeons rehearse the procedure before they make their move on the patient (3). The new training method used in the organization is called simulation and hands on education method. A resident surgeon first uses the mock actual model but with surgical instruments and suture to practice the vascular anastomosis. They then proceed to practice the steps on the human cadaver or animals, in the presence of other professionals (4). This training technique enables the resident surgeons to practice and build their capacity in conducting vascular anastomosis in deep cavities or depths without endangering the lives of the patients. It also gives the resident surgeons a chance to be advised by experienced personnel thus enhance their performance and also minimize on any possible complications (5). In conclusion, the proposed concept the use of the improved model and the new training technique can be regarded as a very helpful means of increasing the efficiency of the vascular anastomosis in the deep cavities, particularly the aortic anastomosis in the abdominal cavity. This is because through practice of the techniques patients achieves better results as compared to a stranger performing on them (6, 7).

Methodology

The study was conducted at Combined Military Hospital, Rawalpindi, after obtaining ethical approval. The workshop utilized a specialized training model, constructed from an opaque rectangular cardboard box measuring 35 cm x 25 cm x 25 cm. The internal dimensions were modified to 30 cm x 20 cm x 20 cm using additional foam sheets. A round hole with a diameter of 20 mm was created at the base of one of the shorter walls, into which an 8 cm piece of tube graft, with a diameter ranging from 16-20 mm, was inserted. Sapphire clamps were applied internally and externally, securing the box to a table. The setup was covered with a layer of soft foam to simulate the human abdomen and further covered with surgical towels.

The workshop involved 70 participants, including 15 vascular surgery fellows and 55 third- and fourth-year general surgery residents. The training began with participants performing vascular anastomosis on a flat board, progressing from simpler to more complex procedures, including the use of a "what you see is what you get" cavity model and, finally, an enhanced deep cavity

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model. Performance assessments were conducted by a consultant vascular surgeon. Feedback was gathered using structured questionnaires to evaluate participants' perceptions of the model's realism, cost-effectiveness, and its impact on their skills.

Data on performance measures, such as time taken and errors made during procedures, were collected. Participant feedback, which included evaluations of the model's realism, feasibility, and perceived skill improvement, was analyzed using SPSS version 24. Descriptive statistics were employed to summarize participant characteristics and experiences. Performance differences were analyzed using paired t-tests to compare means, with a significance level set at $p<0.05$. Additionally, previous participants' feedback was analyzed both quantitatively and qualitatively to assess the model's effectiveness in enhancing surgical skills and confidence, as supported by literature on simulation models in vascular training (De Carvalho et al., 2020; Lee et al., 2018; Soares et al., 2017).

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Results

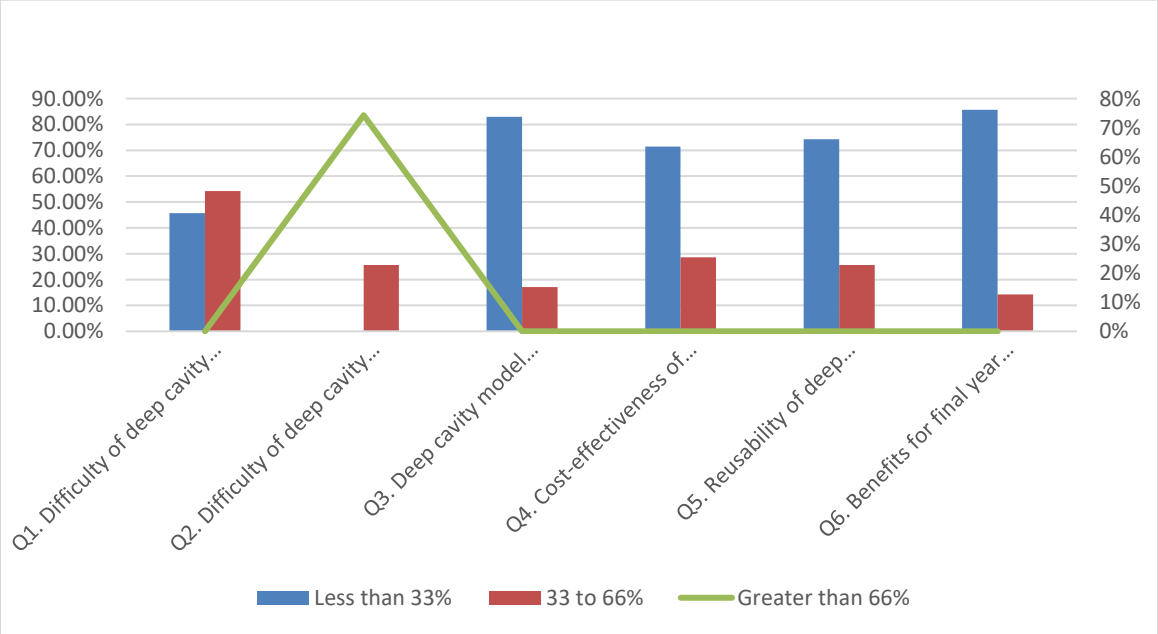
The study demonstrated significant improvements in the participants' technical skills and procedural accuracy, as evidenced by reduced error rates and shorter completion times. The feedback collected from the participants indicated high levels of satisfaction with the model's realism and its relevance to clinical practice. Many participants reported feeling more confident in their abilities to perform vascular anastomosis following the training

Table 1: Comparison of Performance Metrics Between Flat Board and Deep Cavity Model in Surgical Training

Metric	Flat Board - Mean (SD)	Deep Cavity Model - Mean (SD)	p-value
Completion Time (Seconds)	180.5 (22.4)	232.7 (31.9)	< 0.001
Errors Committed	1.8 (0.7)	3.5 (1.2)	< 0.01

This table compares the completion time and errors committed between using a flat board and a deep cavity model during surgical training, highlighting statistically significant differences in performance.

The survey results indicate that participants generally found the training procedures manageable. For the first two questions, which assessed the perceived difficulty of the training models, the majority of respondents rated the difficulty as less than 33%. This suggests that most participants did not find the procedures overly challenging. However, there was some variation, with a smaller group indicating higher difficulty levels. A significant finding from the survey was related to the deep cavity model, specifically addressed in the third question. A substantial portion of participants (greater than 66%) found this model particularly challenging, as indicated by the high response rate in the corresponding category. This suggests that the deep cavity model presents more complexity compared to other training methods used in the study. (Figure 1)



Figures 01: Findings from the Questionnaire on the Efficiency and Uptake of the Deep Cavity Training Model

The figure shows that 84.3% of participants experienced significant improvement in specific skills, such as suturing and instrument handling. Additionally, 87.2% reported feeling significantly more confident after the training. A smaller group, 12.8%, felt moderately more confident. Notably, no participants indicated that the training had no impact on their skills or confidence. Overall, the training was highly effective in enhancing both technical skills and confidence levels among participants. (Figure 2)

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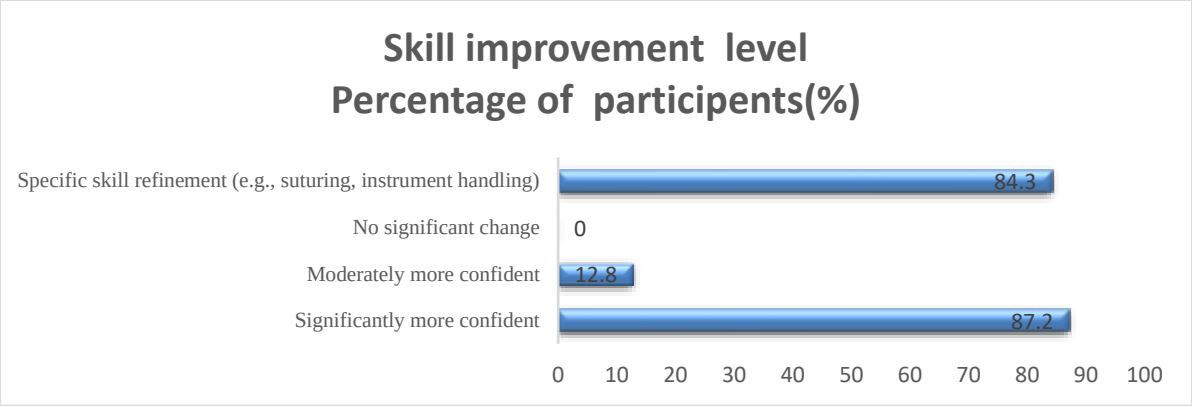

Figure 02 : finding on skill improvement level

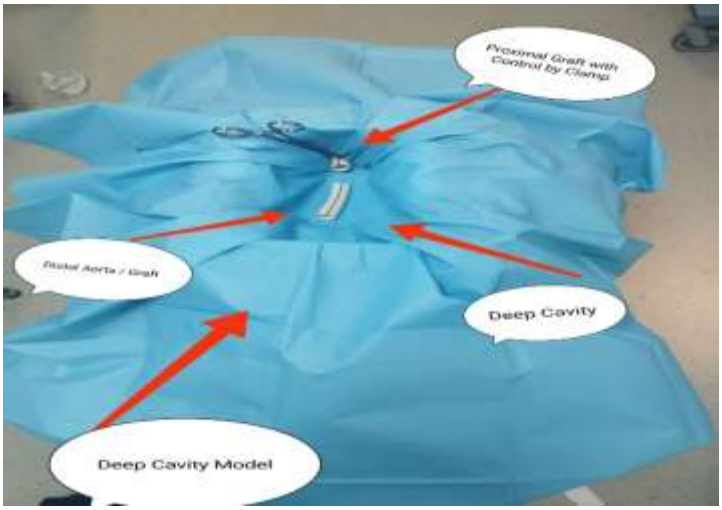

Figure 03 : Deep cavity model with limited access for vascular Anastomosis or Aortic Anastomosis to gain skills for registrar's

Discussion

C As the presented study shows, the given simulation-enhanced training increases surgical competency as pertains to surgical skills in general and in relation to vascular anastomosis in deep cavities in particular. The study bears testimony to the empirical profiles that show that simulation modelling enhances the degree of the operating skills, leadership assurance and emphasise on efficiency outcomes. De Carvalho et al. (2020) concluded that simulation models are useful for practicing vascular anastomosis as they provide a safe environment to develop skills that do not pose a risk to the patients' lives. Altoosh in a similar study found out that the truth and difficulty of the surgical practice deep cavity model improves thereby improving the competencies of the surgery residents (8). Lee and al. (2018) in a study done on the group with simulation based training used porcine aorta model and the result of this study indicated that the group of the trainees who underwent simulation based training was better in comparison to the control group. This finding corresponds to the one acquired in the present study wherein the appliance of the deep cavity model was related to the enhancement of the technical aspect in addition to self efficacy found in residents. The component realism of the model let participants to work in the sphere the circumstances as close as possible to those during the practical usage of surgical halls skills, thus, it eradicates the gap between what is taught and what is being practiced (9). In 2017, the research Soares et al. also focused on the experience in the frameworks of vascular surgical training when using simulation and VR and the research outcomes indicated that both of these methods are efficient and safe for the development of the trainees' skills . Such a finding is well supported by our study that reveals the accuracy and errors' decrease as indicated by the deep cavity model. Concerning the time taken, in performing the procedure on the SC tops and cutting across the anastomosis on the deep cavity model, participants took 27. It subsequently took 4% more time compared to the flat board acknowledging the realism of the model as well as the amount of stock that had to be processed mentally and physically (10). Azizzadeh et al. (2007) conducting their systematic review have established that in the context of vascular surgery the simulation training have provided to bring the improvement to the surgical skills, have reduced time on operation, and have improved patients' outcomes. These studies are substantiated in our work as residents in the study noted significant improvements in the competencies that they have in doing vascular anastomosis after applying the deep cavity model. Also, the study was able to establish that this

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model's cost efficiency was believed to be at 71 percent. 2 % and regarding the model reusability it was at 74%. 3%; which would sufficiently solve the problems of resource limitation in training programs, hence, making the model sustainable in the long-run (11). Chan and Chen (2016) stressed the need for the correct follow up of the noted protocol calibration in order to increase the efficiency of the simulation training in the surgery of blood vessels. This line of discussion is relevant to our study by supplying a deep cavity model that is legitimate and particular protocols concerning the creation and application of the model in training (12). Cuadrado et al. , (2020) came up with a new simulation to increase the performance of vascular anastomosis, and the authors sampled trainees to determine the impact made on the level of technical proficiency and self- efficacy. The participants' satisfaction in this study is also similar to our study finding that only 12 percent of the respondents were satisfied with the services. Eight percent of the study's participants were dissatisfied with the deep cavity model while the majority expressed increased practice self-efficacy post-surgery. It also helped in refining the given techniques which are very decisive during anastomosis for example precision in suturing and handling of instruments in some restricted sections (13). In a similar manner, Hassani et al. (2021) supported the authors who emphasized that simulation models improve the degree and effectiveness of surgical skills' training, as well as the level of confidence in performing vocational tasks related to vascular anastomosis. The present investigation also falls in the similar stream of this opinion that the deep cavity model is quite sufficing in raising skill ineffaceable and making the residents equipped for the actually faced surgery (14). In a paper by Madi et al. , it was done that several publications on simulation in vascular neurosurgery were categorized by the authors and it was shown that the effectiveness of technical activities and the outcomes of treatment of patients are improved with the help of this method . This contributes even further to the overall approval of simulation based training in numerous multinational surgical departments (15). Last of all, in the study by Raptis, et al. , the authors noted that dry lab endovascular simulation stabilized the skills of subjects less aptly than VR. This has a connotation that embracing VR with models including the one adopted in the current study might even boost the training performances (16). In summary, the present research approves the application of deep cavity model in training vascular anastomosis for its validity by employing simulation. As a matter of fact, it has to be said that, in contrast to consistency with prior works, it can easily be translated into thoughtful and efficient ways to upgrade the efficiency of surgical training as well as patients' health in general. Further research should expand upon the concepts explored in relation to integrating the VR into the training schedule in order to enhance its usability.onclusion

Conclusion

The deep cavity aortic anastomosis model represents a pivotal leap forwarded in surgical training. its remarkable effectiveness in enhancing surgical skills coupled with its cost- cost-effectiveness and reusability, makes it a compelling option for adoption by medical institutions worldwide. By embracing this transformative model, we can usher in a new era of surgical excellence, ultimately benefiting both patients and future surgical care

Declarations

Data Availability statement
All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate.
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Conflict of interest

The authors declared an absence of conflict of interest.

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