Original Article

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Anatomy Section

Cadaver as an Effective Tool for Simulation Based Procedural Skill Learning Compared to Manikin- An Interns Perspective

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ABSTRACT

Introduction: Procedural skill learning is fundamental part of medical education. Simulation based learning helps students acquire the competencies without putting patients at risk. Manikins and cadavers are available resources of medical simulation. Which one is more effective in learning the skills with acceptable confidence, competence and satisfaction is to be elucidated. Establishing a cadaver based Procedural Skill Lab (PSL) may play a role in early exposure of procedural skills to medical students.

Aim: To study the intern's perceptions of effectiveness of procedural skill learning on cadaver and manikins and to record their opinion on need for establishing PSL in Anatomy Department.

Materials and Methods: An observational study conducted at S. Nijalingappa Medical College, Bagalkot, Karnataka, India. Twenty five (n=25) interns who volunteered to participate in the study were included. After collecting the baseline data about exposure to said skills, students were divided into two groups. Students learnt six procedural skills on manikins (M group) and on cadavers (C group). Post-test data was collected. Then crossover was done and survey about the satisfaction, preferred mode of learning and need of the PSL in anatomy was collected. Non parametric test were applied: Wilcoxon signed rank test for paired data Mann-Whitney U test for unpaired data, using Medcalc and Statistical Package for the Social Sciences (SPSS) software.

Results: Perceived confidence and competence of students after training in both the groups (M and C) increased for all the six skills which was statistically significant (M group $p<0.0005$ and C group $p<0.0002$). Satisfaction score was more for cadaver group ($p<0.0001$). Students chose cadaver based learning as the preferred method of learning and wanted PSL.

Conclusion: Soft embalmed cadaver can be an effective tool to learn procedural skills at all level. Establishing a cadaver based PSL in anatomy can provide undergraduates with early exposure of skills develop the requisite knowledge, postgraduates can learn the speciality concerned procedural skills and faculty can venture upon innovative procedures and prevent de-skilling.

Keywords: Competence, Medical simulation, Procedural skill lab

INTRODUCTION

Medical students of this era are facing challenges of exponential growth with newer and more complex surgical techniques on one side and public intolerance for medical errors on the other side. These developments mandate the medical students to be competent and confident in performing the procedural skills.

Opportunities to learn procedural skills during medical school are limited [1]. Majority of the medical students across all phases have neither observed nor performed common and emergency procedural skills and thus suffers lack of confidence in performing the basic skills which increases stress [2,3]. Usually skills are learnt through "see one, do one, and teach one" approach where skills are learnt directly on patients which may put patients at risk [4]. Simulation-based learning can help mitigate this tension by developing health professionals' knowledge, skills and attitudes while ascertaining the patient safety [2].

Manikin simulators for procedural skill training have been available for several decades. There have been many advances in the manikins which breathe, talk and behave just like live patients. On the other hand there are the oldest of medical simulation assets, the human body [5].

A lot of debates have been going on over which simulator is better for teaching procedural skill; cadaver based or manikin based. This study was conducted to know perceptions of interns about effectiveness of learning the procedural skills on cadaver based simulation vs manikin based simulation. This study was also conducted to know the requirement of establishing cadaver based PSL in Anatomy Department.

MATERIALS AND METHODS

An observational study was conducted on 25 interns of SN Medical College, Bagalkot, Karnataka, India, who volunteered to participate in study. Ethical clearance was obtained from Institutional Ethical Committee (IEC: A-60). Study was conducted at Skill lab and cadaver based PSL over a period of one month. Six Common emergency procedural skills were selected- pneumothorax needle decompression, intravenous line placement, interosseous needle insertion, intercostal chest drainage, cricothyroidotomy, umbilical vein catheterisation.

Study Procedure

Pretest survey was done to obtain baseline data by assigning scoring for frequency of exposure to said skills (never-0, once-1, twice-2, thrice-3 and >thrice-4). Confidence of performing the skill (not confident-0, little confident-1, fairly confident-2, very confident-3) and Competence of performing the skills (level 0 - unable to decide, level 1- able to do under supervision only, level 2 - able to do under minimal supervision, level 3 - able to do independently). Then all the students were oriented regarding the procedures to be practiced using appropriate videos and presentations by specialists. Later, students were divided into two groups- manikins (group M, n=12) and cadaver (group C, n=13). Group M practiced skills on manikins [Table/Fig-1] and group C practiced on cadavers [Table/Fig-2] in PSL under supervision of instructor. Instructor used the competency based checklist to observe the performance of each student. Post-test survey was conducted with same questions as were in pretest to access the change in confidence, competence and satisfaction of performing the skill.

Then crossover of groups was done to learn the skills on the next day with same checklist. A survey which contained a satisfaction rating for two methods of learning the skills using 5 point scale (scoring: 1-very unsatisfied, 2- unsatisfied, 3- neutral, 4- satisfied, 5- very satisfied) and also opinion on preferred method of learning skill and requirement of PSL were collected.

[Table/Fig-1]: Students performing skills on manikins: a) Interosseous needle insertion technique on manikins; b) Cricothyroidotomy technique performed on manikins; c) Intercostal chest tube drainage technique performed on manikins.

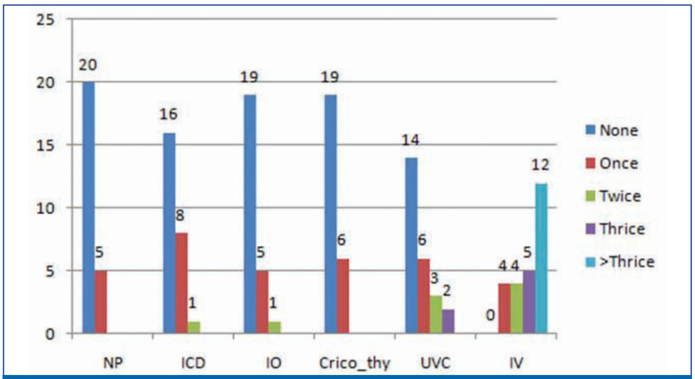
[Table/Fig-2]: Students performing skills on cadavers: a) Interosseous needle insertion technique on cadavers; b) Cricothyroidotomy technique on cadavers; c) Intercostal chest tube drainage technique on cadavers

STATISTICAL ANALYSIS

Non parametric test were applied, Wilcoxon signed rank test to evaluate the change in confidence and competence in performing the skills within the group (paired data) and Mann-Whitney U test for comparison between groups (unpaired data) and level of significance $p<0.005$. Medcalc and SPSS software version 19.0 (Statistical Package for Social Sciences, IBM, SPSS Statistics, USA) were used for data analysis.

RESULTS

A baseline survey about exposure to emergency procedural skill was collected at first (all the students had gotten exposure to the i.v technique). It is evident from [Table/Fig-3], that, all 25 (100%) interns got exposed to i.v. needle insertion technique in varying frequencies (once- 16%, twice- 16%, thrice- 20% and more than thrice 48%), but when it came to other skills like, Pneumothorax Needle thoracostomy (NP)- 80% (n=20), Intercostal Chest Drainage (ICD) technique- 64% (n=16), Inter-osseous (IO) needle insertion- 76% (n=19), (Cric-thy) 76% (n=19) and Umbilical Vein Catheterisation (UVC)- 56% (n=14), the interns had never seen these technique. Though these skills are emergency procedural skills which have the greatest impact on patient outcome, interns did not get an opportunity to learn these skills.



[Table/Fig-3]: Frequency of exposure to skills before undergoing the procedural skill training (N=25).
*NP: Pneumothorax needle thoracostomy; ICD: Intercostal chest drainage; Cric-thy: Cricothyroidotomy; IO: Inter-osseous needle insertion; UVC: Umbilical vein catheterisation; IV: Intravenous line placement

From [Table/Fig-4], it's clear that, after training on manikins, the perceived confidence level of students to perform the skill were increased which was statistically significant ($p<0.0005$ for all, except $p<0.0010$ for UVC) for all the procedures.

The students who learned skill on cadaver also showed significant increase in the confidence level ($p=0.0002$, except 0.0039 for i.v) of performing the skills [Table/Fig-5].

Skills	Pretest score Median (IQ range)	Post-test score Median (IQ range)	p-value
NP	1 (1-1)	2 (2-3)	0.0005
ICD	0 (0-0.5)	2 (2-2)	0.0005
Cric-thy	0 (0-0)	2 (2-3)	0.0005
IO insertion	0.5 (0-1)	2 (2-2.5)	0.0005
IV placement	2 (2-2)	3 (3-3)	0.0005
UVC	0 (0-1)	2 (2-2.5)	0.0010

[Table/Fig-4]: Comparison of pretest and post-test scores with respect to perceived confidence in performing the procedural skill among manikin group (M group).
*Wilcoxen Signed Rank Test was applied

Skills	Pretest score Median (IQ range)	Post-test score Median (IQ range)	p-value
NP	1 (0.75-1.00)	3 (2-3)	0.0002
ICD	0 (0-.25)	3 (2-3)	0.0002
Cric-thy	0 (0-0)	3 (2-3)	0.0002
IO insertion	0 (0-1)	3 (2-3)	0.0002
IV placement	2 (2-3)	3 (2-3)	0.0039
UVC	1 (0-1)	3 (2-3)	0.0002

[Table/Fig-5]: Comparison of pretest and post-test scores with respect to perceived confidence in performing the procedural skill among Cadaver group (C group).
*Wilcoxen Signed Rank Test was applied

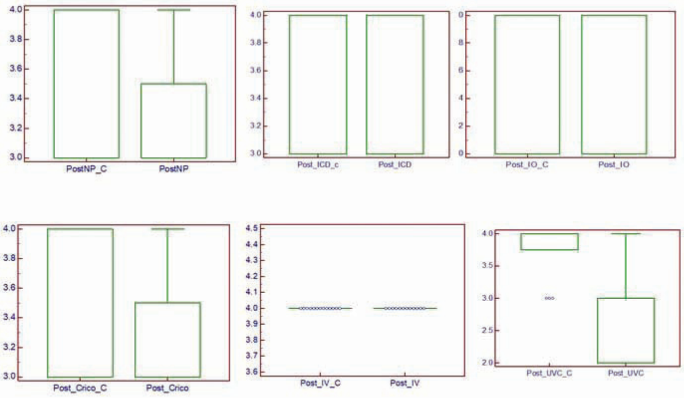
Post-test score when compared between the groups, it was found that except UVC ($p<0.0002$) other skills does not show statistically significant difference in perceived confidence level of students [Table/Fig-6]. It is clear that, perceived confidence of performing procedural skill increased when they learnt skills in simulated environment irrespective of simulator being cadaver or manikin.

From [Table/Fig-7], it is evident that, except for UVC ($p=0.0002$), rest all the skills did not show statistically significant difference in perceived competence between two groups. This means, the perceived competence was also increased when skills were practiced in simulated environment irrespective of simulator being used.

[Table/Fig-8] shows that the participants felt more satisfied when they learnt procedural skills on cadaver than on manikin and this difference was statistically significant ($p<0.0001$).

Skills	Post-test score Median (IQ range) Manikin group	Post-test score Median (IQ range) Cadaver group	Mann Whitney U	p-value
NP	3 (3-3.82)	4 (3-4)	55.5%	0.1655
ICD	3 (3-3)	3 (3-4)	76%	0.89
Cric-thy	3 (3-3.5)	3 (3-3.5)	61.5%	0.30
IO insertion	4 (3-4)	3 (3-4)	62.5%	0.35
IV placement	4 (4-4)	4 (4-4)	78%	1.00
UVC	2 (2-3)	4 (3.75-4)	12.5%	0.0002

[Table/Fig-6]: Comparison of Post-test score of confidence gained between manikin and cadaver group in performing the skills.
*Mann Whitney U test applied to know the difference between the groups



[Table/Fig-7]: Comparison of perceived competence level of students between two groups after training in procedural skills.

Variables	Median (Inter quartile range)	Mann Whitney U	p-value
Cadaver	5 (5-5)	1.5	<0.0001
Manikin	3 (3-3.5)		

[Table/Fig-8]: Survey on satisfaction of performing skills between the groups.
(Mann-Whitney U test was applied)

It is evident from [Table/Fig-9] that, 98% students rated cadaver as preferred simulator for learning procedural skills and rated to have 100% structural fidelity and 95% functional fidelity which was rated less in manikins.

Particulars	Manikin	Cadaver
Structural fidelity	90%	100%
Functional fidelity	60%	95%
Preferred method of learning	02%	98%

[Table/Fig-9]: Survey on fidelity and preferred method of learning of skills.

DISCUSSION

According to Swayer T et al., procedures are integral part of the medical profession. Acquiring competency in procedural skills is a fundamental goal of medical education [6]. Procedural skills like needle thoracostomy, Intercostal chest drainage, Cricothyoidotomy, Inter-osseous needle insertion, Umbilical vein catheteriation are emergency life skills which have profound impact on patient outcome. In our study, majority of the study participants never got to do these procedures. This may be due the reason that, training medical students in procedural skills at clinical setting is not always possible as patients want the most expert clinician to perform the procedure, not a medical student or an intern [7]. Also, there is pressure of high standard of medical service, improvement in quality of healthcare services rendered and reduced training duration for medical students and all these add limited opportunities to learn the skills [8].

As one cannot master the skills while treating patients, simulation based training helps to overcome this problem as one acquires knowledge, skills and attitudes by practicing on simulators before actually doing on patients. Thus simulators developed should have reliability and validity and they should simulate one's performance in the operating room setting [9]. So, one has to develop simulation based mastery over the skills to able to become competent. Competency-based assessment using medical simulation plays a key role in simulation as a patient safety modality [2,10]. In 2015, Sawyer T et al., published a competency-based pedagogic follow-up framework—learn, see, practice, prove, do, and maintain. The "prove" step includes Simulation-Based Mastery Learning (SBML) [6].

Now that we have enough data to suggest that simulation-based mastery of skills is superior to non mastery instruction [11], one needs to look for medical simulators which have validity and fidelity. For CBME, simulation validity is of prime importance as we assess milestone progression (construct validity) and ultimately certify the learner as competent to perform their clinical activities independently (predictive validity) [9]. Fidelity is "the extent to which the appearance and behaviour of the simulator/simulation matches the appearance and behaviour of the simulated system or task [12]. Fidelity can be either physical (structural, engineering), fidelity describing appearance and functional (psychological) fidelity which reflects the behaviour of the simulator or simulation [12-14]. Two important medical simulators are manikins based and cadaver based.

Manikins are not new in the field of simulation. In the current times, high fidelity dynamically responsive manikins are available which behave just like humans [5]. But many authors have observed that manikins though they have physical fidelity, lack functional fidelity [15,16].

Ever since Thiel W proposed Thiels' embalming fluid, which produced clinical cadavers (soft embalmed cadavers which retain the natural colour, tissue architecture and flexibility) there has been much research happening in the soft embalming fluid preparation and technique of embalming to produce cadavers suitable to practice procedural skills [16]. These soft embalmed cadavers are life-like and retain near life-like appearance. They are called as clinical cadavers [5]. On the other hand, cadavers can be frozen and used after thawing whenever it's needed. Baltimore and Halifax [5], used newly deceased, previously frozen, and soft-preserved cadavers for performing many high-acuity procedures and found that these cadavers have high physical and functional fidelity.

In our study, we found that students who learned skills on manikins and cadavers showed statistically significant perceived confidence and competence. (M group $p<0.0005$, C group $p<0.0002$) But, students were more satisfied after performing the skills on cadavers ($p<0.0001$) than on manikins. Students also rated cadavers to have more structural and functional fidelity when compared to manikin. While 98% of students rated cadavers as the most preferred simulator for learning procedural skills.

Similar findings were reported by, Kovacs G et al., [5]. Author stated that, most cricothyrotomy training manikin models, while anatomically correct, fail to reproduce the significant lateral mobility of the larynx within the neck in an apnoeic patient (and clinical cadavers). Stabilising this mobility is very critical and failure to do this results in failure in accessing the cricothyroid space in a rescue "can't intubate, can't oxygenate" scenario. Thus, cadavers were reported to be superior in training of cricothyroidotomy skill. In a study conducted by Takayesu JK et al., observed that, improvement in comfort level for cricothyrotomy and tube thoracostomy procedure was more and statistically significant for cadaver trained group ($p<0.0001$) than for manikin trained group [15]. Students also reported more fidelity. Authors concluded by stating that, cadaver-based training provides superior landmark and tissue fidelity compared to simulation training. Similar findings for endotracheal intubation were reported by Pedigo R et al., [17].

It is observed in manikins when trying to raise the bar of functional fidelity to match that of cadaver, it resulted in technologically very complex and very expensive models. While these high-tech, expensive manikins may talk, blink, and accommodate various procedures, these fully loaded models were often not realistic and acted as source of distraction for trainees which deviates them from intended task [12,14,18,19].

Whether it is manikin based simulation or cadaver based learning, one factor that has been shown to improve is resident confidence in performing a designated task after training as compared to before training [20].

The reason for this may be due to the fact that, there exists micro feedback loop (Adam's psychomotor feedback loop) when one gets sensory input (tactile, visual, auditory) to brain, brain sends back adaptive, appropriate motor response which results in skill acquisition [19,21].While cadavers being functionally and structurally high fidelity simulators, students perceive more confidence on practicing skill on cadaver. Cadaver training, however, appears to be the best compromise between learning on live patients in the operating room and on animals in the laboratory or inanimate simulators [22].

The use of cadavers for learning clinical procedures has emerged as a potential new, realistic (high-fidelity) simulation resource [5]. Establishing a cadaver based procedure skill lab act as a source of simulation for undergraduate with early exposure for procedural skills [7].

Cadaver-based simulation has been employed in many subspecialties to teach procedural skills to postgraduate students and it's found to be effective in surgery, emergency medicine, obstetrics and several other specialities [1,7,23]. Not only do the simulations improve self-reported confidence but they have also been verified to improve trainee skills and diminish error [24,25].

Once achieved, competency with a procedural skill needs to be maintained [6]. The procedures if not practiced regularly will degrade with time. The term "de-skilling" has been applied to the gradual loss of skills through infrequent practice [26]. When longer gaps are taken during clinical practice may be for any reason simulation provides the only feasible method to allow needed practice with the procedure [26]. So, establishing the PSL helps all in learning, proving and maintaining the skills.

Limitation(s)

Long term follow-up of participants is required to know the persistence of confidence and competence of learned skills on the cadavers.

CONCLUSION(S)

Cadavers do better justice to medical simulation with more structural and functional fidelity. They are better alternatives to expensive manikins. Establishment of PSL in anatomy department is need of the hour to cater to the increasing demands for procedural skill learning for undergraduates, postgraduates and for clinical staff to hone their existing skills and to learn new skills. Medical colleges should have active body donation programme and soft embalming techniques developed locally and a deep freezer so that continuous supply of cadavers is available for surgical skill practice. Simulation based training should be included as a part of regular curriculum which should be fully integrated. Voluntary/Optional Cadaver Dissection (VOCD) for those who wishes to do dissection (private practitioners) should be made available.

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