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RESEARCH ARTICLE

UTILITY OF CADAVERS FOR HEALTH PROFESSIONAL'S SKILL TRAINING-
A 2 YEAR EXPERIENCE

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ABSTRACT

Introduction: Medical education aims at training of health related professionals predominantly in cognitive, psychomotor and attitude domains. The psychomotor domain is important and needs good infrastructure and resources to deliver skilled professionals to the community. Our experience on the cadavers as a resource for the surgical skill development of the health professionals and its impact on the student learning has been a successful journey.

Material and Methods: Data was collected regarding the age, gender, time of death, time to mortuary, time to cold storage, number of procedures done, number of times thawed to explain the utility, advantages and disadvantages of cadavers in surgical skill training.

Results: The main mode of preservation of the cadavers used for surgical skill training is cold storage at -20° C. The advantage of frozen cadavers for skills training is the organoleptic properties being maintained as in a living human except for the dynamic circulation. The cadavers are being used for continued professional development of all surgical specialties. Allograft tissue of cadaveric origin is a very useful asset in the armamentarium of the present day surgeons.

Conclusion: The frozen cadavers have proven to be useful for psychomotor skill training. Surgical skill training centers need to be developed at all medical colleges to cater to the needs of our medical graduate students in terms of patient safety and competencies.

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INTRODUCTION

Medical education aims at training of health related professionals predominantly in three domains – cognitive, psychomotor and attitude. The cognitive domain is taken care as it is the easiest mode of delivery to the students of any field. The psychomotor domain is important and needs a good infrastructure and resources to deliver skilled professionals to the community. Most of the medical schools in India cater to the cognitive domain mainly with less importance to psychomotor skill development. A young graduate is equipped with enough knowledge but the confidence and experience to do procedures is lacking. The medical education and health care of our country have recognised this lack of competence and proficiency in the making of the physicians of first contact (Vision 2015, 2011). This could be because of lack of resources in the form of manikins, cadavers, simulators to try out the basic procedures as per curriculum for both undergraduate and postgraduate training.

The Medical Council of India has made a Vision document, however its implementation by the stakeholders is still lacking, since specific guidelines and structured content has still not been made available. The common goal would be to train our health related graduates in terms of patient safety and competencies. The undergraduates observe the procedures from a distance and only few graduates during internship get to do some of the procedures. The postgraduates get to do a few procedures directly on the patients without proper structured training on simulators/cadavers. This does not instill confidence and competence among the graduates and professionals. They spend another two to three years working under the guidance of experienced professionals to get trained which should ideally have happened during their actual training period. Many studies have proved that hands on to be joined by a hyphen (hands-on) training is very essential to improve the confidence and competence for performance in procedural and physical examination skills. (Sarah et al., 2013)

There is a major lack of psychomotor skill training among our medical schools in the country. In order to overcome this dearth of training, M S Ramaiah Advanced Learning Center

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was set up with a vision to train undergraduates, post graduates and professionals in medical and surgical skills in the year 2011. The cadavers can also be used for the purpose of tissue donation. The surgical specialities such as Orthopaedics are developing at a fast pace. More and more joint reconstructive procedures are being performed. The spectrum of revision surgeries is looming large. There is a need for allograft tissues to bridge this gap. Cadaver allografts are the most suited in this situation. Our experience on the cadavers as a resource for the surgical skill development of the health professionals and its maintenance from receiving to disposal, the impact on the student learning, cadavers as a source of tissue donation will be discussed.

MATERIALS AND METHODS

The cadavers coming to the center was recorded for the following details:

- A) Identification number, Time of death, Time of arrival to mortuary, Time of arrival to cold storage
- B) Gender (M/F) and Age
- C) Time of Death to Time to reach mortuary
- D) Time required for transfer of cadaver from Mortuary to cold storage
- E) Cause of death
- F) Investigations done at the time of arrival
- G) Procedures done
- H) Number of times thawed
- I) No. of Times the body have been used for more than 1 day

The observation was made from Oct 2011 to April 2014. The data was meticulously entered into a software developed for the institution to record all the above mentioned details. After the following details were entered and analysed the average data was calculated. Photographs were taken while doing procedures to visually demonstrate the quality of the tissues and organs. The cadavers being used for tissue donation was also noted. The kind of tissue harvested and utilised were also recorded.

RESULTS

Based on the details collected, the results derived have been tabulated in Table 1,2,3,4 and Figure 1.

Table 1. showing the percentage of donated cadavers from 2011 to 2013

S.No.	Year	Male (%)	Female (%)	Foetus (%)
1	2011 (Oct to Dec)	31.25	56.25	12.5
2	2012	58.73	33.33	7.93
3	2013	63.93	34.42	1.63

Table 2. Details regarding the process of utility of cadavers

S.No.	Criteria	Average	Range
1	Age	70.66	0-93 yrs
2	Time of Death to time mortuary	10 hrs	1 hr to 16 hrs
3	Time of Mortuary to cold storage	23hrs	1 hr to 47 hrs
4	Investigations done at the time of arrival	HbS Ag, HIV, HCV	-----
5	Number of procedures done per cadaver	9	4-16
6	Number of times thawed	5	3-8
7	No. of Times the body have been used for more than 1 day	1	1-2 times

DISCUSSION

Receipt and storage of cadavers

The cadavers are voluntarily donated by the community to M S Ramaiah Medical College. The cadavers on reaching the center is given an identification number and personal details noted. Table 1 demonstrates the percentage of cadavers received based on gender. The table shows a predominance of male donations than the female donations by 50%. The main mode of preservation of these cadavers is cold storage at -20°C . Once the donated body reaches the mortuary within 6-10 hrs of death after documentation procedure, the body is shifted to cold storage of -20°C . This might get delayed if the donor's relatives have to come from far off places to have the last look of their dear ones. By our records and documentation, the average time for the donated body to reach the mortuary ($0-4^{\circ}\text{C}$) has been 10 hrs for the past three years (2011-2014). From the mortuary to the cold storage the average time required has been 23 hrs. On the whole the body reaches the cold storage of -20°C by 36 hrs. (Table No.2) The cadavers are shaved and cleaned with warm water and dried. Preliminary investigations to rule out HIV, HBsAg and HCV are sent for every cadaver received. A rectal wash is given in order to remove the faecal matter if any as the faecal matter if left over creates a mess during the performance of the procedures.

Utility of cadavers

The cadavers are being used for continued professional development to cater to the needs of undergraduates, postgraduates and professionals in four broad categories as mentioned in Table No.5. The average number of procedures done on each cadaver is 9 with a range from 4 to 16. The following table shows the range of procedures being done at the center. (Table No. 2) The Fig.1 demonstrates the quality of tissue and organs in fresh frozen cadavers used in the center. It can be seen that the organs and tissue look almost like in the living. The table 3 mentions the spectrum of possible surgical skill procedures for which the health professionals are trained. All these programs are offered to postgraduates and professionals from inside and outside the institution.

Process of cadaver preparation

The center mainly uses fresh and frozen cadavers for all the above purposes mentioned. The cadavers are identified at least a week prior to the course. They are removed from cold storage (-20°) 24 to 36 hours prior to the hands on session. The time taken for thawing depends on the ambient room temperature. The thawing process is hastened during summer and delayed during winters. It also depends on the thickness of subcutaneous fat and region required for the procedures. It is usually the limbs which become free to use initially, followed by neck, thorax and abdomen. The abdomen takes the longest time to thaw and be free for access by the professionals. Once the cadavers are thawed, the cadaver is wrapped except for the region required during that course. They are placed in the desired position for the particular procedure and kept ready for usage.

Table 3. Demonstrating the different kinds of procedural training in the surgical fields

S.No.	Dept.	Course/Workshop	Numbers done
1	Orthopedics	knee arthroscopy, hip and knee arthroplasty- basic, advanced and revision, shoulder arthroscopy, balloon kyphoplasty, foot and ankle, lower and upper limb trauma, hand surgery, pelvic and acetabular fractures, wrist	78
2	General Surgery	Basic and advanced laparoscopy,	5
3	Obst. And Gyn	Pelvic anatomy dissection, internal iliac artery ligation, colposcopy, total laparoscopic hysterectomy,	5
4	Plastic Surgery	Flap dissection, facial plastics	3
5	Spine	Cervical and lumbar spine related procedures-TLIF, pedicle screw placement, posterior and anterior approaches	19
6	Neurosurgery	Skull base, endoscopic sinus surgery,	8
7	Anaesthesia	Pain management	2
8	Ophthalmology	DCR and Orbitotomy	1
9	ENT	Temporal bone dissection, PNS dissection, Head and neck approaches	6
10	Oral and Maxillofacial surgery (OMFS)	TMJ exposure, head and neck incision and approaches	5
11	Cardiovascular surgery	Minimally invasive cardiac surgery, Thoracotomy approaches,	6
12	Research and Development	Hip and knee implants	17
13	Others	Cystoscopy, Paediatric surgery, Bariatric surgery, Breast reconstruction procedure	4

Table 4. Statistics of graft material harvested and its utilisation

S.No.	Type of Graft	Living Donor grafts	Cadaveric grafts	Total Grafts harvested	Utilisation	Balance
1	Freeze dried bone	45	0	45	44	1
2	Femoral Head	95	0	95	95	0
3	TKR Slices	46	0	46	38	8
4	Bone Tendon Unit	8	5	13	9	4
5	Calcaneum	3	1	4	3	1
6	Radius/Ulna	0	6	6	6	0
7	Full Tibia	0	1	1	1	0
8	Humerus	0	3	3	3	0
9	Metacarpal/Metatarsal	6	5	11	7	4
10	Half Tibia/Femur (upper and lower)	7	7	14	14	0
11	Talus	2	1	3	2	1
12	Tendons	17	4	21	13	8
13	Half Fibula	2	0	2	2	0
14	Soft tissue	1	0	1	0	1
15	Meniscus	4	0	4	1	3
16	Full Fibula	1	0	1	1	0

Table 5. Categories of surgical skill training and research

S.No.	Category	Target Audience	Content
1	Basic surgical skill training	Postgraduates	Basic surgical exposures of anatomical regions and training for common procedures in the field of General Surgery, OBG, Orthopaedics, ENT, Ophthalmology, Neurosurgery, Plastic surgery.
2	Intense Surgical skill training	Professionals	Various surgical procedures done under their field.
3	Advanced Surgical training	Professionals	Minimal access Spine techniques, bariatric surgery procedures, Minimal Invasive cardiac surgery, Intracranial endoscopy, Pelvi-acetabular fractures, Cervical pedicle screw placements.
4	Research	Professional experts	Validation of Implants, trying and evaluation of new surgical techniques, anatomical research

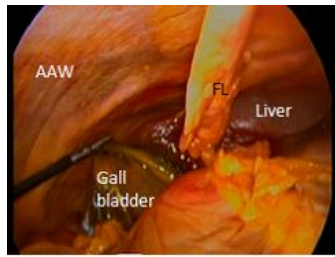
Once the procedure is done, the cadavers are cleaned up and the exposed areas are neatly closed by sutures and staples. The cadavers are then stored again at -20⁰ cold storage cabins. If the cadavers are required for the next day, they are stored in 0-4⁰ C storage so that they can be used continuously for more than one day.

Frozen cadavers- pros and cons

One of the primary advantages of using frozen cadavers include easy procedure for storing, the organoleptic properties are maintained wherein the colour and tissue allow realistic dissection giving an almost real like experience. The complete mobility of the joints is very useful in the performance of orthopaedic surgical skill training like arthroscopy, arthroplasty, spine procedures etc. Frozen cadavers facilitate

the psychomotor skill development and provide a wide range of opportunity to develop models for different kind of procedures especially in basic laparoscopic skills, orthopaedic skill training etc. (Sharma, 2013) A study conducted wherein the medical students were made to do procedures on manikins and frozen cadavers revealed that the latter was a more feasible and valid tool for procedural skill training as it gives them realistic feel which does not happen when performing on a manikin. (Ocel, 2006)

Hence the use of frozen cadavers facilitates ideal circumstances for surgical skill training. Our documentation shows that on an average, a cadaver can be thawed five times, the range being from two to ten. Since there is a facility to store at around 0-4⁰ C. sometimes the cadavers have been kept thawed for more than 24 hrs.



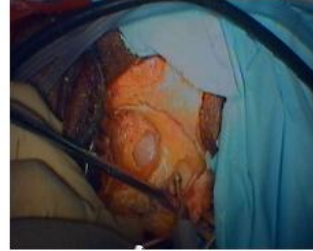
Laparoscopy showing liver, gall bladder and falciform ligament



Acetabular cavity



Spine procedure



Skull base procedure



Facial musculature dissection



Knee arthroscopic view

AAW- Anterior Abdominal Wall, FL-Falciform ligament, AC-Acetabular cavity, SP-Spine, ACL-Anterior Cruciate ligament

Fig.1. Quality of tissue in frozen cadavers

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Home Add Cadaver Add Investigations Add Usage Amputated Parts Availability Search Add Workshop Workshop List Help Logout Pattern Report

Enabling Research

Cadaver List

Disposed: No | Procedures Done: - Any - | Gender: - Any - | Eyes Donated: - Any - | Uterus Present: - Any - | Items per page: 20 | Total: 42 found.

Body Number	Sex	Time to Mortuary	Time to Cold Storage	Is Disposed	Thaw Count
117	Male	46.0 hrs / 1.9 days	46.0 hrs / 1.9 days	No	0
119	Male	2.5 hrs / 0.3 days	26.8 hrs / 1.2 days	No	0
120	Male	70.0 hrs / 3.0 days	77.5 hrs / 3.2 days	No	0
121	Male	6.5 hrs / 0.3 days	57.5 hrs / 2.4 days	No	0
122	Female	3.5 hrs / 0.1 days	75.0 hrs / 3.1 days	No	0
123	Male	25.0 hrs / 1.1 days	58.8 hrs / 2.4 days	No	0
124	Male	7.0 hrs / 0.3 days	36.3 hrs / 1.5 days	No	0
125	Male	6.5 hrs / 0.3 days	79.9 hrs / 3.3 days	No	0
127	Female	2.5 hrs / 0.1 days	112.8 hrs / 4.7 days	No	0
128	Male	5.9 hrs / 0.2 days	26.0 hrs / 1.1 days	No	0
129	Male	6.0 hrs / 0.3 days	94.5 hrs / 3.9 days	No	0
130	Female	13.3 hrs / 0.6 days	50.3 hrs / 2.1 days	No	0

Fig.2. Screenshot of the cadaver showing the cadaver record maintenance

This is of great advantage when there is need for long term procedure or research involved for over a period of 24-48 hrs. There have been experiences with the ENT faculty operating from 6 am in the morning to late at midnight. Hence a 0-4° C is very helpful for continuous usage of cadavers for more than one day.

There are some disadvantages of use of frozen cadavers especially uncertainty. These include difficulty in estimating the time of thawing. Repeated thawing can initiate the process of decomposition and starts to show by foul smelling. Hence strategizing the order of utility of different regions of the frozen cadavers can yield optimum utilisation of the cadavers. In this regard, a software has been developed in the institution for cadaver utility and record maintenance (Fig. 2). This keeps track of the cadaver from its entry to exit by disposal, of the cadavers. It is user friendly where information can be got in the form of personal details, cause of death, investigation done for the cadaver, procedures done on the cadavers with date, availability search which helps us to get the cadavers that can be used for a particular procedure. Archival of the data regarding cadavers are maintained once the cadaver has been disposed/dissembled.

An issue with frozen cadavers is the deterioration in the quality of the tissue. The brain is the first one to decompose by liquefactive necrosis during the first thawing. Procedures dealing with the brain matter cannot be effectively done on frozen cadavers. Identification of blood vessels in the subcutaneous tissue is known to be a problem in frozen cadavers making the flap procedures an incomplete exercise. The micro blood vessels are also fragmented. This does not allow good training during flap procedures in plastic surgery.

Cadaver disposal

Optimally, the cadaver gets completely utilised by the end of one year. Once the cadavers have been optimally utilised for all procedural training, they are disposed by as per standards recommended by the State Pollution Board. There is also an option of salvaging the bones of the cadavers for purpose of medical education and research.

Cadaver tissue donation

Cadaver Tissue donation is an accepted practice worldwide, provided the cadaver is received within the stipulated time. A consecutive time of 15 hours at room temperature following death is an accepted standard.

Stringent criteria are followed to select cadaver for harvesting tissues and when they are met, a cadaver tissue harvest is performed in the Minor Operating Room attached to the Tissue Bank. Standards of asepsis with regard to harvest, processing and storage to match that of the Asia –Pacific Association of Tissue Banks and also the European Association of Tissue Banking are followed. Currently bones and tendons are harvested. Table No.4 gives the statistics of tissue harvested and utilised from cadavers and living donors.

Conclusion

The voluntarily donated cadavers are an invaluable resource for continued learning of health care professionals especially in the surgical field. The frozen cadavers have proven to be useful for psychomotor skill training. In order to optimise the usage of the cadaver donation and overcome the shortcoming of frozen cadavers for the purpose of medical education and research, specialised chemical preservation is one of the solutions. This provides added benefits such as long term preservation, preservation at room temperature (avoids the time of thawing), promoting instant usage and expands the spectrum of utility. Though the center has found satisfactory results for skills training on cadavers, there is a need to provide an evidence on the impact of lifelong learning by cadaver usage for psychomotor skills training through Educational research. Surgical skill training centers need to be developed at all medical colleges to cater to the needs of our medical graduate students and enable to become competent physicians of first contact. Patient safety should be the end point for training of all medical professionals and surgical skill centers for training facilitates this process. Allograft tissue of cadaveric origin is a very useful asset in the armamentarium of the present day surgeons and their availability and usage should surpass that of any other nation in the years to come.

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