AUTOGENOUS VEIN GRAFT AS A CONDUIT FOR NERVE REGENERATION - AN EXPERIMENTAL STUDY

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KEY WORDS :
Thick Nerves, Wide gaps.

ABSTRACT :

This study is based on earlier experimental work of similar nature carried out by David T. Wchin in 1982 and experimented to find out if autogenous vein graft can act as a successful conduit for nerve regeneration. Twenty adult healthy guinea pigs were divided into different groups. Operative, histopathological and electrophysiological studies stretching over to 10 months period were then carried out. Results of experiments conducted are tabulated and presented and compared with previously conducted studies.

INTRODUCTION :

Difficult problem that confronts the surgeon is how to repair large defects in the thick peripheral

nerves. Various manoeuvres such as mobilization of both stumps, rigid fixation of joints in flexion to achieve approximation of both cut ends, are ways available to bring together without tension the divided ends. Yet when the gap between severed ends is large and end to end anastomosis without tension, is not possible one often takes to cable nerve graft for bridging the gap. Auto grafts cannot be harvested from large size nerves and peripheral cutaneous nerve used needs to be cut in pieces and bundled to reach a size same as that of the thick nerve to serve as adequate diameter auto cable nerve graft. Results are disappointing when this is carried out. Homografts and heterografts have been tried experimentally. As yet there is no report of successful nerve regeneration after use of Homo and Hetro Nerve Cable grafts in human beings.

David T.W. Chieu et al (1982) have used autogenous piece of vein to serve as a conduit for nerve regeneration.

Veins of different lengths and diameter, in large numbers are readily available in an individual's body. The vein walls are thin but resilient, large enough to act as a conduit and prevent growing nerve fibres from getting trapped, in surrounding scar tissue. Present study was undertaken to substantiate whether vein can function as a conduit and improve the result of nerve regeneration.

REVIEW OF LITERATURE

Classic work of nerve repair by auto cable grafts, show that axon fibrils grow through such nerve graft. (Weiss P. et. al. 1943). Bridging the nerve gap with arterial segments has resulted in successful regeneration through lumen of the artery but in some cases marked fibrosis results. Spurling R.G. et. al. 1943, David T.W. Chiu 1982. Bridging the small gap of severed nerve with plasma clot resulted in easy passage of growing nerve fibrils through it. Gutmenn et al 1943. Tentalium tubes and Millipore tubes used as conduit to bridge the gap has resulted in successful nerve regeneration. Campbell J.B. et al 1963 Use of autogenous vein graft for nerve regeneration has also proved successful. Since lumen of vein acts as a conduit. David T.W. Chiu 1982.

MATERIAL AND METHODS

Young adult guinea pigs are selected for experimental study. The animals are divided in following groups :-

GROUP-I : Is of 10 animals.

This group is further divided into group - IA which consists of 5 animals in which right Sciatic nerve gap of 2 cm length is repaired with autogenous femoral vein graft and left side gap is left unrepaired. The repair of resected nerve with autogenous vein graft is done with the help of operative microscope with nylon suture 8/0. The whole thickness of vein wall is anastomosed with epineurium of nerve by interrupted sutures, with due precautions to achieve proper co-optation and to avoid rotation of nerve.

GROUP-1B : In the rest 5 animals, gap on the left side is repaired and gap on the right side is left unrepaired.

Each month one guiny pig from Gr. I (A+B) is sacrificed. Eight of the total ten are used for histopathology study (1,2,3,4,5,6,8, 10 months). 2 animals (No. 7 & 9 months) are used for muscle nerve preparation (electrophysiological study) to determine the conduction velocity in vein grafted

nerve, of the total 20 ginny pigs, remaining 10 are used in Gr. 2.

GROUP-2 A : Consists of 5 animals. A segment of 2 cm. of one sciatic nerve is resected. No repair is done. The animals are observed for 10 months and then sacrificed and autopsied.

GROUP-2 B : Consists of 5 animals. A segment of femoral vein is resected and animals are observed for of ischaemic changes in limbs.

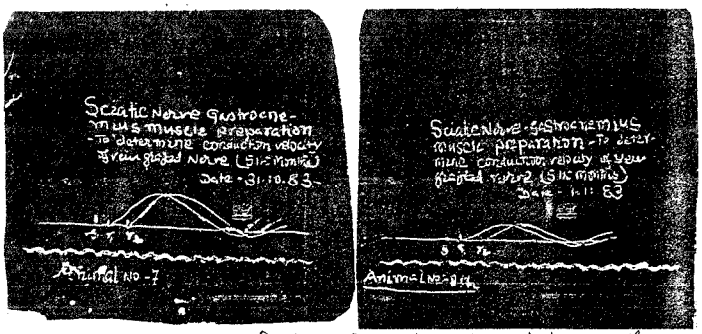


Fig. 1 :- Curve obtained on electromyograph to determine conduction velocity.

Sketch showing :

(i) Electromyograph curve to determine conduction velocity.

OBSERVATION AND RESULTS

The animals of group IA and group IB are observed for trophic changes in their skin, nail, hair & clinically the muscle atrophy is determined by measurement of girth of muscle.

TEST FOR SENSORY RECOVERY

The animals of Group 1A, 1B and 2A are studied at intervals. The planter skin is pricked with a pin and withdrawal of limb due to sensory reflex is noted. So also studies of motor, power and motor activity are carried out prior to sacrifice. Naked eye observations are made of the nerve under study, prior to its removal and in Histopathology study, Following points are noted :-

1. Traces of suture material
2. Mass of scar tissue present at junction
3. Neuroma formation
4. Consistancy of grafted vein and that of nerve within, to palpation.

ELECTROPHYSIOLOGICAL STUDY

For determination of conduction velocity of vein grafted sciatic nerve, a sciatic nerve gastrocnemius muscle preparation is prepared and simple muscle curve is recorded by stimulating the nerve at its spinal end and on muscle end. The latent period of two curves is then measured by callipers. Conduction velocity is determined by the following formula.

$$\text{Conduction velocity} = \frac{\text{Nerve length}}{\text{Difference between two latent periods}} \times \frac{1}{100} \text{ M/S}$$

OBSERVATION AND RESULTS :

Table - I

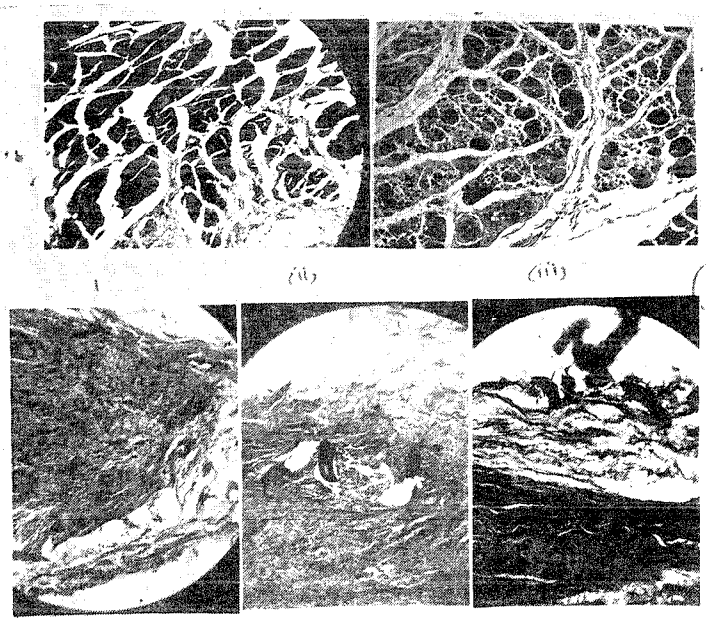
Plantar Ulcer

Months of Observationlimb	Repaired limg	Un-repaired
1-2 months	+	+
3-4 months	+	+
5-6 months	Small ulcer with indolent ulcer signs of healing.	
7-8 months	More healing	"
9-10 months	Ulcer healed	

Table - II

Sensory Recovery

Months of Observation	Vein grafted limb	Un-repaired limb
1-2months	Absent	Absent
3-4months	"	"
5-6months	Present	"
7-8months	"	"
9-10months	"	"



Photographs showing

(i) Histological view of gastronemius of vein grafted side.
(ii) Unrepaired side showing marked atrophy.
(iii) Nerve fibre growing in conical shape in the lumen of vein.
(iv) Suture material, vein wall and regenerating nerve fibres.
(v) Confinement of nerve fibre within the lumen of vein.

Table - III

Electrophysiology Study

Animal number	Sciatic nerve length(from spinal end to N muscle end	Difference betweenlatent periods of two muscle curve	Conduction velocity
7 5.	5 cm	0.0117 second	4.78 meter per Second.
8 5.	7 cm.	0.0117 Second	4.86 meter per Second.

HISTOLOGY STUDY

Nerve fibres grew into the lumen of the vein in a conical shape which is separated from the wall as showin in figure-V.

The suture material vein wall and regenerating nerve fibres are seen in figure-IV. The centre of the lumen of vein is seen occupied by more orderly fibres. The fibres are separated by gaps from vein wall. At 5th month the nerve fibres are confined within the lumen of vein which is clearly seen in Figure-III.

The histological study of proximal stump on unrepaired side reveals a disorderly, disorganised gathering of nerve fibres within the fibrous stroma. Rapid stain of myelin sheath show myelination of vein grafted regenerated nerve earliest by 5th month.

Histological Examination of the gastrocnemius muscle of vein grafted side showed signs of atrophy to a lesser extent (Fig. I) as compared to marked fibrosis on unrepaired side (Fig. II).

DISCUSSION

Good functional recovery can by expected when the fibres enter selectively to the corresponding sheath. It is seen that the result of nerve repair varies with the type of nerve, the best is in pure motor and the worst is in mixed nerve (Marmer 1972).

Nerve injuries may produce disturbances of motor, sensory, sudo-motor, Vaso-motor, nutritional and reflex functions in the territories of the affected nerve. In the present work it is seen that immediately after nerve section, muscular contraction on stimulation of nerve proximal to the site of section fails to elicit contraction. Trophic changes are seen after some time and are due to loss of sensory function of the affected part. David, T.W. Chiu. et. al. (1982) after creating a gap of 1 cm. and its replacement with autogenous vein graft observed that the motor activity returns by 5 th month. It is observed that when the gap is not repaired, no motor activity is seen even after 10 months period. In present study gap created was 2 cm. and it was observed that motor activity on pinch test returned by 5 th month in the vein grafted limb. This finding was absent on unrepaired limb. Hence it is presumed, that the vein graft provides a tunnel to regenerating axon fibrils. And on the unrepaired side, absence of vein graft results in neuroma formation. This is not seen by David T.W. Chiu et. at. in their study. This difference may by due to bigger size of the gap.

Kornblueth (1949) after nerve grafting in rabbit reported that deep sensibility appeared in 4-6 weeks and finer tactile sensations in 3-4 months. In this study cutaneous sensation elicitation was done by pin prick test. The vein grafted limb of the animal showed return of cutaneous sensation earliest by 5 th month and it went on improving in the subsequent period of observation. The late return of sensation in this study in comparison to Kornblueth may by due to variations of animals and quality of nerve regeneration in vein graftged limb. Ulcers on vein grafted side started healing in 5 th month and completed by 8-10 months where as no evidence of healing process was seen on unrepaired side. This contrast findings on both sides proves the fact that healing of ulcer is due to reinnervation. This finding was also collaborated by David T.W. Chiu, et. al.

Histological study was made and nerve sprouting in the lumen of the vein is seen as early as 1 month after grafting. In subsequent months regenerating nerve fibres advance in the lumen and by 4 th month the whole vein lumen is occupied by nerves. This finding was also seen by David T.W. et. al. in their experimental work.

The histological study of muscle taken from unrepaired limb and vein grafted limb is done. The degenerative changes are seen as early as 3rd months in both limbs. The vein grafted limb does not show further degenerative changes, i.e. loss of cross striations fibrosis shrinkage of cells after 5th month of grafting and clinically the girth of muscle became static while the muscular changes continue on the unrepaired side. At the 10 month there is marked change on the unrepaired side, muscle became fibrotic and atrophied. On vein grafted limb, the uneven shrinkage of muscle fibrosis is quite clear. This indicates that reinnervation occurs by 5th month. The histological evidence of reinnervation was seen only on vein grafted side and wasteful regeneration on unrepaired side. These histological findings are very close of David T.W. Chiu et. al. 1989 and others.

The excitability and nerve conductivity of excitable nerve fibres is studied by sciatic nerve gastroenemius muscle preparation. Shrivastav B.K. et. at. 1976. David T.W. Chiu, et. al. reported electrophysiological recovery in 4 th month and in their experiments on rats showed that the conduction velocity was quite low which may be due to the immature myelination. Low conduction velocity of regenerating fibres is due to less number

of medullated nerve fibres and their small diameter Gutmann 1943. During early stage of regeneration peripheral meduallated nerve fibres have reduced conduction velocity as they have small axons, thin myelin sheath and short internodes. In this study the thin immature nerve fibres might be responsible for low conduction velocity. The conduction velocity of two animals is recorded on drum kymograph as shown in sketch I have the conduction velocity about 10% of the normal value. This figure is almost similar to the result of David T.W. Chiu et. al. recorded by lovelace methods.

CONCLUSION

In this study the vein graft across the nerve gap provided a passage for regenerating nerve fibres, protecting them from the surrounding scar tissue and prevented them from going astray. The study stresses the fact that autogenous vein graft is free from possibility of graft rejection and is readily available in wide variety of size and lengths and it can be used for bridging the larger defects in nerve where end to end suture can not be achieved (even after mobilizing the stumps).

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REFERENCES

1. Aird. I 1957 Comp. in Sug. Study P 369
2. Campbell J.B. et. al. 1963 J. Trauma 3,303.
3. David T.W. Chiu et. al. 1982 Surg. Feb. 226.
4. Gutmann et. al 1943 J. Physiology 101, 489.
5. Marmer L. 1972 Surg. Cli. North Am. 1177 Oct.
6. Sanders F.K. et. al. 1941 J. Anat. 76. 143.
7. Spurling R.G. et. al. 1944 Surg. Clinic North Am. 93,173.
8. Weiss P. et. al. 1944 J. Neuro Surg. I., 209.
9. Shrivastav B.K. et. al. 1976 A.J. B. of Practical Physio. 3rd P. 30.

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