LIST OF PROCEDURES DONE

PROJECT REPORT

TITLE OF THE PROJECT: *EVALUATION OF THE 6mm DIAMETER BIOMER GRAFT IN THE SUBCLAVIAN TO PULMONARY ARTERY SHUNT POSITION IN PIGS.*

NAME..... *DR. SHEKHAR RAO*

PROGRAMME:..... *M.Ch. CVTS.*

MONTH & YEAR
OF SUBMISSION:..... *NOVEMBER 1989*

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. *SHEKHAR RAO* hereby declare that I have actually performed all the procedures listed/carried out the project under report.

Signature.....

Place: *TRIVANDRUM*

Name in *SHEKHAR RAO*
capital letters

Date: *11.11.'89*

Co-topics that his statements are correct.

13-11-89.

CONTENTS

* Photographs attached at the end.

Title: *Evaluation of the 6mm Biomer graft in the subclavian to pulmonary artery shunt position in pigs.*

Duration: *6 Months*

Aims & Scope:

1. *To implant the 6mm Biomer graft in the modified Blalock-Taussig shunt position in 6 cases.*
2. *To follow the progress of the animals over 6 months with a view to determining shunt function over this period.*
3. *To harvest and study the grafts at the end of 6 months for patency and gross changes.*
4. *To forward the harvested material for further evaluation to be done by the manufacturers.*

Summary of work done:

Six implantations of the 6mm Biomer graft were done in adult pigs during January-February 1989. The pigs were kept under observation for the subsequent 6 months and auscultation for the shunt murmur was done every week. One animal was sacrificed after 102 days and the remaining grafts were explanted 6 months later to the date of implantation. The explanted specimens were examined for gross evidence of thrombosis, degradation and tissue reaction. They were then forwarded for further studies to the manufacturer.

INTRODUCTION

The 6mm Biomer [Polyurethane] graft represents another step in the continuing quest for an ideal small diameter synthetic vascular prosthesis [1]. It has been produced by an entirely new process known as electrostatic spinning in which a continuous stream of polyurethane is deposited as a jet onto a rotating electrostatically charged mandril. In this, the graft is unique and differs vastly from the usual weaving and knitting processes by which fabric grafts have been hitherto manufactured, or the extrusion process by which polytetrafluoroethylene grafts are manufactured. The Biomer graft has been pioneered by the biomedical technology group at Liverpool Medical School led by Professor David Annis[2] and after laboratory evaluation, was taken up for manufacture and further trials by the Johnson and Johnson Company [USA].

While long-term successful implantation [patency of upto 1 year] could be achieved with 10mm grafts in animals in the thoracic aortic position [2] human trials of the graft in small vessel peripheral arterial positions yielded unsatisfactory results due to accelerated macrophage mediated biodegradation of the graft. To try and reduce this process, the grafts were given a coat of silicone and this modified graft awaited further trials.

The small diameter polytetrafluoroethylene vascular graft has been used frequently in the performance of the modified Blalock-Taussig shunt especially when it is needed to function temporarily until definitive correction of the congenital cardiac defect is carried out. In this position, it may however be desirable to have a graft that has a predictable limited duration of patency so that the additional time spent for and

potential hazards of shunt take-down at the time of definitive repair can be obviated.

This series of implantations was meant to examine both these aspects viz. the resistance to biodegradation of the siliconised biomer graft and the question of whether a predictably limited duration of patency in the subclavian-pulmonary position could be achieved.

The adult pig was chosen because of our previous experience in aortic grafting in this animal model, its easy availability and improbability of changes occuring due to further growth of the animal.

AIMS AND OBJECTIVES

1. Implantation of the graft in 6 animals in the subclavian-pulmonary position in adult pigs.
2. Follow-up over 6 months to determine shunt function by regular auscultation.
3. Harvesting of the graft at the end of 6 months and gross examination of the same for evidence of degradation, thrombosis and tissue reaction.
4. Forwarding of the specimen for further analysis to be conducted by Messrs. Johnson and Johnson Company in the USA.

METHODOLOGY

The 6mm internal diameter siliconised Biomer [polyurethane] vascular graft was evaluated in the modified Blalock-Taussig shunt position in pigs. Six implantations were made in adult Chitra mini-pigs [25-35 Kg.] which were $1\frac{1}{2}$ to 2 years in age and were selected from our breeding colony. Five to 6 cms. long segments of the graft were used in each case.

Animal care and medication

Aspirin [350 mg.] and Dipyridamole [200 mg.] were administered for 7 days before surgery and continued daily throughout the post-operative period. Digoxin was begun pre-operatively and given daily subsequently on a maintenance basis. Streptopenicillin injections were given for one week starting at the time of operation.

Anaesthesia

General anaesthesia with endotracheal intubation was as per the established protocol.

Operation

The chest was entered through the left third intercostal space. After retracting the apex of the left lung downwards, the left subclavian artery was dissected free starting from its aortic origin. The first dorsal branch was divided between ligatures to facilitate mobilisation of the main artery. The subclavian artery was 0.8 to 0.9 cm. in diameter in each case. The subclavian A. was then side clamped with a vascular clamp and a vertical 0.8 cm. long arteriotomy was made in it. One end of a 5 cm. long segment of Biomer graft was bevelled to 45° and anaestomosed to the side of the left subclavian artery using continuous 6/0 prolene. No systemic heparinisation was done.

The graft was then positioned in a virtually straight downward course to lie over the antero-superior surface of the main pulmonary artery.

A limited pericardiotomy was then made over the main pulmonary artery, medial to the phrenic nerve. The main pulmonary artery was 1.8 to 2.0 cms. in diameter in each case.

The MPA was side-clamped and a 0.8 cm. long arteriotomy made over its antero-superior surface. The distal end of the graft was suitably bevelled and anastomosed in an end-to-side fashion to the MPA with continuous 6/0 prolene.

First the distal and then the proximal clamps were released. Minor suture-line oozing could be easily controlled with pressure alone.

The presence of a thrill was noted.

The chest was closed in layers after evacuation of air.

POST-OPERATIVE CARE AND OBSERVATIONS

The animals could be extubated on the table and returned to the floor. They resumed feeding in four to eight hours time. The animals were restrained manually in order to auscultate them for the shunt murmur in the immediate post-operative period and weekly thereafter.

Auscultatory findings have been summarised [Table 1].

There was no mortality. The animals remained active and well after the first day.

Restraint of the animal proved to be difficult due to aggressive behaviour and auscultation was quite difficult in many cases. The murmurs were best heard over the ventral surface of the chest just medial to the fore-leg in either the left or right lateral positions [Absence of any murmur pre-operatively had been confirmed under anaesthesia].

Angiography was attempted in one case but was unsuccessful owing to difficulty in arterial access and extremely fragile peripheral arteries.

The subclavian artery in the pig is an extremely delicate vessel too and sutures were prone to cut-through with even the slightest use of force.

The graft was very easy to handle and suture. There was no graft bleed or excessive needle-hole bleed. However, it kinks badly when moulded into anything greater than a gentle 'C' shape. This is the chief operative limitation.

RESULTS

All the cases had very satisfactory thrills palpable on the table after release of clamps.

Good continuous murmurs were heard in the post-operative period in four cases and systolic murmurs alone in two cases.

The earliest absence of shunt murmur was on the 21st day and the longest clinical patency was upto 46 days post-operatively.

The first animal was sacrificed 102 days after implantation and the subsequent grafts were all harvested 6 months after their date of implant. Harvesting of the graft was done after systemic heparinisation.

The gross findings in each case were identical and are mentioned below.

[a] Native vessels totally normal

[b] Moderate perigraft fibrosis

[c] Suture-lines regular with fibrosis denser in this area

[e] Both ends of the graft were totally sealed-off from the native vessels. From within the MPA and LSA, the site of the graft anastomosis could be seen as a dimple. No thrombus could be visualised from within the native vessels.

[f] On opening the graft, a full length partially occluding organised thrombus was found. The thrombus was free from the graft thoughout except at the ends where it was densely stuck at the suture-lines with darker appearing thrombus.

[g] The intimal surface of the graft appeared smooth and glistening.

Impression: Completely occluded anastomotic ends with graft thrombosis starting at the suture-lines.

CONCLUSIONS

1. The 6mm siliconised Biomer graft when implanted in the side-to-side subclavian to pulmonary shunt position in pigs functioned for a period ranging from 3 weeks to $6\frac{1}{2}$ weeks as determined by clinical evaluation.

2. Gross examination after explantation showed complete occlusion of the graft at the anastomotic ends due to thrombus and what appeared to be neo-intimal resurfacing of the native vessels at the site of anastomosis.

3. The graft body itself was free of adherent thrombus and had undergone no gross degenerative changes having invoked a moderate tissue fibrosis in each case.

4. *The graft was very easy to handle and suture, having the consistency of the native arteries and did not bleed either through the body or the needle holes. It however, kinked very easily in any lie which assumed a greater curve than a gentle 'C' shape.*

5. *The subclavian artery of the pig is very delicate and of difficult accessability and hence the pig is not an ideal model for evaluation of a graft in this position.*

6. *Angiography through the femoral artery is not possible due to the extremely delicate and small calibre of the arteries. Open carotid or abdominal aortic cannulation may be tried in the future but were not attempted this time as these are more invasive and it was imperative to keep the animals alive for 6 months and harvest the graft.*

7. *Results of further analysis of graft surface characteristics by histology and scanning electron microscopy are awaited.*

8. *On the basis of the present findings, it is concluded that 6mm. Siliconised Biomer graft did not function satisfactorily in the subclavian - pulmonary shunt position in adult pigs, the maximum period of patency being about $6\frac{1}{2}$ weeks as determined by clinical follow-up examination. The reasons for early occlusion are to be re-examined after all the details of microscopic examination of the graft become available.*

REFERENCE

1. *Cronenwett JL, Zelenock GB: Alternative small arterial grafts; in, Biologic and Synthetic vascular Prosthesis, Ed. Stanley J.C., Burket WE, Lindanauer SM et.al. Grune and Stratton Publ. Pg. 612 - 614, 1982.*

2. *Annis D, Bornat A, Edwards R.O., Higham A., Loveday B., Wilson J., An elastomeric vascular prosthesis. Trans. Am. Soc. Artif. Intern. Organs 24; 209 - 214, 1978.*

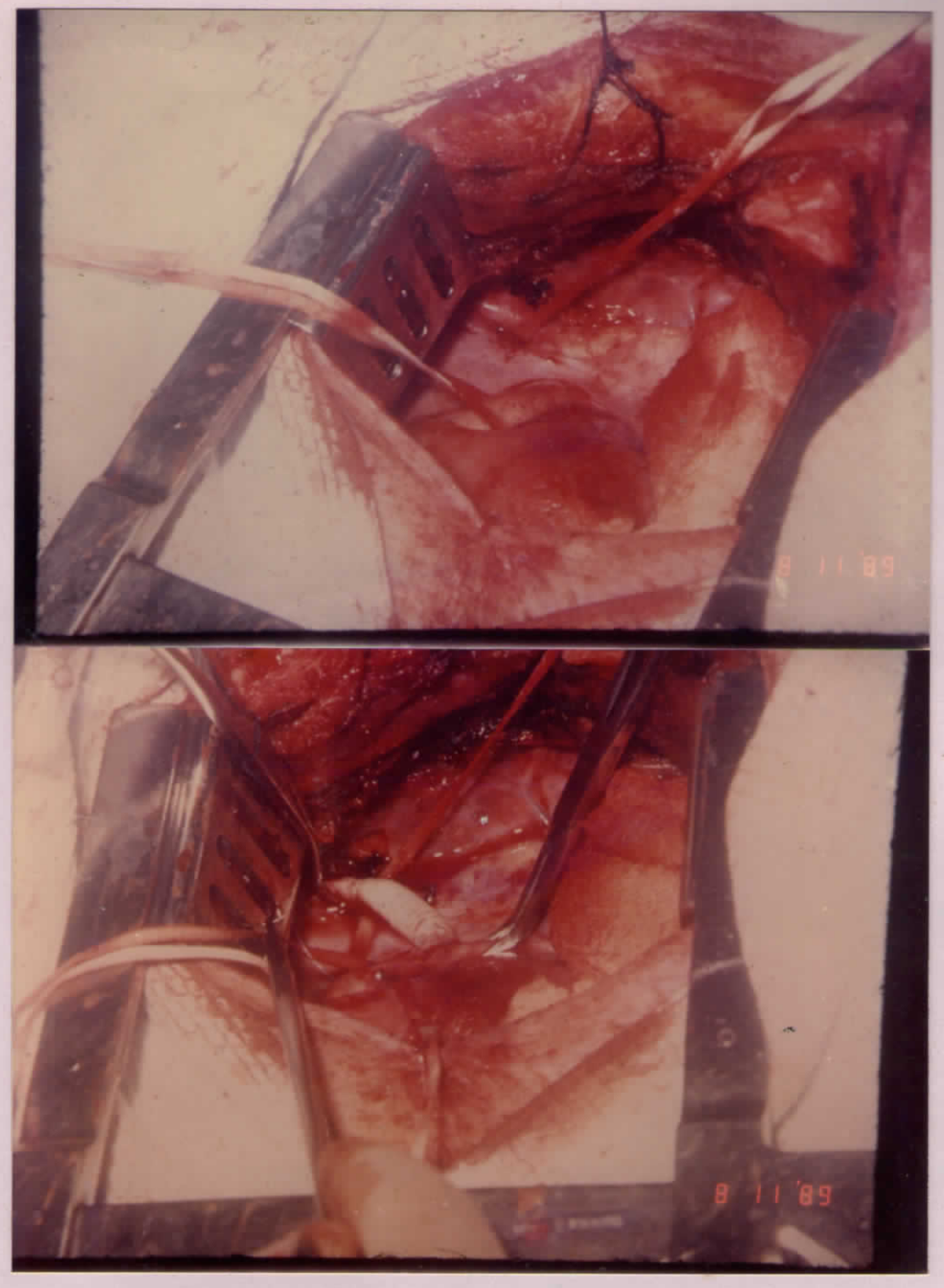
BIOMER GRAFT SUBCLAVIAN - PULMONARY SHUNTS IN PIGS

TABLE - 1

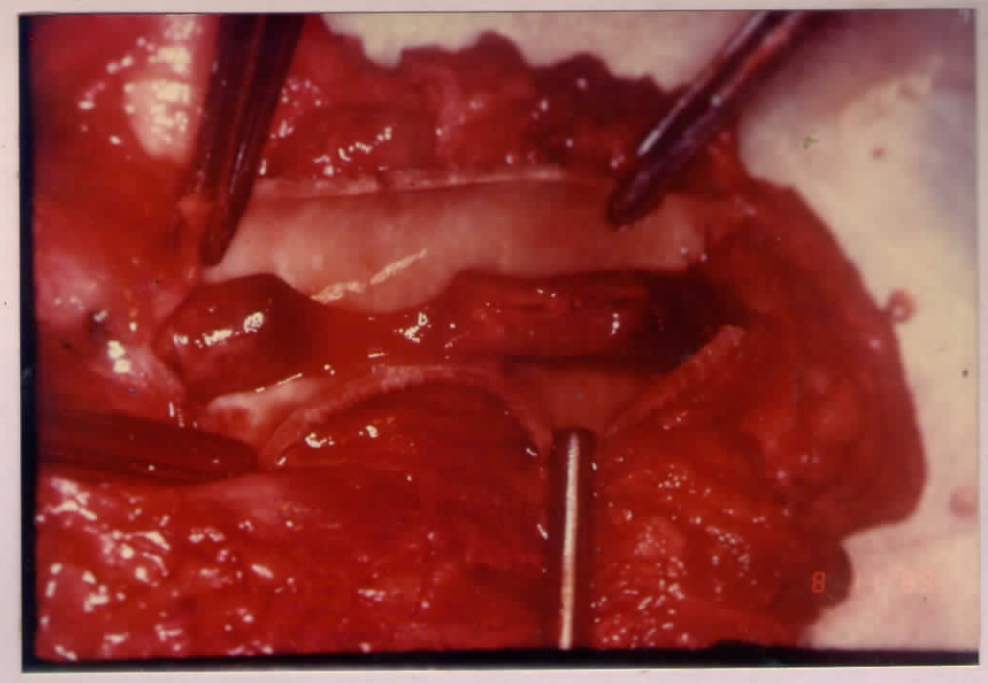
Date	SL.	Wt/Sex	Intra-OP Problems	Thrill on Declamping	Murmur After of	Murmur Ist week	2nd week	3rd week	4th week	5th week	6th week	7th week
24.1.1989	1	26.5/M	Nil	S thrill over MPA	S	Nil	2/6 LS	1-2/6 SS	1-2/6 SS	Nil (37 days)		
28.1.1989	2	33.5/F	Nil	C thrill over MPA + Graft	2/6 SD	3/6 C	2/6 S	1-2/6 S.S	1-2/6 S.S	1-2/6 S.S	1-2/6 S.S	Nil(days
4.2.1989	3	33/F	Bleeding from MPA as clamp was released due to bradycardia.	S thrill over Graft + Proximal MPA.	1/6 S	3/6 S	2/6 C	2/6 C	3/6 S D	3/6 S D	3/6 S D	Nil(days
11.2.1989	4	34/M	Nil	C thrill over Graft + MPA	1-2/6 C	2/6 C	1/6 C	1/6 C	1/6 C	1/6 C	1/6 C	Nil(days
18.2.1989	5	29.5/M	Nil	C thrill over Graft + MPA	3/6 C	3/6 C	3/6 S D	3/6 S D	Nil (23 days)			
25.2.1989	6	32/F	Nil	C thrill over Graft + MPA	3/6 C	3/6 C	3/6 C	3/6 C	Nil (21 days)			

Key:-

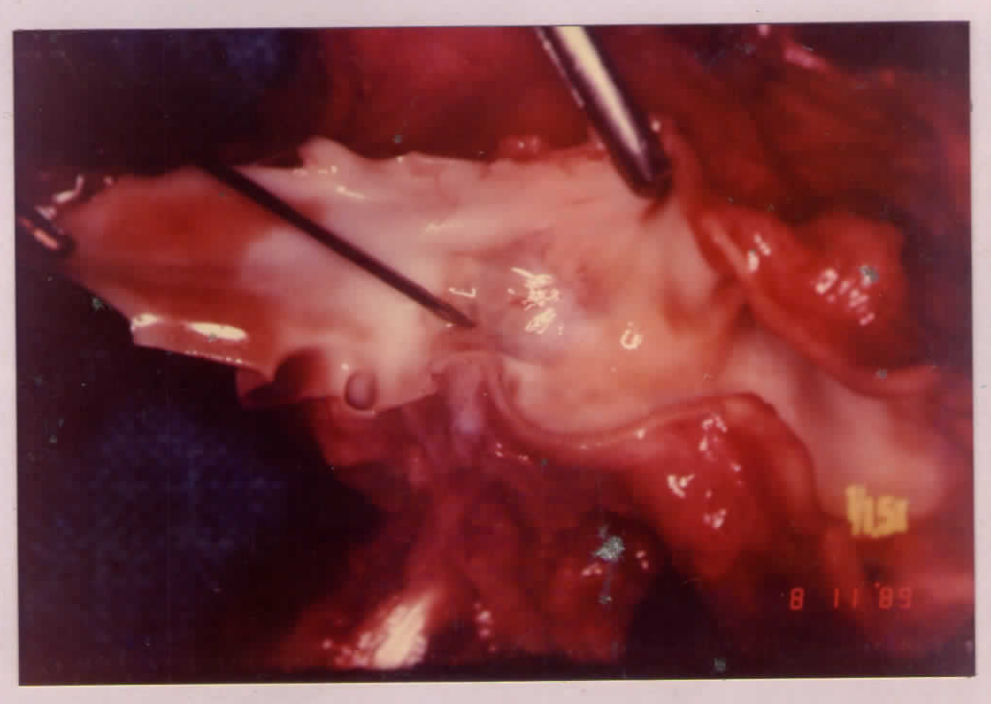
C: CONTINUOUS
S: SYSTOLIC
D: DIASTOLIC
LS: LONG SYSTOLIC
SD: SYSTOLO-DIASTOLIC
SS: SHORT SYSTOLIC



* Showing the graft in-situ in the left subclavian artery to main - pulmonary artery shunt position.



* Explanted graft opened to show thrombus starting at the anastomotic ends and the glistening "intimal" surface of the graft.



* Showing complete occlusion of the pulmonary end of the graft seen as a dimple from within the main pulmonary artery.