Discussion
Chapter 6
Discussion

(a) OLD METHODS VIS-A-VIS NEW METHODS

The Ayurvedic methodology of the study of Anatomy was based on the actual dissection of dead human body. The teachers at that time insisted on "Pratyaksha Dnyana". This was almost 5000 years ago. These methods may have been crude and may not have given all the details, which the modern anatomy gives, but certainly, the way the cadaver was effectively used to impart lessons in Anatomy, are praiseworthy and admirable.

So far, no experiments have been made to find out whether these methods are effective and useful for imparting the knowledge of Anatomy to the present day Medical Students.

Present methods of preserving the cadavers in the formalin solution and dissecting them for almost one and half years may have all the advantages for learning all the details, which may not be necessary for a basic doctor. The greatest disadvantage in formalin preserved bodies is that they become rigid and there is altered coloration of many tissues. Irritation of the eyes during dissection is another big disadvantage.

One of the ways of contributing to the research in any branch of science is to examine the ways and the
procedures mentioned in the history of that science. The famous journeys of "Kon-tiki" or that of the Hawaiian Canoe from Hawaii to Tahiti and around Tahiti, a journey of 6,000 miles are very famous. These journeys served many purposes such as

- they functioned as the cultural catalysts
- they inspired the revival of almost forgotten aspects of Hawaiian life.

The great ancient science of Ayurveda used human cadaver dissection some 5,000 years ago. It is worthwhile making experimental models or the actual working experiments to test the claims made in Ayurveda and to know their value.

Even today, the students and teachers of Anatomy are not happy about the methods of dissection of the human cadaver and the methods of the preservation of the cadaver, which have many disadvantages.

In the present work, in the first place, a model of the landscape of a cadaveric dissection, as described by Sushruta was prepared. This was in the form of a metal (tin) tray of the dimensions 90 x 45 x 22.5 cms. Also, in this tray a miniature ecological system was created by germinating mustard and wheet seeds so as to remove the dissolved animal matter and to keep the water currents clean and free from stink. The choice of
mice as the experimental animal has already been justified.

For the purpose of surgery, Sushruta has described various ways of exposing the internal structures by:

1. Chedana: To cut open or to remove
2. Bhedana: To incise to drain.
3. Asharana: To remove (to enucleate)
4. Sevana: To stitch
5. Chooshana: To suck
6. Vishravana: To drain
7. Awasechana: To bathe or to wash
8. Pradhamana: To blow
9. Vidharana: To separate a part forcefully
10. Lekhana: To scrape
11. Eshana: To probe in.

For the purpose of dissection, in the present study, all these ways were utilised as and when required. All these ways are very effective to bring out the hidden structures or to expose the deeper ones or to examine the contents of different cavities. All these processes do not require any sharp instruments.

In the present work, it was noticed that the tissues which had more white or elastic fibers, were more stable in running water and more tough for even rough handling. It appears that the white or elastic fibers do
not easily get disintegrated under the effect of the running water as well as the bacterial action. The present methods of dissection are more impressive and perhaps more hygienic and clean also, but, even with the 5,000 year old method of dissection used in the case of the mouse cadaver, throughout the period of dissection of one week, it was not felt that the method was unclean or unhygienic. As long as the water was flowing over the cadaver, the decaying matter and the disintegrated tissues got washed off down stream and newer and deeper layer of tissues and newer planes of tissues came to view quite easily, sometimes with the help of little dissection. Even a forceful jet of water was enough to separate many of the planes particularly those between the muscle bellies. During the entire seven days' dissection, there was no stinking odour, and the irritating fumes of formalin were, of course, absent. The most important finding was that for such a small animal as mouse, which hardly weighs 30 gms. the clarity of the delicate and small structures of the palm or the sole or the structures in the neck and the mediastinum were very clear and convincing. Finally, the bones obtained at the end of the dissection, were very clean and not discoloured. As mentioned earlier, the modern methods of dissection
which are essentially prolonged and tedious, do not give any idea or impression about the true condition of the organ during life. In Ayurvedic Anatomy (Sharir), there are many gaps and the information is patchy. The present study substantiates the Ayurvedic claims of deriving this knowledge of human body by the dissection of the cadaver in running water. It appears from the present experiment that such a claim is justified.

Crowding in the Anatomical Dissection Halls is not desired by any anatomist. The student to cadaver and the student to teacher ratio ideally should be 1:1. This is almost impossible at any time. Even in the past, the acute scarcity of human cadavers was felt all over and attempts were made to find out alternative sources for receiving cadavers. Bhadakamkar in 1962/1967 publicly appealed for the voluntary donation of bodies after death to Medical Colleges. Sohoni in 1986, got the legal procedures involved in donation of such bodies simplified. However, if animal cadavers are used, they can provide good information about different systems and organs.

The dissection of some of the regions of the human body such as hand, foot, face etc. is extremely difficult as in the dry and hot tropical climate, in this country, these parts shrivel and dry up too fast and
the tissue planes come closer, particularly in formalin hardened bodies. This makes the dissection of these parts an arduous task but if only the anatomy of, say, the hand could be studied in fresh hands or the hands which are prepared by Ayurvedic methods, the dissection could be a rewarding experience.

It is not the purpose of this work to prove that the Ayurvedic method of cadaveric dissection is the ideal, but it is a modest effort to point out that "Hydro-disintegration of the tissues" gives an excellent opportunity to study the human and the animal organs and the tissues in a near natural state.

The factors responsible for the hydro-disintegration are not only the mechanical action of the running water, but undoubtedly, the action of different bacteria and the lytic enzymes of cadaveric tissue which continuously bring about the disintegration of different tissues. The disintegration could be controlled by controlling the rate of flow of water, the temperature of the water, the arrangement of ecological system and perhaps by the use of some medicinal plants. At each stage of disintegration, it was possible to learn the different organs and the tissues in a near natural state. In the present experiments, the slow disintegration of pectoralis
muscles gave a clear and vivid appearance of the direction of the muscle fibers which were rendered almost transparent so that one could see almost through them.

The same is true about the nerve fibers, which do not disintegrate earlier than the muscles or the organs they supply, with the result that the finest fibers of the nerves could be traced into an organ or the small muscles. The aponeuroses, the ligaments and the tendons can be better studied by the "Hydro-disintegration" as these contain a lot of fibrous or elastic tissues which are able to withstand the disintegration to a longer extent. These tissues when studied by this hydro-disintegration can give the correct ideas regarding the "Dhamani", "Marg", "Panthanaha", "Ashayah", "Srotasa" etc. which generally are either disbelieved or laughed at by the Allopathic as well as Ayurvedic Doctors. If Ayurvedic observations are substantiated by animal experiments and proofs, the Ayurvedic claims can be sustained and popularised.

By the help of hydro-disintegration, the Ayurvedic ideas about the Srotasa become clear. So far, these channels which are the spaces between various tissues and organs were not studied in details with the result that we do not know or understand, how some of the
bacteria or the parasites or the toxins spread inside the body in a surprisingly short time and without resistance from the body's defence mechanisms. If the Ayurvedic knowledge about these Srotasas is utilised adequately and in the correct manner, after experimental analysis, one can expect that the control over the spread of bacteria or the pathogens or the toxins etc. is easier. From this angle also, this hydro-disintegration method can prove useful in such studies.

The almost correct number of bones in the body mentioned by Sushruta, the detailed description of some of the organs, marmas, basti, apatya-patha, yoni, mutra-vaha srotas, anna marg etc. speak for the importance of "Pratyaksha Dnyana" which Ayurveda insisted on. It should be our endeavour to add to this "Pratyaksha Dnyana", without any bias and for achieving this "Pratyaksha Dnyana", different approaches must be attempted. The Ayurvedic approach of controlled hydro-disintegration enables one to understand the different tissues and the organs in a near natural state. Even zoological dissections are done under water in waxed trays. Water improves the clarity of dissection. Under the water, different organs and tissues tend to float to a variable degree depending upon their contents.
Thus, different tissues pull apart from each other and this improves the clarity of tissues or the organs, whereas the dissection in the dry state can not achieve this. The use of a blow pipe which produces a current of water by students of zoology during dissections further improves the clarity of dissection. Hydro-dissection as described in Ayurveda using running water has the obvious advantage of washing away putrified matter.

In Ayurveda, the term 'Kothayet' is used to denote putrefaction. It appears that the correct meaning of the term 'Kothayet' is hydro-disintegration leading to controlled putrefaction. Different tissues disintegrate at different periods and while undergoing disintegration, they not only expose their own internal structure but also bring out deeper tissues and organs. If 'Kothayet' would have meant only putrefaction, then there was no need for running water. The cadaver could have been well allowed to decay in a tank or a well. This certainly would have turned the cadaver into a stinking corpse where one cannot go nearby and do the dissection.

The running water from upstream could have been medicated but no such evidence is available today. This possibility needs further exploration by experimental
methods.

It may not be incorrect to think that the Acharyas, 5000 years ago, might have used medicated running water by placing the logs or barks of medicinal plants tied into bundles and fixed or anchored in running water so that the water first flows over these medicinal plants, extracts some quantity of the medicinal principle which will not allow gross decay of the cadaver, thus helping the hydro-dissection. This idea is similar to a tannary where the hides and the skin are not allowed to putrify in toto but by the use of barks of Harda (Terminalia Chebula) and Khair (Acasia Catachu) or fruits like Harda (Terminalia Chebula) and Behda (Terminalia Bellerhica) and a number of other plant parts, controlled putrefaction is achieved. The main mass of skin remains intact. In the present experiment, in the final stages of hydro-dissection of the mouse cadaver, it was possible to procure the skin of these animals devoid of fur and fat and almost intact and without any foul or rancid odour. It is presumed that the use of medicated water might bring about a better controlled putrefaction to enable one to extend the period of learning of Anatomy. Medicated hydro-dissection in running water may extend this period considerably. It is planned to conduct the experiments on these lines in
future. Ayurveda does not specify the time that was needed for dissection of cadaver. As a wild guess, it could be up to 70 days.

A comparison of the teaching of anatomy almost 5000 years ago and the present day teaching of anatomy to the first year M.B.B.S. student has been made (Please refer to Table 6-1). Admittedly there is a vast difference in the teaching time and the environment. An attempt has also been to put these ideas in a pictorial form (Fig. 12 to 17). With the help of hydrodissection it was possible to separate the layers of skin of the mouse cadaver (Please see Fig. 10). All these diagrams are purely imaginary, but certainly based on the information available in text books on Ayurveda. None of the Ayurvedic text books on Sharir contain any picture on the mode of dissection practised 5000 years ago. It is believed that the pictures incorporated in this thesis will fill this lacuna. The Ayurvedic method of hydro-dissection can perhaps be carried out all the year around. There is no mention of any particular season for the human cadaveric dissection, as mentioned in texts of Ayurveda. However, lower the temperature of the water, the better. Low temperature of water even in summer months is possible with Himalayan rivers as compared to the rivers of
central and Southern India. Therefore, hydro-dissection appears to have been more practiced in northern India than southern and central India.

If the water contains some dissolved substances it may act as a "preservative". This is possible with the Jammu-Kashmir and sub-Himalayan rivers as at many places the water has a high sulphur content. Sulphur is a known preservative. After coming out of the "hot sulphur springs", further down stream, where it cools down, if this water were to rush over pebbles and the sandy river bed, then it could be an ideal site for hydro-dissection. Likewise, iron, calcium and many other dissolved materials may have a beneficial effect on hydro-dissection particularly when the water containing them is running.

Hydro-dissection also is dependent upon the speed of water and also the structure of the river bed which should be sandy and not muddy. From this point of view only the Himalayan rivers could be effectively used for hydro-dissection and possibly a few can be pointed out from Karnataka and Kerala.

Himalayan rivers contain less number of bacteria and their source of water is the ice from Himalayas. The ice is sterile, whereas the other rivers receive water from the rain which immediately comes into
contact with the soil and gets contaminated heavily. Even though the mechanical washing action of the river water is the main factor to keep the cadaver sterile, if the water right from the beginning is bacteria free then the hydro-dissection can be carried out for a longer period of time which is certainly an asset. The criteria for the selection of the site for hydro-dissection should be based upon

1) Clarity and purity of water
2) Speed of water current - sufficiently strong
3) River bed of sand and the pebbles - no mud
4) Approach up to water front absolutely clear and without any plant life.
5) Facilities to dig trenches with ease - canal system

It is proposed to study in future the effect and interaction of bacteria free water from various sources on cadaveric tissues.

Ayurveda is old science. It is amazing that even at that time there was a great curiosity to study the human body for the purpose of treatment and surgery. Keeping the cadaver in the running steam at a lonely place which is not frequented by common public, the
place away from water fetching places. This idea for selecting the place for dissection must have been finalised after a great experience. The scientist were aware that the public dislike such dissections therefore they took all the precautions to avoid confrontations with the common and ignorant public.

Collecting the body and bringing it at the place of study was a task by itself. Which required wit, courage, presence of mind and zill to gain knowledge. How the cadavers were procured one does not know. Probably these bodies were donated by the Sanyasis.

Removing the G.I.T. and the adnexa clearly indicates the awareness that if these are allowed to remain in cadaver, the putrefaction of the body is uncontrollably quick. The knowledge about "Antras", "Amashaya" and "Pakwashaya" etc. was first gained and then attention was given to the rest of the parts.

The sequence of the study of different organs was probably dependant upon the sequence of disintegration.

Placing the cadaver in a cage is for protection. Wrapping it in layers of grass may also serve the same purpose. The instruments used for dissection were essentially of separating and cleaning type. Cutting type of instruments were not used. Therefore, the instruments were prepared from Bamboo or wood.
method for dissection frequently used was teasing, separating, pulling and cleaning.
A bird's eye view of the possible dissection site at the time of Ayurveda. The place is lonely, away from the human disturbances and interferences, clean, calm, and quiet with plenty of water for the cadaver as well as for the students to bathe and clean themselves.

Sentries with bow and arrows are posted to keep away the wild animals and human beings.

Fig. showing the site of cadaveric dissection. Note the clean water and loneliness of the site.

The course of dissection may not last for more than a month. Probably, the best season was November, December and January, i.e., according to Hindu Calendar 'Kartik', Margasheersha 'Pausha' and 'Magha'.

Cadavers were collected from the Dharmashalas and places of pilgrimage where a traveller died and there was no near and dear one to cremate it. Probably, King's permission was necessary for this purpose.
Method of placing the cadaver in a "bamboo cage" and fixing the same in running water stream. The stones are used as weights to "fix" and to "emerge" completely under water the cadaver. All the parts are fully bathed in water and no part is left exposed to air.

Fig. No. 13
An imaginary plan of the dissection site, prepared from the description available from the various texts.

There could be many more plans, according to the geographic site, the "Guru Kula" etc, but the basic requirements remain the same.
Cadaver wrapped in "Munja" and "Kusha" grass for protection and prevention of dehydration. Body is loosely wrapped.

Separate cap for Head

Trench for the prevention of water creature to enter the trench where the cadaver is kept.

River or Stream bed.

Fig. No. 15
A hydrated cadaver gains weight as it imbibes water and can become even twice in weight. To bring it out, it may require helpers as well as the mechanical arrangement like the ropes and the pulleys, which might have been effectively used in India at the time of Ayurveda for bringing out water from the deep wells, with the help of rope and the pulleys fixed over the wells.
"Hierushta Aentra Purisha" cadaver will look something like this. To remove "Aentra" where to cut, at the cephalic end and where to cut the GIT at the caudal end? Is tying of the ends necessary to prevent the escape of the GIT contents? What about the organs like liver, kidneys, spleen? What about the lungs? How the skull was opened and the brain exposed? Can brain stay in running water? How long?

No answers are found in the Ayurvedic texts.
Chapter 6

(b) PROBLEMS WITH THE MODERN METHODOLOGY

For the present allopathic method of dissection, the time interval which lapses between the death and the arrival of the body in dissection hall is at least 12 hours, sometimes even more than that. In most of these cases, the hands and the feet which are already emaciated become dry and hence are difficult to dissect. The situation is worsened by the formalin hardening. Ayurveda considers the palm and the fingers as one of the very important "Karmendriyas". The method of hydro-dissection which is proved useful in the present investigations, may prove valuable in the dissection of hands and feet. This may enable one to gather more and accurate knowledge about their functions as described in Ayurveda.
Chapter 6

(c) EXPERIMENTAL ANALYSIS

Continuous immersing of the cadaver in running water has some sort of interaction with different kinds of tissues and the organs which are composed of, fats and proteins. In the present experiment the fat got disintegrated soon and got washed off in running water. The testes and the kidneys were wrapped in the fat envelope and they got exposed after the 3rd or 4th day to the fullest extent. In these experiments, these two organs appeared smaller in size and shape on the 4th day very conspicuously. Whereas the organ like the liver did not lose its shape or did not get reduced in size even on the 5th day, the muscles from the 3rd day onwards appeared to become "thin", they were slimy to touch and were transluscent. The liver became soft and slimy on the 3rd day but still its shape and size was near normal. It crumpled only on rough handling. It was enough firm.

Since the main aim of the study was to find out whether the Ayurvedic method was possible or not in the first place, no attempt was made to go into all the details of each structure or the system separately. From the present work it appears that a considerable knowledge can be obtained by this simple method.
The water samples collected every day showed only E. coli and no protein disintegrating, fat dissolving and gas forming organisms were identified.

It is proposed to undertake this experiment in controlled, sterile, medicated water to study the speed of disintegration for controlled hydro-dissection and to control the growth of organisms which hasten or delay the process of decay.
(d) UTILITY OF THE ANIMAL MODEL

In modern medicine the animal experiments are done for the study of physiology, anatomy, histology, biochemistry and drug action etc. This is because it has been found that in each of these animals some system or the other resembles that of the human. e.g. rats are very close to the human beings as regards the blood pressure. For the study of the adrenergic system, cat is the animal of choice because it's adrenergic system (the nictitating membrane and iris) resembles that of man. Similarly smooth muscles of the ileum and rectum of the guineapig are studied for the antispasmodic action. The rabbit's isolated heart is used to study drug effects (Lagendorff's preparation). Even in Ayurveda animals were certainly used for bio-assessment. Today, for the purpose of the gaining knowledge about methods of dissection, as attempted by the Acharyas, animal model coupled with human cadavers is an ideal proposal. So far, unfortunately, animals have not been used for the study of Ayurvedic anatomy, i.e. "Sharir". It is felt that animal study will help in the better understanding of the "Aashayas", "Srotasas", "Dhamanis" etc. which one can not have from modern text books on anatomy. The mouse is a
delicate animal and cannot be studied for more than a week, under favourable conditions. For this purpose the rabbit, guineapig, rat, dog and monkey may be better animals as they would withstand the hydrodisintegration for a much longer period. If animals are used for experimental purposes there is no reason why they should not be used to study the various Ayurvedic principles in "Sharir" such as "Anga-pratyanga", "Srotasas", "Aashaya" etc.
After the dissection an Ayurvedic student had to take a bath, pray god in the form of "Sandhya vandan" or related prayers.

It is also possible that after the "course" in dissection the student was required to take "prayashchitta" so that even the residual feeling of "guilt" or "fear" may disappear.

For a modern student of anatomy only washing of hands after dissection is adequate, there is no need for any bath or prayer after the dissection. The apron is only an incomplete protection from the dirt of the cadaver. Only a bath after the dissection can afford complete protection. Of course, in western countries with an extremely cold climate, a bath after every dissection may not be feasible.

The fingers become shrivelled after a long dissection of formalin preserved cadaver. When the cadaver is dissected according to Ayurvedic methods no shrivelling of the fingers occurs nor there is any burning of the eyes as formalin or other chemicals are not used for the preservation of the human cadaver.
Prayer before the dissection and bath at the end of the dissection was a normal procedure. It helped in the cleanliness of the body, but definitely helped in keeping the moral high of the student. It might have contributed for the concentration and devotion.

Fig. No. 18
SUMMARY

1. A historical review of the Ayurvedic cadaveric dissection is made.
2. The modern teaching methods of anatomy are reviewed.
3. A comparison is drawn between the dissection methods in modern medicine and Ayurveda.
4. An experimental analysis of the Ayurvedic method of dissection is made by using mouse cadaver as an experimental model.
5. The merits of Hydro-dissection are discussed.
6. The bacterial role in the hydro-dissection (disintegration) is studied and discussed.
7. The utility of the experimental model for study of Ayurvedic Sharir is discussed.
CONCLUSIONS

1. The animal models to study the ayurvedic "Hydro-dissection" in running water is possible to gain knowledge regarding the animal and human cadaver.

2. Formalin preserved human cadavers do not give the correct impression regarding the physiological functioning of the body. It alters its appearance and the character.

3. Hydro-dissection in running water has a number of advantages, such as clarity, ease of dissection, non-irritant and odour-free atmosphere.

4. Animal dissection can partly substitute for human dissection.