

Notebook #13

Chicago Rat
Narapid Rat
Florida Mask
" Amphib.

NAME

Research 1941

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Forearm Crosses

Results of 1940

- 1) Animals operated before 50 days may recover function of crossed biceps w/in a week after the operation.
- 2) Lateral triceps doesn't oppose flexors in its normal position.
- 3) Uncrossed biceps + sheared triceps longus gives good coordination.
- 4) Med. triceps opposes both flexors, but not strongly, coord.s = near normal.
- 5) Biceps alone opposes in reverse the tric. lang. or tric. lat. OK.
- 6) Brachialis is strong enough to hold up forequarters when crossed.
- 7) Looks as tho animals younger than 50 days - 40-30 show some adjustment
- 8) Ether does not abolish the apparent adjustment.

There is a definite recovery in small % of cases. and this adjustment must be analysed.

Must get some good motion pictures of:
reversal
adjusted coord.
controls
double crosses

The caracobrachialis is inserted on distal half of humerus and so does not act on elbow. It arises from coracoid process of scapula, so acts on the shoulder joint.

The musculocutaneous n. supplies the caracobrachialis as well as biceps & brachialis.

The brachialis is partly innervated by a branch from the radial (musculospiral) nerve.

Long head of biceps & other heads innervated by radial n.

The anconeus is inserted on ulna from humerus & ∴ may help to extend the elbow.

M. pronator teres arises from humerus & inserts on radius in middle - so ∴ may have an action on the elbow.

M. carpi radialis arises from humerus so may act on elbow. Also palmaris longus, flexor carpi ulnaris, flex. dig. sublimis, flex. dig. profundus, & most of other anti-br. m's.

They arise from the lateral & medial ^{epi}condyles of the humerus, & supinator ridge,

Can get flexion of elbow from forearm m's, but don't get much in way of extension. Most of cases don't show the extension adjustment so probably not forearm m's that are responsible - try cutting m's to the crossed m's & see if that abolishes adjustment. Also get controls w. no upper arm m's.

(Sin of radial n. causes flexion of elbow (below brachium).)

(The elbow will lock if the weight is put on palm of hand just as the adjusted rats walk.)

(Seems to be no definite factor this adj't is tied to - all types of operation show it & all ages. Have seen the Pin in spasmodic struggling before any voluntary adjustment appeared.)

Is the adjustment due to:

✓

1. action of other than the crossed m's?

2. suff. of crushing the nerve to brach. & biceps will abolish the extension.

no 2 motor n's of anti-brach. innervated by m. cutaneous so crush as enter the m's!!

Put by m. stimulation the action of the crossed m's in a case that never adjusted (save good case for pictures).

Look for char. of adj'd - age, time used, opp'g m.'s type of oper., ?? time of oper.
Muscle-crosses

Showing adjustment (best at top)

♂ 76 - cr. bice. & brach. only 37 days (good)

→ ♀ 42 - brach. crossed, biceps in place, 40 da's (still 1/19/48)

see if true. br. to p. only

♂ 77 - brach. - only cr. & m. 38 da's.

♂ 71 - 24 days - double cr.

♂ 69 - 20 days, double cross.

♂ 74 - 60 days, bice. & brach. crossed

♀ 38 - 1/2 gm, double cr. w. ~~let. biceps~~

Good reversal, no adjustment

♂ 65 - 48 days, double cr.

♂ 62 - 50 days, "

♀ 35 - 1/2 gm, double cr.

♂ 56 - 54 double cr. back arm.

♂ 67 - 53 da's, brach. & bice. cr. w. ~~arm~~ single cr.

♂ 70 - 22 da's, double cr.

X ♂ 57 - 7/8 gm, cut should. m's, ^{bice. lo.} ~~did not take~~, ^{cut} ~~brach.~~

♀ 37 - 5/8 gm. let. biceps revid later,

♂ 53 - full grams, double cross

X ♂ 75 - 26 da's, ^{cr. brach.} left biceps in place,

Adjustment tendency

♂ 63 - 48 da's, double cross, cut m's

♂ 73 - 50 " , crossed brach. only

→ ♀ 39 - 1/2 biceps cut, & let. biceps. brach. - cut,

♀ 36 - 1/2 gm, double cross,

♂ 72 - 26 days, " " revid bice. lo.

Prain 2 A's, 1 R.,
& a N-M control if
can get it.

Do autopsies to be sure all m's removed except crossed ones.

Get double N-M cross controls to run along w. rept's in loco, landing, feeding, & swimming R's.

[Cutting the nerves of reversed muscles abolishes the adjustment ⁼ reversal - try latter once more. ^{+ reversal.} most of the]

As soon as possible

Remains to be done w. M-cross cases. :

- 1) Cut nerves & cut tendons on couple more cases so can be sure it is the crossed m.'s causing the elbow mov't.
- 2) When there w. good adjust cases cut these nerves. Cut radial n. to encourage to be sure it's not that muscle.
- 2.) See if they show reversal in swimming. (good cases)
- 3.) See if they " " " " cf. w. control. " landing. (good cases)
- 4) " " " " adjustment in feeding (good cases)
- 5) " " " " look " under anesthesia. "
- 6) " " " " " " " alcohol. "
- 7) " " " " " " " after brain lesions. "

Remove brachialis on ♀36, & ♂72 - see if biceps works & " " in case which showed biceps after cutting n. to brachialis.

Yes, the biceps will produce the stiff-arm all alone.

Remove anconeus on a couple of adjusted cases.

To do

Check on 863 & 857 after 1/16/41 once more.

Watch N-N cases. ♀46 / ♂80

" single n-cross to bic. m. ♀48

~~Get motion pictures of reversal, $\frac{1}{2}$ adj't, & good adjustment~~

~~of both n-cross & nerve cross.~~

Later get pictures of controls, & of performance in training cage.

Control in which all n's to upper arm n's = cut. except anconeus.

♀42 has only brachialis crossed & shows a good adjustment at any. No sign of anconeus & cut the access. tendon from latiss. dorsi. So check to see if the biceps can act also as the brachialis.

Two cases showing adj't w. only the brach. crossed. So: where have adj't — cut the nerve to brach. & see if the biceps will do the trick alone.

Two cases operated alike — brach crossed & biceps left. In the one where biceps lost its function showed adj't — the one where it is still functioning, ~~shows no adj't.~~ Scherbi's laws. That case was not still functioning at least as forearm flexor.

Does normal rat not use stiff arm in going backward. Rats w. no flexors in 'em except the brachioradialis show good flexion — maybe the dorsal forearm n's.

They tend to use stiff arm more when raised up on hind quarters with front p's on floor. In struggling, the arm naturally gets in correct position.

The brachio-radialis m. is lacking in the rat.
The pronator teres which inserts on radius from medial epicondyle is supplied by the musculospiral n.

(Suspect that any gradual improvement not due to strengthening of muscles because one muscle alone is effective. However, might be adaptation to new location, length, origin, etc.

(Question in climbing & locomotion, — do the trapezoid muscles extend arm at same time that body weight is shifted on to scapula & shoulder. — or can body weight be shifted onto " " only when joint mechanically locked.

(You see in the stiff arm it wouldn't be necessary that biceps & brach. act during the supporting phase. They merely need to act during suspended phase to keep the joint locked.

(The stiff-arm is not due to any anconeous muscle. Case 3 of 67 shows stiff-arm & yet the triceps longus muscle is functioning so that dec. 5 in produces good flexion of elbow. *but not sharp vigorous flex*

(Biceps alone or ~~triceps~~ ^{triceps} alone will produce stiff-arm so that it can be used for support.

(They continue to go thru scratching R in w. hind limb stumps months after the foot has been amput'd, altho the stump doesn't even touch body or head in its rhythmical mounts.

Muscle Cross Cases

double cross*

- ♂ 76 - training Fib. - (bic. & brach.) ±
 ♂ 77 - " " " - (brach. only) ±
 ⊕ ♂ 71 - tric. lo. had no actn. no remid (bic. & brach. only) ±
 → * ♂ 69 - does tric. lo. fix?
 ♂ 74 - (biceps only) ⊕
 ♀ 38 - (biceps only) ⊕
 * ♂ 63 - crushed n's see if adjt returns
 ♂ 73 - (brach. only) m. appears weak. ⊕
 ♀ 39 - (biceps + lat. tric.)
 ⊕ ♀ 36 - tric. lo. fg = good rev. ⊕
 * ♂ 72 - remained poor tric. lo. ±
 * ♂ 65 - rem. tric. & see if adjt improves. ⊕
 ⊕ ♂ 62 - tric. fg - good rev. ⊕
 ⊕ ♀ 35 - very good double reversal. ⊕ amp. after pictures.
 * ♂ 56 - ⊕ - amp. ✓
 * ♂ 67 - ⊕ - amp. ✓
 ⊕ ♂ 70 - joint wait lock rem. tric. lo. ⊕ and amp. ✓
 X ♂ 57 -
 ♀ 37 - (biceps & brach.) caused adjt, amp. ⊕
 X ♂ 53 - ankylosis

One of bilat cases (67) shows adjt in one arm where there is no triceps & none in other arm w. tric. lo. opposing flexor action.

Narrow delimit problems on m. crosses so know just what to test w. nerve-cross controls.

Graded n's a bit tighter on well-adjt cases but no knowing whether = cause or effect.

Cases which have slight ankyloses of joint so that it won't quite lock, continue in reflex w/out showing any reversal.

Try top of wall reaction - see if can standardize it
✓ Amputate central hind leg on cases which show no good adj't, but which ^{have} possibilities.

Have now analysed cases so that know that it is the transposed m's that are producing the stiff arm.
Question now:

Why don't all cases show it?

What has prevented adj't in cases where there is no tric. lo. & joint can flock?

Looks now as tho action of tric. lo. inhibited the adj't - tho not entirely in couple of cases.

Remove the tric. lo. on cases that show no adj't and see if adj't comes in.

[In rapid walk, the adj't breaks down in most cases tho is retained in a few of best.]

To be done with m-cross cases:

- 1) Movies of swimming.
 - 2) Try to force adj't out of likely cases by amputin. does amput. make any diffie?
 - 3) See if case w. slight ankylosis of jt will show adj't after removal of tric. lo. ④ Extreme amputation.
- 4) Action Currents to see if biceps & brachialis are firing continuously.
Amp. m. crosses & centrals

No show w. nerve-cross controls:

1. Whether adj't due to peculiarities of anatomical m-cross or not.
2. Pictures of tric. lo. & tric. med. controls with m-crosses to tric. lo. & tric. med.
3. Nerves crossed to both flexor & extensor m.s. to determine whether or not double crosses will show adj't or no.
4. N-M crosses as controls for m-cross group.

Go ahead w. the nerve crosses for a while, checking up on m-crosses now & then & pinching 'em off. I can tend to m-crosses while p-crosses are regener'g.

Cut misreg'd fibers on cases of stiff-arm & see if it remains. ♀ 4 & ♀ 6.

Case w. crushed nerves begins to show adj't again after several weeks.

The single nerve-cross cases w. biceps into tric. lo. show same type of adj't as the muscle cross cases.

Working on w. diff't types of crosses, espec. double crosses beyond the pronator teres or cut its nerve.

N-curve

For N-M

X ♀ 17 arky based in flex

♂ 55

♀ 44 normal

♀ 43 "

♂ 78 normal

N. Single

♀ 3 not normal

♂ 81 nearly normal

♂ 2 " "

♂ 1

♀ 48 rev. no adjt; bad wrist drop.

→ ♀ 49 some rev. amp.

♀ 51 nearly normal

♀ 47 normal

♀ 50

♀ 4 very slight rev.

♀ 5 adjt.

N-double

♂ 82 - ~~to~~ reversal doesn't show much.

♂ 10 - little rev., little adjt.

♀ 9 - some stiff arm amp.

♀ 8

♀ 11 - abnorm. some rev. very amp.

♀ 6 - some stiff arm, some rev.

N-M

♀ 46 no reversal, weak, amp. central.

X ♀ 45 no grad.

Have to remove pronator-teres muscle & anconeus.

Origin: med. epicondyle of humerus, medial to flex. carp. radii.
Inserts: middle of medial surface of shaft of humerus.

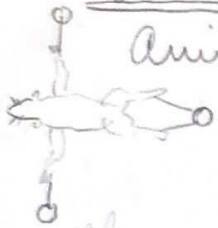


Lies just under the lateral-dorsal extensor group.

Origin right off insertion of anconeus.

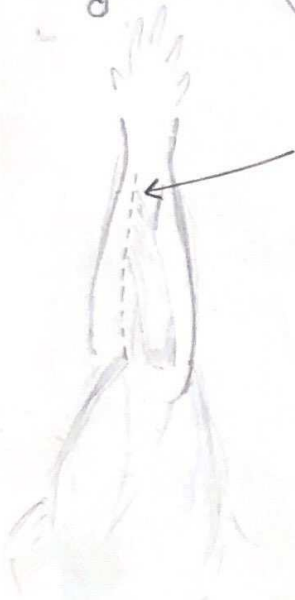
Supp. by musculocutaneous which gives off a large branch to the skin just above elbow & a small branch deep to pron. teres.

To remove pronator-teres:



Animal on back, arms stretched out to sides, with arm to be operated away on far side.

Incision on medial side of forearm slightly to anterior of axis. Then go in carefully between dorsal & volar muscles avoidg. superfic. n's & bl. v's. Start separating pronator teres from volar n's distally at point of arrow. Find large nerve just under it.



Operation for double reversal of brachial muscles. (Cross brachial n. as usual 10 days after nerve cross)

To cross tric. br. n. into biceps nerve; med incision

Remove coraco-brachialis muscle. It arises in common w. short head of biceps muscle.

Tie off the nerves to coraco-br. & short head of biceps so can't regenerate.

Put sheet of allant. m. between musculocutaneous nerve and biceps muscle.

Separate large nerves - can block art. to tric. br. if it is in the way.

Clear tric. br. n., then lift it by putting hook distal to point where tric. br. branches off main trunk.

Cut it & suture to biceps leaving plenty of slack.

(May want to crush branch to brachialis m.)
(to prevent ankylosis by persistent flexion.)

Small n. to pron. teres. comes off main branch of m. cut. just oppas. point where branch to brach. m. comes off. which is about ^{level} point where biceps n. enters it. Be careful in cutting the pron. teres however, to tie it first & sew it far out of harm's way.

Program coming up:

Get m-crosses & n-crosses of past in permanent condition including removal of paw. tips in crucial cases.

Get low numbers checked, poor cases thrown out, and way cleared for new operations next quarter.

Polaroid in microscope, oculars.

Comb. n. & m. double crosses & split m. crosses. next quarter.

Start on older animals getting some good double crosses first.

End of Winter quarter 1941:

Have plenty of single crosses both nerve & muscle and get the same results in both.

They both show the lock-joint adjustment.

Have pretty good criteria that it does not represent an entirely new intra-limb contraction pattern.

But don't know exactly how suddenly it appears?

Must get few snapshots of these cases & then turn to more complicated peripheral conditions - the double & split crosses.

Get a series of split crosses diff ages — that is with the brachialn transposed and the biceps left in place, with its nerve crushed. Crush nerves quite high so take long time to regenerate.

Expect adj't first on amputation, then wait to see what happens when the biceps nerve regenerates. Use cases young enough so get quick and good adj't.

Use animals from 20 days up to 40 days. The optimum age seems to be about 37 days. Start operating this week end on Whittler's litter for split muscle crosses & continue till the litter is used up.

(Start breeding cages of own and arrange for more space. By that time the split crosses are worked out, will have young ones for double crosses.)

Operation for Split Crosses.

Go in medially and remove coraco-brach. & one head of biceps, and crush biceps nerve high up. When healed, cross brachialis.

Maybe can remove medial triceps medially. Or do both operations at same time.

Remove anconeus.

Cut down the biceps muscle pretty well in 1st operation.

① Operation for Double Cross

Remove coraco-brach. & one head of biceps.

Cut out the nerve to pronator teres m.

Cross triceps lo. n. into biceps nerve.

Tie off med. stump of biceps nerve.

Cross brach. m. a day or so later.

② Operation for double cross

① Remove coraco-brachialis & one head of biceps m.

② Cut out nerve to pron. teres, & cut thru n. to brachialis m.

Cross biceps m. into triceps & triceps into biceps, by cutting lengths app'ly so they'll reach each other.

③ Free musculocutaneous & pull it posteriorly nearer median n. Cut deltoids, etc. well back.

lay wide sheet of all. memb. between sutures.

Operation for Double Cross

Do not injure musculocutaneous n.

Dissect off tric. br. far into muscle & free it well proximally from other n's & trunk. Doesn't matter if cut up to tric. med. & lat. as long as they don't get into the arterial sheath.

Leave fairly long. prox. stump on biceps & tuck it down towards tric. muscle.

Follow w. muscle trans. of brach. n. in couple days to prevent ankylosis & remove denervated n's that may attract stray nerve fibers of tric. br.

Try to keep other n's away from the denervated biceps muscle.

In 4 days the suture will become sufficiently imbedded in place so that don't have to worry about pulling it loose in the muscle transplant. The suture is protected by the musculocutaneous nerve so the biceps n's should be exercisable w/out pulling suture loose.

Don't have to worry about ankylosis in young rats.

4/8 Do During Summer Quarter

Open up the split cases after recording their bkr.
Remove biceps & see whether regrowth has occurred
in all cases.

On double reversals, check nerve sutures and
note condition of biceps. Cut away any misreg'd.
fibers.

Follow their bkr. See if biceps acts at all
or if as after m. crosses. See if extensor
action in forelimb depends of good deal
on proprioceptive S.

1941 { In discussion - mention Anokhin's statement
that m. influences sensory nerve in adult
dogs just as in amphib. s. - how inter. there
is - but repeat work of Anokhin correct
then it favors W's interpretation.
Can also get in trophic inf. which discussion
was missed in W. work.

In split crosses and double crosses, the crossed brachialis overcomes the biceps. The biceps is anatomically lengthened.

So have to explain both sets of cases same way.

If crossed brachial contracts all the time & stretches & overcomes the biceps, then can't tell about these questions wanted to know.

How tell when biceps & crossed & normal is working? See if get w.d.'s reflex out of split case?

On split cases: Can say adit got worse as nerves regenerated (but not completely abolished & explain this as due to stretching of biceps.) After cutting, withdrawal reflex increase & after regeneration adit abolished completely. Then cut the biceps out altogether & see if adit returns ^{immediately}. If so, then can say there was no dissociation of function.

On 2-way crosses: adit can occur with slight action of opposing muscle. Can it occur w/ strong action of " " ?

Shatter biceps tendon? Cut brach. tendon.

Have to take Action-Currents from these upper-arm muscles.

1) Take from ~~single~~ ^{one-way} crosses to see if contraction is rhythmical and when strongest contraction occurs #76 & maybe a nerve-cross

2) From split crosses to see if there is any dissociation of junctions. Also see which contracts most strongly by switching the leads.

During loco. & withdrawal reflexes.

3) From 2-way crosses to see if contraction is reciprocal or not - if extensor is acting at all.

A.C. from ♂ 76 (bic. + brach)

Slight sustained contractions during support at rest. (not as strong as in suspended phase of load)

None when landing

Large in withdrawal reflex.

Large when reaching forward.

Not sustained in locomotion, but rhythmic & the pulses seem to come on the suspended phase of limb swing. i.e. no adj't.

↓ same results from a nerve cross case.

Tried two-way cross ♂ 11

Brachialis working very clearly in the suspended phase of locom.

Couldnt get much from biceps - the brach leakage was loud.

Only hint of biceps action was a low pulse on the landing R'm. Have to test further

Get pulse in w-draw reflex

Very good & fast motor units in these animals

Try both double & single ^{normal animal} split ~~crosses~~ where
have cut thru the brachialis m.

In split cross ^{no. to break cut} find biceps is working in
connormal phase.

// In normal animal get good rhythmic contr'n
in extensor phase from biceps.

// In double-cross get biceps pulsing very
sharply & nicely in the extensor, supporting
phase of locom. w. brach. m. cut.

Try it in muscle-cross case and a two-
way cross in which brachialis is still
working.

Use large lead for ground & just the cut end
for active electrode.

♀ 35 two-way m-trans. shows good
contr'n of biceps in normal extensor phase
of locom.

♂ 71 (which shows adjt) - get no sign that
biceps muscle is acting at all.

(♀ 36 couldn't tell that biceps was acting)

Do another case where brachial n. is cut.
Then try a n. cross case w. biceps - brach n.
cut

Cf. the forearm flexion on a normal & on a
exp. case to be sure that resting length of
n. is changed.

[88 The biceps in 2-way cross works nicely in
reverse when elbow comes in, but not
when stiff arm is used successfully.]

Action Currents. Shaw

1) Split case - biceps continues to act in its normal phase during locom. During support at rest it acts like the brachialis.

Remains only to demonstrate that actual resting length of m. has been increased.

2) 2-way crosses - The triceps m. is discharging in its normal phase when adyt is not present. When animal uses stiff arm either during locom. or at rest, the triceps remains quiescent.

So the adyt is not indiscriminate contraction of all brachial m's but involves a flexion action - so some learning in voluntary movement.

? whether normal biceps function during support at rest?

No follow up

Whether the adjit from beginning involves an inhib. of the extensor extensors.

Contra of transp extensors in reverse does not cause relapse, but follows because of it.

Cross nerve to biceps & then wait a month or more before transposing brachialis.

To do: (before public.)

A.P. records:

One-way cross - at rest test m's
locum. & " , pectoral m's

Normal

biceps at rest
pectorals loco & rest.

Records for public.

The inward rotation + adduction does have a good secondary extensor action on the elbow.

The deltoid (clav) also may help.

No question, but that it's the rotation of limb that does it. Limb becomes firmly locked, hard to pull out. The inward rotators of the humerus

Results of pect. M. removal + A.C.'s show that it is involved, but question that it is major factor.

When cut tendons of all adductors 'eye lat, dorsi severed, adj't practically gone - controls still work OK. tho' not steady.

Cannot distinguish the flexor action in exp. from the normal postural tone + contraction of flexors in normal rats.

Cutting the insertions of adductor m's, the pectoral, ~~acromiodeltoid~~ and latiss. dorsi, abolishes the adj't. On other hand, cutting the abductors ~~spinodeltoid~~, ~~acromiodeltoid~~, and ~~infraspinatus~~ does not affect the adj't.

Cutting same in normal + controls doesn't affect support very much.

Amphibian Experiments

Repeat newt regen. of optic n. on the tree frog
w. fff problems in fund.

Do normal eyesight restored in adult?

if so — good enough — occurs in frog then
where possibly have more accurate projection
of retinal quadrants — certainly have more
highly diff'd texture in terms of cortical layers.

Also Adams optic n. will regenerate in
amurans & cf. w. poor results of eye transpl.

if not — because n. won't regenerate,
this won't mean much — cf. younger cases.

" " — even tho n. regeneration appears
to be quite good, then have evidence
no. reconnection & for connections being bad
— but complicated

" " — " " but do get normal recovery
in tadpoles, then evidence that it is
a matter of growth processes affected, not
physiol. function

if get regeneration — trace deg'd quadrants
thru the chiasma.

Need a good sized stock terrarium - or several large jars

Need individual or smaller jars for operated cases.

Get a $\frac{1}{2}$ dozen cases started w. severed optic n.s. - after have one test vision of remaining eye to see if one eye alone is O.K.

Also get a stock of food & explore visual. Run further.

Saphenous into saphenous

main trouble will be w. length of nerves & allowing plenty of stretch so that anastomosis will not be pulled apart.

so:- free ipsi as far down as possible

:- free contra ^{well down} and stretch it a bit

:- use long pieces of artery for tubulation.

May be able to do it by starving rats 3 days or so before operating & 2 days after so as to decrease circumference of abdomen

Go thru peritoneum, - can lift up to light and see clearly thru body wall - can pull intestines anteriorly out of way. If go thru between rectum & bladder sharped hit nothing & have no hemorrhage.

Need forceps very long and thin or a needle w. hook of same kind

Try both methods thru per. cavity and around it. Hold rat up by hind legs when going thru
See if ♀ = better than ♂

Probably better thru perit. cavity.

Have to be careful that prox. stump doesn't regenerate to central. foot.

Thru perit. cavity is by far the better method as far as operation goes. Go thru as far dorsally as possible.

Sural n., when freed far proximally, will reach up to pit where revoluting ant. comes off saphenous.

But large tibial n. will reach only up to knee.

Nerves to foot:

off post. tibial:

Sural
Tibial

Off common peroneal:

Sup. peron.
N. under ant. tib. n.
N. close to & deep to
sup. peron. (small)

Locate branches off peroneal thru lat. incision, superficially at ankle and then pull up between m.s. & cut. (Can bring over & wrap around sept. maybe few fibers will sprout off into env.)

To bring in tibial and sural n.s.:

Medial incision. Remove two lowest adductor m's. sever medially and over tibia. Then can free sural, and tibial by splitting 2 gastroc. farther apart. After freeing, bring both nerves to medial surface along saphenous by bringing up between gastroc. & post. tibial muscle. (tibial between 2 gastroc, & sural under tendon of both).

Could cross over the tibial n. & peron. (sciatic) but would lose m. action of foot m's entirely, which would not be so bad if amputate ipsi foot.

Cases 5 A w. saphen. crossed l → r Tibial + sural over
 * 7 B " " + tibial " " " , contral. foot amput. other sensory n's
 3 C 2-way cross - saphenous one way, tibial the other,
 15

Cases B = most crucial.

With both saphenous + tibial n's into opposite leg means that all sensory centers, still working, supply opposite foot.

|| + contralateral foot is missing.
 If cross saphenous at 25 days, then can cross sciatic as early as can do the operation.

Concentrate on crossing sciatic now till have 10 cases.

Operation for crossing sural & tibial n's

- A//
- 1) Lateral incision up both legs & across back.
 - 2) Flap back biceps femoris right side - be careful not to cut peroneal nerve.
 - 3) Isolate sural nerve ^{cut & tie} off proximal stump and tie to tissue ^{below sciatic} so ^{it} will regenerate into crossed nerve.
 - 4) Separate 2 heads of gastroc. m. and isolate tibial n. well down toward ankle. cut leaving good proximal length to tuck away.
 - 5) Free place for central sciatic to come thru between neural spines.
- B//
- 6) Flap back biceps left side, flap gluteal m. laterally from mid line, so as to free sciatic.
 - 7) Free sural as far down as possible & cut.
 - 8) " tibial " " " " " & cut.
 - 9) Cut all other branches of sciatic close to main trunk, except branch to bic. fem.
 - 10) Make hole just under sp. cord above rectum (caudal artery) and draw left n. thru.
 - 11) Anastomose tibial to tibial as low down as possible.
 - 12) Sew back biceps fem. flap.
 - 13) Anastomose sural to sural low as possible.
 - 14) Sew back gluteal & incisions.

Want cases with sciatic and saphenous
crossed. & central. foot amp'd.

Do some very young sciatics getting tibial
just as low down as possible. Leave
plenty of slack and leave under for
while after operat'n.

Might as well amputate when cross
saphenous in 2nd operat'n.

Don't sew biceps fem. back in position,
make incision thru bice. fem. so sew back
w. the skin.

Pull tibial thru normal course after
crossing under gastroc. & soleus. So make
sure that orig. tibial is tucked well out of
way into med. gastroc.

Sever ^{origin} tendon of soleus before suturing &
thru distal 3rd of belly after suture - makes
blood clot & gives much more length, slack.

Will probably have to wait for 2nd operat'n
till 1st has healed because rats chew off
bottom of foot otherwise.

Leave #s 12-17 for couple weeks yet before
crossing saphenous.

Oct 10

No Cross Both Ways

Separate peroneal & tibial far up along spine.

Cut the peroneal far proximally and the tibial more distally.

Shave prox. ends of peroneal down into abdom. cavity & cross the prox. tibials under sp. column at a slant.

Suture prox. tibials to distal peroneals & intersperse the distal per. & tibial n's. so that outgrowing fibers will enter both trunks. i.e. remove sheath & intersperse.

Monk

No cross n's to elbow n's (clamp off artery pathway so can shut it off quickly) (expose n's by cutting coracobrach. + slip of lat. dorsi)

1) Biceps & long tric. nerves when freed far centrally can be brought to lie side-by-side. Then cut, stretch distal ends & cross-suture. (N. to epi-trachlearis can be included in distal long. tric.)

2) Brachialis & med & lat. tric.

Free brachialis as far as possible centrally - cut running from radial & tie it off & insert thrombolytic.

Cross long branch to distal med. & lat. tric. into distal brach. stump.

Cross prox. brach. stump into pass. r. to med. tric.

(The long tric. has pronounced 2-jt action)
(" biceps also has considerable 2-jt actn.)

(The ext. carp. rad. ligament & the brachioradialis) (n's will have to be excised.)

Foot not so good, n's small & multiple 2-jt action, many n's have to be excised.

Elbow cross on monk.

The medial & lateral triceps m's should be used. The lat. should be sutured more firmly to long. tric. tendon toward insertion.

If long. tric. m. used, cut ^{posterior} origin & re-suture to anterior $\frac{1}{2}$ of origin.

- ① Cross biceps m. into long triceps m.
- ② " upper med. tric. m. into biceps m.
- ③ " lower lateral tric. m. " brachialis m.
- ④ " brach. m. into lower med. triceps. & into upper lat. tric. (cut musc. cut. m. so can pull it anywhere.)

Excise coraco-brach. m. & slip of lat. dorsi.
" epitrochlearis m.

[In 2nd oper. excise forearm m's]

In remaining epit. m. keep close to muscle & save cutaneous n.s that run over poster. surface of m. (also save n.)

Free caraco brach. from below up.

Pulliceps forward to fl. musculocut. to brach. branch. Take 1st obvious r. to brach. — other small ones don't go into it.

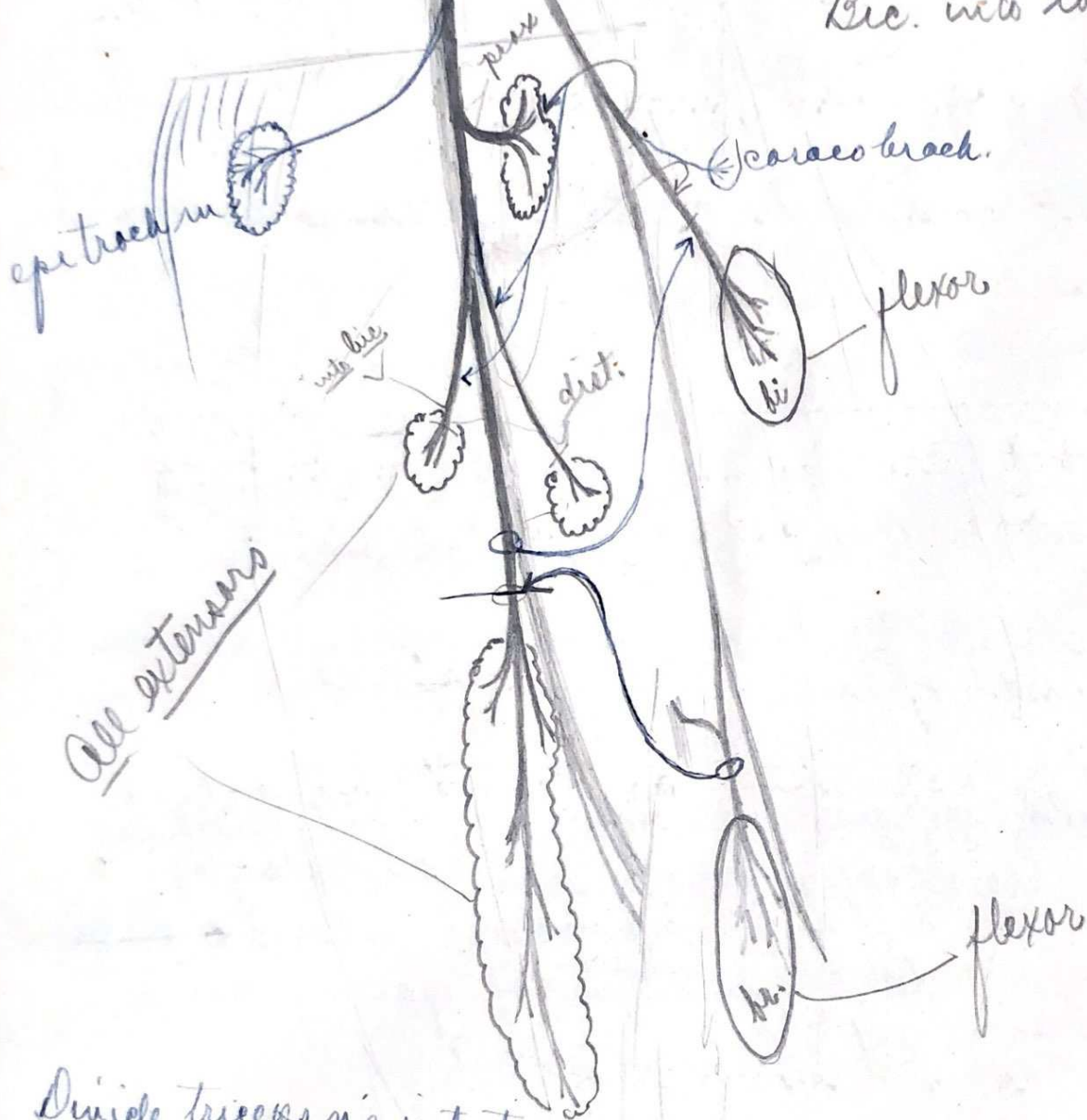
When get brachial r. free, cut off branch from median/close to " ". Cut brachial after leaving long enough stump for anastomosis. & cut musculocut. far distally so it's longer in brachial & won't be mistaken for it.

The r. of radius in deep & low & a cutaneous br.

To hold nerves:

- Use esophagus of rats (22 ± days).
 - * " " " adult mice! 5 per month
 - " large intestine of young mice.
- Better get dog or monkey arteries

R. of Long tric. into bic.
Brach. into all other
tric. m's
 Bic. into long tric.



Divide triceps m's into two groups, prox. & distal & try to include all rami in the divisions.

Perhaps preferable to suture a long branch of triceps to biceps n. rather than those above. Can still suture brach. to distal end of — as shown. That leaves all prox. branches of radial to receive biceps.

Then, the only prox. branches of radial for innervation = those high up where biceps n. anastomosed. plus one or two medial branches that couldn't get

① Put bic. nerve into main upper part of tric. lo. n.

② Put couple of lower ^{longer} accessory branches of long tric. into biceps m.

③ Put brach. into all the lower branches of radius into tric. m's.

Want to test flexion - so put tric. long. into biceps ~~no~~ the n's are stretched too much this way

Cauterize prox. stumps not used.

Try to anastomose as close to muscle as is possible

1. Excise coraco brach. & epitroch. m's
2. Separate bic. n & musc. trunk
3. Free radial. & several r. of tric. long.
Make 2 exsurg.

4. Free brach. r.

5. " all lower r. to tric. m's

turn inside out if possible

For suture, use intest. of rats ~~just~~ ^{just getting hair (1 mm. long)} inches long. Bring one end thru, sew 2 ends together then slip intest. over suture. Fill down #12 needles & bend 'em. Use pieces $\frac{1}{2}$ in. long (after shrinkage) Squirt antiseptic thru 'em. Prepare 2-3 hrs before oper.

1944 (O.P.)

(1st) - cut out all extra forearm m.s. - see how many can be removed and still leave the hand capable of grasping.

(Then) - cross n.s. cutting out the epitrochlearis m. and possibly the brachialis? The nerve cross must be clear-cut above all - no chance for misregeneration.

Cut out the biceps fibers cause they are complex in function. Cross brachialis fibers to the triceps m.s. Question of whether to use long triceps fibers for biceps m. I expect to test flexin primarily may be better to use med. triceps fibers.

Controls - should test cases for both flexin & hand closure after cutting out the brachialis m. if not going to use that one. Also watch hand closure and elbow flexin & extension during month off the nerve - cross open.

Excise:

1. Prox. teres - get border distally 1st. supp'd by med. n. just about level of epicondyle
2. Brach. rad. - get borders in middle of antibrach. supp'd by
① br. from muscul. coming out bet. brach. & biceps & also by
② br. " radial. maybe epifascial
3. Ext. carpi rad. long (unlike brach. rad) supp. by radial, dissect out midway 1st.
4. " " " brach. (" above) The 3 above run inside (medial) relative to radius bone - so just take all inside radius.
5. Extensor digiti. commun. (top one below radius) uninnerv. from rad. after it passes the forearm m.
6. Ext. digiti. IV & V uninnerv. handship of tendon circumferential w. above.

7. Flex. carp. rad. (1st below from tree) supply by med. br. of epic.
 8. Palmar. longus (small next under above - gets its small tendon distally).
 9. Flex. carpi. ulnaris (lowest along ulna)
10. And any other m.s. left insertg on the epicond. of the humerus. There are plenty below to work fingers & if wrist isn't capable of much more that won't matter. Everything about ulnar nerve.

This eliminates all overlap of elbow joint from below. (except aneasure wh. don't find in this animal)

Crossing

① Upper triceps branches will go into biceps very nicely but so would lower med. triceps branches & these, the smaller could be brought nearer the biceps m. & thus reduce regen. time.

- Bic. → upper triceps - not good functionally
- Med. tric. → biceps - OK functionally but not so hot mechanically
- Brach. → lower triceps - good both but brach. = very small.

The branches to brach. are very fine.

Chronic spinal animal 23

Rats ♀, soon as weaned, 20 days ±

Praxect cord at T5-T7

cut, don't cauterize. or tie off meninges, then cut
pull on tail to separate ends

Keep under for long while after oper.

Keep in thick sand dust

Empty bladder every 8 hrs. for 2 wks after.

Need only 3 or 4 good cases, start out w. about
10 or 15

Complete recovery (ie. far as it goes) in about
one month.

Pyramidal - Gracilis Cases

Remove three laminae from below zygopods.
Slit sheath & cut 3 dorsal roots - caudal
to pit of section. Pull out periply.

Slide large hook under coral. well
forward.

Cut cord in dorsal & ventral halves w.
hook & sever ventral half in retracting
hook.

Cut dorsal $\frac{1}{2}$ w. hook & ^{sever} pull out the
lateral portions in retracting.

Will have to remove couple segments when
cutting to eliminate function of fasciculus
interfascicularis & fascic. septo-marginalis.

Spider Monkey - Upper Arm

Biceps - Branch from musculo-cutaneous, - apparently clear cut

Coraco-brachialis - Fine branch from musc. cutan. - high up

Brachialis - Fibers from musculo-cutan + fibers from median + few fibers from radial which enter laterally where radial swings around humerus & shoots between brachialis & the overlapping forearm muscle.

Epi-trachlear - fine slip from ulnar.

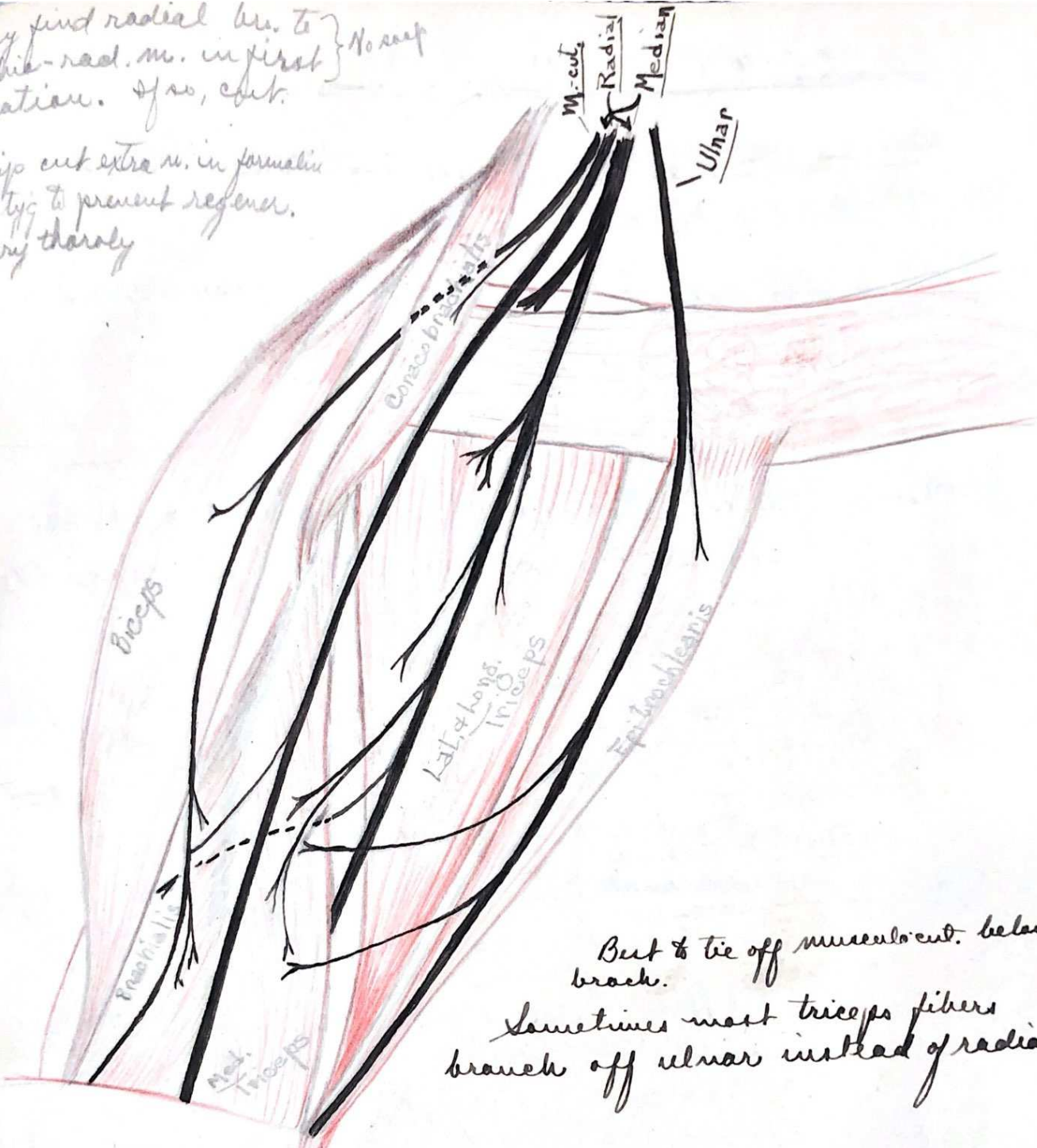
Long & Lateral Biceps - fibers from radial that branch off below latiss. dorsi m. All n.s. to Biceps branch off below the " tendon. (The nerve that shoots deep above the " innervates shoulder m.s. only.) In man gives branch to later. tripe occasionally, so may in monkeys also

Medial Biceps - a couple strands off ulnar n. and a larger branch from the radial.

[All nerves to triceps m.s. are separable from main trunks way up over the lat. dorsi tendon. Have to be pulled or cut out of the common sheath.]

May find radial br. to } No reap
brachio-rad. m. in first }
operation. If so, cut.

Dip cut extra m. in formalin
after tyg to prevent regener.
to dry thoroly



But to tie off musculo-cut. below
brach.

Sometimes most triceps fibers
branch off ulnar instead of radial.

Blood plasma ^{clot} invades invasion of connective
tissue. But exudate from nerve stumps after
blood flow ceases favors sheath & neural cell fibers

Can't be sure hetero-tubulation will work. Better try
homo or auto. Fine auto-sutures of animal's own hair
might be better than silk. Perhaps allantoic membrane
would be best for tubulation. Fresh auto causes pressure-block.
Get some of silica drugs in powder form to be sprinkled
around union. no! Keep silica drugs away from nerve
tissue.

Operation for Nerve Cross

- 1) Bring m. cutan. down midline - can remark coraco-brachialis m. if want to.
- 2) Hunt out all the fibers innervating the triceps m's, separate them well up over the latiss. dorii tendon from their main trunks.
- 3) Bring extensor strands all together in one cable side by side w. the m. cutan. & cross-cross the two.

Difficulties: ① Have to cut lateral br. s to brachialis m. in a later oper.

not in monkey
X ② Have fibers of musculo-cut. that innervate (prox. teres occasionally in man) ~~forearm m.s.~~ going into triceps. Also have fibers that innervate coraco-brach. going into triceps.

X ③ Have triceps fibers going into forearm w. muscles cut.

ans ② - find very fine strands to forearm m. which would seem to work synergically w. brachial since it has a fascial connection of origin w. it.

To prevent ankylosis of elbow joint, leave an extensor functioning - preferably the epitrochlearis (and cut out brachio-radialis as soon as possible?) Remove brach. radialis & m. below it before making the nerve cross.

Upper $\frac{1}{3}$ of brachio-radialis can be removed - there are blood vessels to lower $\frac{2}{3}$. Have to be careful of n.s. & b.s.s. under & over it.

Aqueduct on lateral side of elbow is extremely small.

Nerve branch from radial trunk enters brachialis
m. laterally about 1 in. above top of brach-rad tube
about $\frac{1}{2}$ in. above radial n. + have to excise
a couple inches of it.

Can cut part of origin of m. just below brach-rad
which comes up rather high on humerus.

Have to make large incision from
middle of humerus down over $\frac{1}{2}$ of forearm.
lateral & a bit medial.

Have to cut large vein from brach. to brach-rad.
Be careful of radial nerve that runs over humerus
& down between brachialis & brach-radialis. It
continues along just under ~~surface~~ brach-rad.

M-out. n. = easy to locate - most anterior n., runs under
coraco-brach. m., branches off median high up.

Branch from med. to brachialis easy to find by following down
median, - only branch - cut low & tuck into med. trce. belly.

Ulnar n. should be exposed thru-out and any branches
in upper arm - strays to triceps. Separate these carefully
from main trunk to point well above lat. dor. tendon.

After cleaning med. & ulnar n.'s all others = from radial
after setting insertn. of lipo-tracheal, reflect it & locate
its nerve entering an inch or less below lat. dor. tendon.

About $\frac{1}{2}$ way down humerus find radial br. cutting over to
brachialis, cut & insert in med. triceps. All other br.'s entering below
tendon = to triceps m.'s separate up.

Two Joint M's & Effects

Brachialis, Med Biceps, & Lat. Biceps = all one joint m's.

Biceps has some 2-joint action. When upper arm pulled back along side of body, one head of biceps shortened about $\frac{1}{4}$ - $\frac{1}{2}$ inch. If m's were tight & constant, this could give a slight flexion of elbow. When arm held up & out to side, slightly back, the other head of biceps pulls about $\frac{1}{2}$ in.

Epitrochlear and Long Biceps have pronounced 2-joint action causing complete extension of the elbow when the upper arm is raised forward. i.e. when the angle between the humerus & the scapula is increased beyond 90° or so.



Normally, the scapula moves in such a way, so that angle between it & humerus is not greatly increased - monks might learn to extend elbow by manipulating scapula.

(has origin in common w/ short head of biceps)

Might as well remove epitrochlearis, & Coracobrach.
Biceps inserts on radius & brach. on ulna

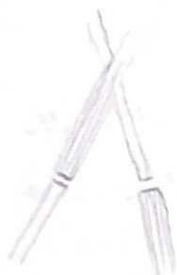
Could arrange a cage where animals to squeeze
in pretty tight & put arm out thru pipe in such a
way that couldn't manipulate shoulder very much.
Also arrange so that both extension & flexion from
~~straight~~ ^{neutral} position are made slightly vs. gravity.

Upper arm strapped to body for a week or so
will immobilize suture area & keep slack on
sutures. Let mank tear off wrappings gradually
so don't get sudden stretch on let nerves.

Nerve Sutures

Muse: cut. n. = 1.5 mm in diam. in dead musk 2 days

Combined ext. strands = 2.0 mm " " " " " "



Leave in this position so cut ends be well apart.

The sutures covered w. artery could be sewed down tightly in place to the underlying tendon of lat. dorsi. This probably does not stretch or move much if sutures don't go deep into n. below.

If bandage the elbow in extended position, get less mount pulling around the point where sutures are

When cutting n.s. make sure the two trunks & various branches w. in extensor trunk - all have same amount of tension in 'em.

After getting ext.'s can untangle branches that have become twisted or coiled around radial.

Can sew the n.'s together - makes a very strong suture ~~so~~ Have to be careful not to strangulate the sp. w. the thread or its own sheath.

Probably best to depend upon sewing to hold the nerve stumps together - 1 strand fastened well at each end to connective tissue - and use artery to corral and guide the fibers. Can wrap w. allant. membrane afterwards to prevent fibers crossing from extensors to flexors.

Left Arm

Electric cautery to cut & block up blood vessels



superficial cutan. n. runs over surface of bis. & tric.
(pull posteriorly)

Start by freeing ulnar & median n's in middle of arm & then work up & down.

On ulnar start low down & clear top sheath all way up, then can separate the motor branches to triceps.

On median start well up & work down to get anastomosis w. m-cut. This branch = very short until separated.

M-cut. runs all way to wrist w'out giving off any motor branches. & most of this branch comes from median anast. The separate components can be separated out.

Go well up into fat & glands of axilla reflecting on level of nerves.

Reflect coraco brachialis off surface of lat. dor. tendon & find m-cut. n. near upper edge of lat. dor. tendon.

Pull coracobr. away from biceps & cut its insertion carefully watching m-cut. n. Pull corac. away from deltoid retract deltoid & work out coracobr.

Find radial n. dipping between medial triceps & other triceps many large blood vessels running over & around it.

ulnar n. runs along surface of humerus
median n. runs along under edge of biceps

Clearing and getting branches of Radial Nerve.

Go down between med. triceps + other triceps. This separation can be made pretty well to elbow.

No triceps branches come off below middle of med. triceps m. Branches that go to later + long triceps come off above the " " " " med. triceps \therefore find low branch of med. tric. + know that all above are wanted.

There is a rather large branch that goes deep poster. to humerus + innervates brachialis — cut this + stick it into triceps m.

Another good sized branch shoots straight down along post. surface of med. triceps.

Rest of trunk curves along humerus deep.

Start at bottom of radial + separate the main trunk from branches wanted — work up slowly thru blood v.s etc. until get to top of nerve — and will have two nerves, the main trunk + the motor n.s to tric.

Then add branch from ulner n. + suture cross-ways.

Where have a doubtful branch use electric stimulation to test it.

Cut continuation of musculocutaneous and insert it into brachialis muscle near motor point.

Don't let cut ends fray.

Cut n.s well distally leaving only enough distal stump to make good covering by artery.

Before cutting, sew thru the perineurium of triceps strands & tie, then cut between them.



After cutting slide arteries over proximal stumps. In separating radial strands, cut the perineurium don't pull it off.

Two difficult parts of operation

1) separating the triceps br.s from other branches

2) suturing & tubulating the nerves after getting them.

3i-

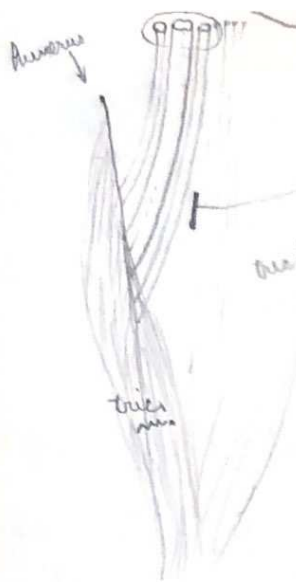
①
plected med. tr.



Highest br. running under humerus = cutaneous to lateral side of arm & elbow joint. The main trunk below that runs down, thru joint - may give very small twig to brachialis (couldn't get it from medial side - too far down) and down well in joint gives off twig, larger, to brachioradialis - (couldn't get this either).

The lowest branch doesn't run between brach & brach-rad like main trunk but = cutaneous & runs to lower lateral dorsal forearm outside brach. m. (between brach-rad. & triceps.)

The upper margin between triceps & rad. trunk = clear but in lower margin have to find the cutaneous r. that runs from rad. to lateral forearm.



get these 3 br.s of radial and isolate them - all other branches are up to triceps

This separation is only one have to be careful of. There's no chance to cut any of these r.s. to brach or brach. rad from this approach.

Follow the ulnar high up - sometimes find substantial r. to triceps coming off well up over the l.d. tendon, more off ulnar than radial.

Have mank's head ^{trunk} turned to right - puts less stretch on n.s and muscs pectorals so can get under 'em.

Turning head ^{trunk} toward operating site helps in opening up axilla. Cutting the triceps branches from main trunk makes all the difference. Sew into triceps branches before cutting, and leave both ends of thread. Have to be careful not to strangulate nerves when sewing.

In choosing br.s of lower margin of radial, better to include a couple extra ^{extra} strands in with the radial triceps r. than to miss one.

Bracing up shoulder with a folded towel helps greatly in getting preparation exposed.

Alternate Method of Crossing

- 1) Cut m. biceps low close to m. & cross some long branches to med. & lat. & long triceps over to it.
- 2) Use longish biceps m. to cross into the large highest triceps branch.
- 3) Cross brach. m. into the med. triceps by cutting whole muscul. cut. m. & suturing only the branches to brachialis.
- 4) maybe can cross some triceps into brach.

This requires several sutures of small diameter - has advantage that junctions can be slack & need no sewing.

Repeat on left arm

Clear muscul. all way down to eliminate fine collaterals to plexus.

Excise coraco brachialis & the slip of lat. dorsi which anastomoses with it, insertion end.

A fine branch from muscul. runs into shoulder to the head of lateral biceps

- x Cross upper triceps into biceps m. & get rid of central biceps
- x " brachialis - " lower triceps m.s. & " " triceps m.s.
- x Transpose biceps to ^{long} triceps tendons & excise long triceps.
- x Cross triceps m.s. into the brachialis m.

Possible Problems

Amputate legs & note effect on C.M.S. spinal centers, cerebellum, & cortico-spinal tracts. To prove that the effect is not due loss of function in these ~~these~~ tracts eliminate function but leave nerves intact — do this by ~~local~~ anesthesia? + nutritive injections?

Transplant legs, tail, tongue or something and show that tracts of C.M.S. & synaptic connections are altered.

Implant amphibian limb buds into embryonic ^{axonia} ~~amphibia~~ larvae. See if buds will function.

Transplant amblystoma legs & see if flexion & extension reflexes of tail w. polarized current thru cord are the same in normal & transplanted legs.

Cross sensory n. of hind leg that produces withdrawal reflex to back or tail & see if reflex unalterable

Amp. hind limb ^{very} early stage & put tail bud in to take up limb nerves. Then later S. the dorsal roots & see if same type of reflexes that would get if nerves had normal limb innervation.

Remove motor area of cortex in very young rats and see if surrounding regions take over motor function both as regards physical elect. stim & histologically. If so, required - shows histological structure of S's associated w. habit formation.

If so, trophic, shows peripheral influence of central devel. brings in that question.

Do it on animal born in very immature state. where have definite motor area.

Cross eyes from left to right side

Cut thru optic chiasma & test for transfer of training

Translocate skin flaps.

Sensory nerves into muscles

Rotate the eye ball 180°

Cross touch n.s. of limbs of amphibia to foreign cutaneous areas w/in the limb & see if get normal function as on motor side. Have to have diff't R's from diff' points on skin as in Dusky salamanders.

Preparation for Operation

Wash all instruments and all towels etc. that are not new & clean.

Cook heavy instruments under pressure $200^{\circ}\text{F.} \pm 250$
Small instruments, towels, retractors etc. heat in dry
sterilizer 130°C for $\frac{1}{2}$ hr. or so. ^{30 min - 15 min}

Place small instruments, retractors, etc. in strong carbolic soap solution during operation. (silk & small needles)

Have dish of lysol or weak carb. soap solution for dipping hands & instruments occasionally during operation.

arteries in chlorazene + Ringers

Use chemical sterilization for instruments

Towels, muslin, cotton, gauze go in pressure cooker

Have extra towel for pinning over front of coat.

Cut large gauze swabs in quarters, use rubber bands to fasten couple over microscope handles.

Wet skin & hair w. soap & water & then sprinkle a little Ba sulfide powder on it.

Spider minks (average size) take a little over 1 cc. of nembutal, intramuscularly. 1 cc - 3 cc

About $1\frac{1}{2}$ or $1\frac{1}{4}$ or $1\frac{3}{4}$ = safe

Mercuric Chloride 2/1000

Carbolic Soap 1850 cc satur. soap solution } for use
+ 1 lb of carbolic acid } dilute to
1/10

Collodium Dressing

Thin collodium 95 %
Turpentine 4 %
Castor oil 1 %

Depilatory Powder no. 1 (Mass. College of Pharmacy, Boston, Mass)

Barium sulfide (yellow) 22 gm.
Hard soap (fine powder) 5.5 gm.
Powdered talcum 36.1 gm.
Wheat flour 36.1 gm
Benzaldehyde .5 gm

Sargents ^{electric} drying oven for dry sterilization. Pans etc.

Pressure cooker for wet (need electric plate or stove to heat it). 250° 15 min. Keep instruments under water or they'll rust.

Sterilization

& surgical needles
All heavy chrome plated instruments under ^{wet} pressure 200°F +
Pans, cotton, etc. in dry sterilizer 120°C for long time 2 hrs.
thread, & small instruments " "

All metallic arts in dry sterilizer should be washed thoroughly 1st & then put in liquid antiseptic after. Iycol solution for washing hands during operation.

Mammalian Ringers

H ₂ O dist.	— 5,000 cc	3,000
NaCl	— 45.0 gms	27.1
KCl	— 2.1 "	1.3
CaCl ₂ anhyd	— 1.2 "	.72
KHCO ₃	— 1.0 "	.6

Marking System

Notches	Rt ear	Lf ear
1 front	1	10
2 "	2	20
1 back	3	30
2 "	4	40
1 front, 1 back	5	50
2 " , 1 "	6	60
1 " , 2 "	7	70
2 " , 2 "	8	80
3 "	9	90

10 mgms per 100 gms of ♀
 20 mgms " " " " ♂

Dosage of Na-amytal in cc of 10% solution for rats:

100 gm ♀	— .10 cc
150 gm ♀	— .15 cc
200 " "	— .20 cc
250 " "	— .25 "
300 " "	— .3 "
350 " "	— .35 "

100 gm ♂	— .2 cc
150 " "	— .3 cc
200 " "	— .4 cc
250 " "	— .5 cc
300 " "	— .6 cc
350 " "	— .7 "

subcutaneous

for cats in 10% solution: (same as for ♀ rat.)

7 mgm per 100 gms of body wt — intra-perit.
 10 " " " " " " — subcutan.

for rabbits

7 mgm per 100 gm of body wt subcutan.

Research results, plans, techniques
from 1941—

#13

Chicago Rot

Harvard "

Yerkes Monks

D. A. Amphibian

Sergeant's solis, techniques.