P25

~~LIST OF PROCEDURES DONE~~

PROJECT REPORT

TITLE OF THE PROJECT: QUANTIFICATION OF LEFT ATRIAL PRESSURE USING INTRA ESOPHAGEAL BALLOON IN DOGS

NAME..... GEEVAR ZACHARIAH. A

PROGRAMME:..... D.M. CARDIOLOGY

MONTH & YEAR OF SUBMISSION:..... NOVEMBER 1986

Note:— (i) In the case compilation of procedures done, the contents and the subsequent pages should be made into different sections (a) Procedures done (b) Procedures assisted (c) Procedures participated (d) Procedures attended/participated etc in Other Centres. Each section should be preceded by a leaf carrying the name of the section that is succeeding.

(ii) The Contents page will carry into. as per model given under

**PROCEDURES DONE**

Closed Mitral valvotomy.....124 (say)
Patent ductus arteriosus-ligation.....10
Atrial septal defects.....20
.....
.....

**PROCEDURES ASSISTED**

Closed Mitral valvotomy.....100 (say)
.....

(iii) In the subsequent pages details of each procedure done/assisted should be given in the format given below:—

Heading: **Closed mitral valvotomy**

| Date | Name of the patient | Age | Sex | Patient No. |
|---|---|---|---|---|

(iv) In the case of Project Report in the page immediately following the Certificate page the under-mentioned details should be given:—

(a) Title
(b) Duration
(c) Aim and scope
(d) 50 word summary of work done

## CERTIFICATE

I, Dr. GEEVAR ZACHARIAH A ....hereby declare that I have actually performed all the procedures listed/carried out the project under report.

Signature.....

Place: TRIVANDRUM Name in GEEVAR ZACHARIAH A

Date: 5-11-1986 capital letters

Forwarded

Head Cardiology

TLE : QUANTIFICATION OF LEFT ATRIAL PRESSURE USING INTRA ESOPHAGEAL BALLOON IN DOGS

RATION : One months.

M AND SCOPE :

1. To record left atrial pressure waves using an esophageal balloon positioned behind left atrium in dogs.
2. To ascertain whether basal left atrial pressure could be quantified using an esophageal balloon.
3. To determine whether change in left atrial pressure is predictably reflected by the esophageal balloon.

BSTRACT: A fluid filled balloon catheter system was troduced into the esophagus and positioned behind left trium in Ten anaesthetised dogs. The wave pattern nd basal pressures were recorded and compared with irectly measured left atrial wave forms and pressure. Correlation between left atrial pressure and balloon ressure was sought after interventions to increase eft atrial pressure. It was found that though esophageal alloon adequately reflected the left atrial pressure ve forms, quantification of left atrial pressure was not ssible due to lack of linear correlation.

# INTRODUCTION

Haemodynamic monitoring of Left atrial pressure is extremely valuable in the management of critically ill patients, especially in the post operative period and after acute myocardial infarction. An invasive technique involving measurement of pulmonary artery occlusion pressure and thereby estimate left atrial pressure is already in widespread clinical use and is extremely useful. But a reliable non invasive means of quantifying left atrial pressure would have more practical clinical application.

Left atrial pressure waves have been recorded in man using intra esophageal balloon as early as 1889. Lasser et al in 1952 made extensive studies using esophageal balloons to record left atrial pressure wave forms under varying experimental conditions producing mitral valvular regurgitation in dogs. He coined the term "Esophageal

iezo cardiogram" for the pressure wave pattern
bserved and characterised the changes.
ut attempts to quantitate lyt atrial pressure
y esophageal balloon manometry by these
orkers were not successful.

An earlier experimental model developed
om this institute in 1985 has characterised the
hysical principles involved in the estimation of
yt atrial pressure using an esophageal balloon
atheter. It was found that there was a
near correlation between pressure change
the lyt atrial analogue and the pressure
hange in the esophageal balloon analogue.
owever the vareous biological variables
ere not taken into consideration while con-
ucting this experiment. Present study was
ndertaken to find out the correlation between
irectly measured lyt atrial pressure and intra
ophageal balloon pressure in experimental dogs.

## METHOD

The esophageal balloon catheter consisted of an eighty centimetre long polythene tubing with an inner diameter of 3.5 mm. One end was sealed and 4 openings into the lumen were cut in the sides of the tube about 3cms from the sealed end. A Poly Vinyl chloride (PVC) balloon, 4cms in length and 2 cms in diameter with a volume capacity of 12.5 ml was fixed over the polythene tube in such a way that the inside of balloon is in communication with lumen of polythene tubing through the 4 openings made. A three way stop cock attached to the open end of the tube served to connect it with both a saline filled syringe and the lead tubing leading to the pressure transducer.

The esophageal balloon catheter and the Indirect Left atrial pressure catheter were connected to a statham pressure transducer. The transducer was connected to an oscilloscope monitor which displayed the wave forms along with surface electrocardiogram. The transducer system

as calibrated before each experiment. The pressures were noted directly from the digital display. The esophageal balloon pressures and direct left atrial pressures were measured in quick succession by turning the three way stopcock attached to the left atrial catheter.

Ten mongrel dogs weighing more than kg were selected for the study. The esophageal catheter was filled with saline without air bubbles and partially inflated. The catheter was then placed in a gastric lavage tube 50 cms in length so that the inflated balloon will protrude through the end of the rubber tube. This was intended for the ease of introduction of the balloon catheter.

Dogs were anaesthesised with Pentothal sodium, intubated and ventilated with a mixture of nitrous oxide and oxygen. The esophageal balloon catheter was then introduced into the dog's esophagus. Balloon was then filled to its capacity and connected to the transducer. The position of the balloon is adjusted so as to obtain

be best waveforms. Chest of the dog was
en opened by a lyt lateral thoracotomy and
ophagus exposed. Position of the balloon
the esophagus and its relation to lyt atrium
as confirmed and minor adjustments of the
alloon position made. The pericardium was then
ened and through a purse string the catheter
as introduced into lyt atrium. The catheter
as then connected to transducer for measurement
direct lyt atrial pressure. Basal pressures
the balloon and the lyt atrium were then
corded in quick succession. Only the
an pressures were taken into consideration.
l pressures were recorded with dog in supine
stion, mid chest level being taken as zero
ference point.

600ml of normal saline was then
pidly infused through lyt atrial catheter in
crements of 200ml. After each 200ml
fusion, the maximum pressure obtained in
th systems were recorded in quick succession.

After fluid infusion mitral regurgitation was created by cutting few chordae with an artery forceps introduced through a purse string at Lyt ventricular apex and directed posteriorly. Creation of mitral regurgitation was confirmed by noting the abrupt pressure rise with prominent 'V' waves in the lyt atrial pressure recording. The mean pressures in both systems were noted. Next ascending aorta was cross-clamped to increase severity of mitral regurgitation and again the pressures were recorded in both systems. Pressures were also checked after release of aortic cross clamp.

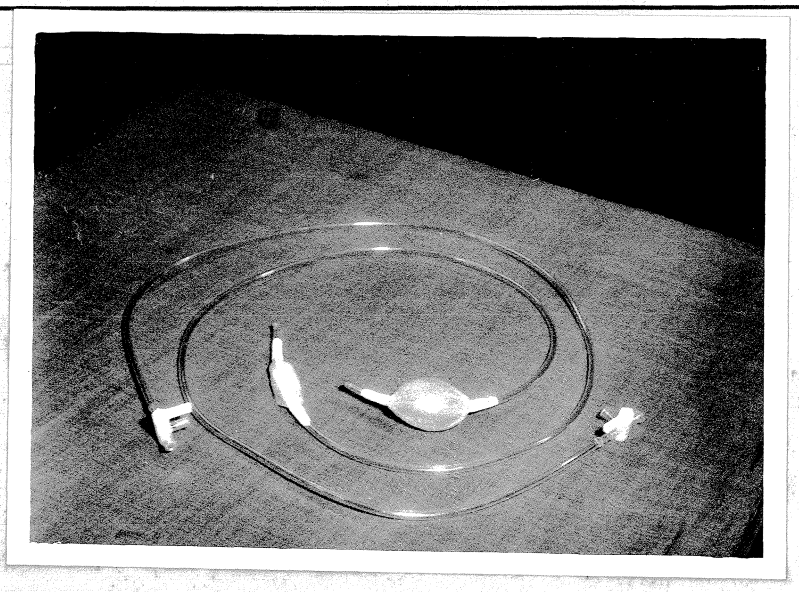

Fig. I Esophageal balloon catheter

g: 2. Left atrial catheter being introduced

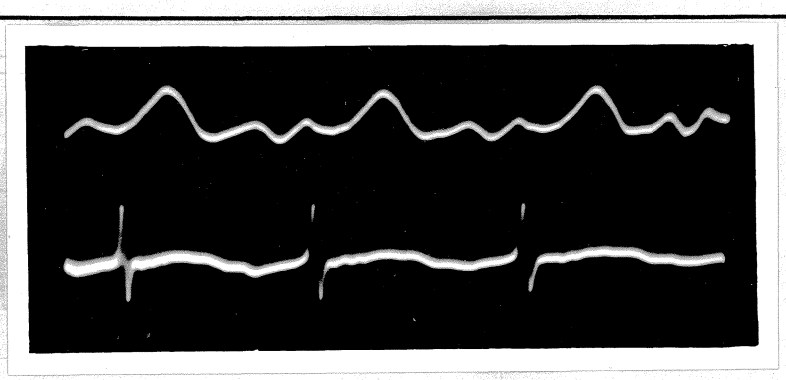

Fig. 3 Left atrial wave forms as recorded by the Esophageal balloon catheter.

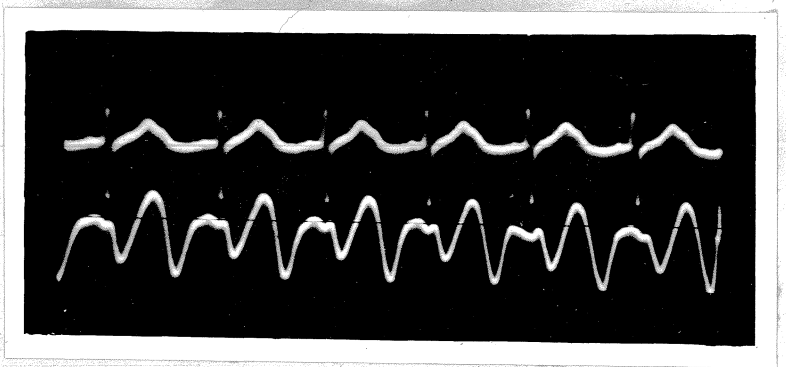

Fig: 4. Left atrial wave forms as recorded by the direct left atrial catheter.

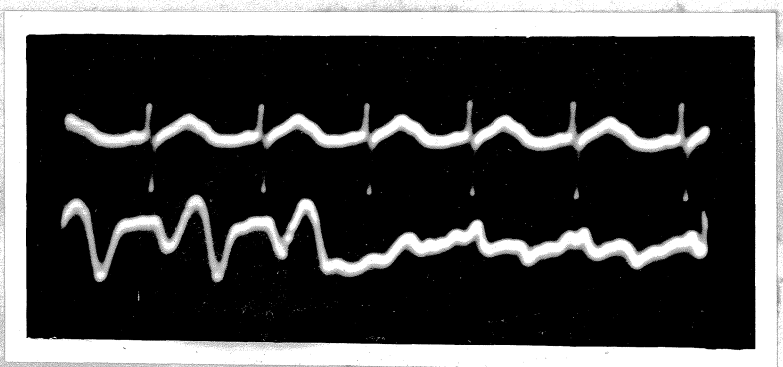

Fig: 5: Left atrial atrial wave forms recorded by direct ~~LA~~ left atrial catheter and esophageal balloon catheter in quick succession.

## OBSERVATIONS AND RESULTS

In all dogs studied a satisfactory pressure ave forms was recorded from the esophageal alloon catheter.

Despite using same sized balloon and same olume of fluid for inflation, the basal pressure corded from the balloon catheter in different ogs were highly variable as shown in Table One. he basal pressures recorded from the balloon nged from 4mm Hg to 19mm Hg. However e variation in the direct left atrial pressure was the order of 3 - 12 mm Hg. It was also observed ed the wave pattern from the esophageal balloon rimarily depended on the position of the balloon side the esophagus. Best wave forms were tained when the balloon was immediately hind left atrium. But the mean balloon pressure d not show any significant change irrespective the position of balloon in relation to left atrium.

Basal pressures in the balloon was checked

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| Dogs | BASAL PR (In mm Hg) | | AFTER SALINE INFUSION | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 200 ml | | 400 ml | | 600 ml | |
| Sl.NO | LA | BALLOON | LA | BALLOON | LA | BALLOON | LA | BALLOON |
| 1 | 7 | 11 | 13 | 14 | 17 | 16 | 21 | 17 |
| 2 | 6 | 16 | 10 | 17 | 14 | 20 | 17 | 22 |
| 3 | 3 | 8 | 6 | 5 | 11 | 9 | 15 | 10 |
| 4 | 9 | 4 | 15 | 12 | 21 | 14 | 25 | 15 |
| 5 | 9 | 17 | 17 | 18 | 19 | 19 | 20 | 20 |
| 6 | 5 | 9 | 12 | 18 | 14 | 19 | 21 | 20 |
| 7 | 9 | 19 | 13 | 22 | 16 | 24 | 19 | 24 |
| 8 | 12 | 4 | 16 | 5 | 18 | 5 | 21 | 8 |
| 9 | 8 | 14 | 12 | 15 | 16 | 15 | 20 | 16 |
| 10 | 9 | 5 | 13 | 7 | 16 | 8 | 19 | 10 |

TABLE I showing mean pressure in mm Hg in the two systems before and after fluid infusion.

ith the dog in supine and right and left lateral
ecubitus positions. Though the waveforms were
tter in the supine position, there was no
gnificant change in the mean pressure in
ifferent positions.

When cotton paddings were placed in
ont of heart, the pressure waves recorded
om the balloon were much superior

changes in both the pressure systems after
e fluid challenge is shown in table One.
n all the dogs studied, pressure in both systems
se after fluid challenge, but the degree of
ise in the balloon was very small when
mpared to the rise in direct left atrial
ressure.

Table II shows changes in direct left
atrial pressure and esophageal balloon pressure
fter creation of mitral regurgitation and after
pplication of aortic cross clamp and its release.
ere again, both pressures rose after mitral
egurgitation and application of aortic cross clamp.
ut the degree of pressure rise was much less

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| Dogs | BASAL PR | | AFTER MR | | AFTER AORTIC CROSS CLAMP | | AFTER RELEASE OF AORTIC CROSS CLAMP | |
|---|---|---|---|---|---|---|---|---|
| Sl.No | LA | BALLOON | LA | BALLOON | LA | BALLOON | LA | BALLOON |
| 1 | 10 | 12 | 19 | 13 | 26 | 18 | 13 | 12 |
| 2 | 12 | 19 | Dog went into VF and could not be resuscitated | | | | | |
| 3 | 5 | 9 | 17 | 20 | 23 | 12 | 8 | 10 |
| 4 | 12 | 13 | 27 | 16 | 30 | 18 | 18 | 14 |
| 5 | 16 | 19 | 22 | 22 | 33 | 25 | 15 | 19 |
| 6 | 15 | 18 | 19 | 21 | 34 | 26 | 16 | 20 |
| 7 | 17 | 23 | 20 | 21 | 27 | 23 | 20 | 18 |
| 8 | 14 | 10 | 28 | 11 | 38 | 12 | 18 | 10 |
| 9 | 12 | 9 | 31 | 14 | 35 | 16 | 22 | 14 |
| 10 | ~~15~~ 9 | ~~18~~ 15 | ~~7~~ 18 | ~~25~~ 7 | ~~9~~ 25 | ~~F~~ 9 | 15 | 8 |

TABLE II Mean pressures in the two systems after interventions to increase left atrial pressure (Pressures in mmHg)

s the esophageal balloon.

Table III shows the percentage of change etween basal and peak pressures in the two estems. The percentage change in the balloon as very small and unpredictable.

| Dog's Sl. No: | LEFT ATRIAL PRESSURE (mm Hg) | | | BALLOON PRESSURE (mm Hg) | | |
|---|---|---|---|---|---|---|
| | BASAL | PEAK | % CHANGE | BASAL | PEAK | % CHANGE |
| 1 | 7 | 26 | 270 | 11 | 18 | 64 |
| 2 | 6 | 17 | 183 | 16 | 22 | 38 |
| 3 | 3 | 23 | 666 | 8 | 12 | 50 |
| 4 | 9 | 30 | 233 | 4 | 18 | 350 |
| 5 | 9 | 33 | 266 | 17 | 25 | 47 |
| 6 | 5 | 34 | 580 | 9 | 26 | 190 |
| 7 | 9 | 27 | 200 | 19 | 23 | 21 |
| 8 | 12 | 38 | 217 | 4 | 12 | 200 |
| 9 | 8 | 35 | 337 | 14 | 16 | 14 |
| 10 | 9 | 25 | 180 | 5 | 9 | 80 |

TABLE III Percentage change between basal and peak pressures in the two systems.



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## DISCUSSION

Present study has shown that good quality
t atrial pressure waves can be reproducibly
corded by means of an intra esophageal
lloon using fluid filled catheter transducer
stem in dogs. It was also found that
ave forms were much better in supine
sition. Similar results were also obtained
preveous workers. There was no change
wave pattern after thorecotomy. Best wave
rms were obtained when the heart was
dded in front by cotton. Even though
wave forms were obtained in all animals,
mplitude of excursion was very variable.

Despite fairly adequate recording of
t atrial wave forms in all animals, there
as no consistent relation between the mean
lloon pressure and simultaneously measured
irect left atrial pressures in the basal state.
asal pressure in the balloon showed marked

luctuation from dog to dog. This was spite of using same sized balloon and same lating fluid volume. When direct left atrial ressure was in the range of 4-12 mm Hg, asal balloon pressure was in the range of -19 mm Hg. It was also found that even hen balloon was not in relation to left atrium ean balloon pressure did not very signi- cantly. Thus observations suggested that eso- hageal balloon pressure cannot be utilized to uantify basal left atrial pressure.

Our experiment carried out after inter- ntions to increase left atrial pressure showed at balloon reflected directional change in the t atrial pressure. But the degree of change as minimal. When the mean change in t atrial pressure was 303% (180% - 666%), e change in esophageal balloon pressure as only 105% (80% - 350%). The change was lso not predictable. In one dog for a 666% hange in left atrial pressure, the balloon pressure hanged by only 50%. In another dog with 337%

hange, balloon showed only 14% change. In
t another dog for a 233% change in lyt
rial pressure, the balloon pressure changed
y 350%. This extreme variability of response
ake esophageal balloon an inadequate tool
r lyt atrial pressure measurement. Lasser et al
lso found inadequate correlation between
sophageal balloon pressure and direct lyt
rial pressure.

The relationship between the magnitude
pressure fluctuations between the two
ystems is very difficult to formulate in general
rms because many factors which cannot be
uantified influence the recording of pressure
om esophageal balloon systems. The pressure
leveloped within the esophageal balloon is the
esultant of two forces. Once force is
mposed by the expanding atrium which compresses
e balloon against the vertebral column. The
ther force is the expression of resistance of the

alloon and the esophagus to the change in hape imposed by the first force. It is pparent then that the pressure in the eso- hageal balloon at any instant is the resultant several variables even under standard berimental conditions. It could be antici- ted that variations in the position of the art in the chest, level of diaphragm during spiration, proximity of esophagus to atrium, ternal dimensions, tone, elasticity and motility esophagus, amount of fluid in the balloon d elasticity in the balloon catheter system ight alter the quantitative relationship of ressure in an unpredictable fashion. Other ctors which could influence balloon pressure easurements in a clinical situation are the ze of the left atrium, hypertrophy of atrial wall d mediastinal disease. Since most of these ctors cannot be standardised and are ghly variable, balloon esophageal pressure will t reflect actual left atrial pressures.

## CONCLUSIONS.

This study shows that left atrial pressure waves can be recorded by an esophageal balloon catheter positioned behind left atrium and connected to a fluid filled transducer system. However there was no correlation between basal left atrial pressure and the measured balloon pressure. Further the sensitivity of esophageal balloon to detect a change in left atrial pressure was very poor and unpredictable. This is because the pressure in the esophageal balloon is influenced by many variables which cannot be standardised. Hence esophageal balloon catheter system cannot be used to quantitate left atrial pressure in dogs.

# REFERENCES.


Gordan, A.J.; Kuhn, L.; Amran, S.S.; Donoso, E.; Braunwald, E.
Left atrial, pulmonary capillary and esophageal balloon pressures in mitral valve disease.
Br. Heart J 1956, 18:327.

Joseph Joy, M.V., Suresh, K.
Quantification of left atrial pressure reading using an intra esophageal balloon. An experimental model.
Project report, SCTIMST. Feb 1985.

Lasser, R.P., Loewe, L.
Esophageal pressure pulse pattern - Esophageal piezo ~~electro~~ cardiogram. Am. Heart J. 1952, 44:531

Lasser, R.P., Ebstein, B.
Esophageal pressure pulse pattern. Clinical studies. Am. Heart J. 1952, 44:681.

Schischmanov, N., Wallentin, I.
Non invasive recording of cyclic fluctuations in the volume of the left atrium.
Electro Medica, 1981, 4:181.

Zoob, A:
Esophageal pulse in mitral valve disease
Br. Heart J, 1954, 16:39.