DEGENERATION AND REGENERATION OF NERVE

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Scientist contributed

Augustus Volney Waller showed the relation of nerve fibers to nerve cells, by describing peripheral degeneration of nerve fibers after sectioning the main trunk of the nerve, the central stump remaining alive. He experimented neural degeneration changes by making sections of glossopharyngeal and hypoglossal nerves of frog. He is widely known for his description of changes in neurons following injury, which is popularly known as ***Wallerian degeneration***.

Source: *Phil. Tr. Royal Society of London* 1850; 140: 423-429.

AV Waller
(1816–1870)

Comprehensive textbook of Physiology, Dr. G K Pal.

COMMON CAUSES OF DEGENERATION:

- TRANSECTION
- CRUSHING
- TOXINS OR POISONS
- ISCHEMIA
- HYPERPYREXIA

GRADES OF INJURY(SUTHERLAND'S)

- First degree: temporary direct pressure over nerve=ischemia
- 2nd degree: severe pressure over nerve with endoneurium intact
- 3rd degree: severe pressure with damage to endoneurial tube
- 4th degree: damage to endoneuial tubes with disorganisation of fascicles
- 5 th degree: through and through cutting of nerve.

Seddon's Classification

1) Neuropraxia (like 1 degree)-

Only loss of function, no anatomical damage

2) Axontemesis (like 2 degree)-

Injury upto axis cylinder

3) Neurotemesis (like 3 degree)-

Injury of whole nerve is injured means upto endoneurial tube

DEGENERATIVE CHANGES

- In nerve cell body (retrograde degeneration)
- In the proximal stump
- In distal stump (wallerian degeneration)
- Transneuronal degeneration

Degeneration in distal stump is called

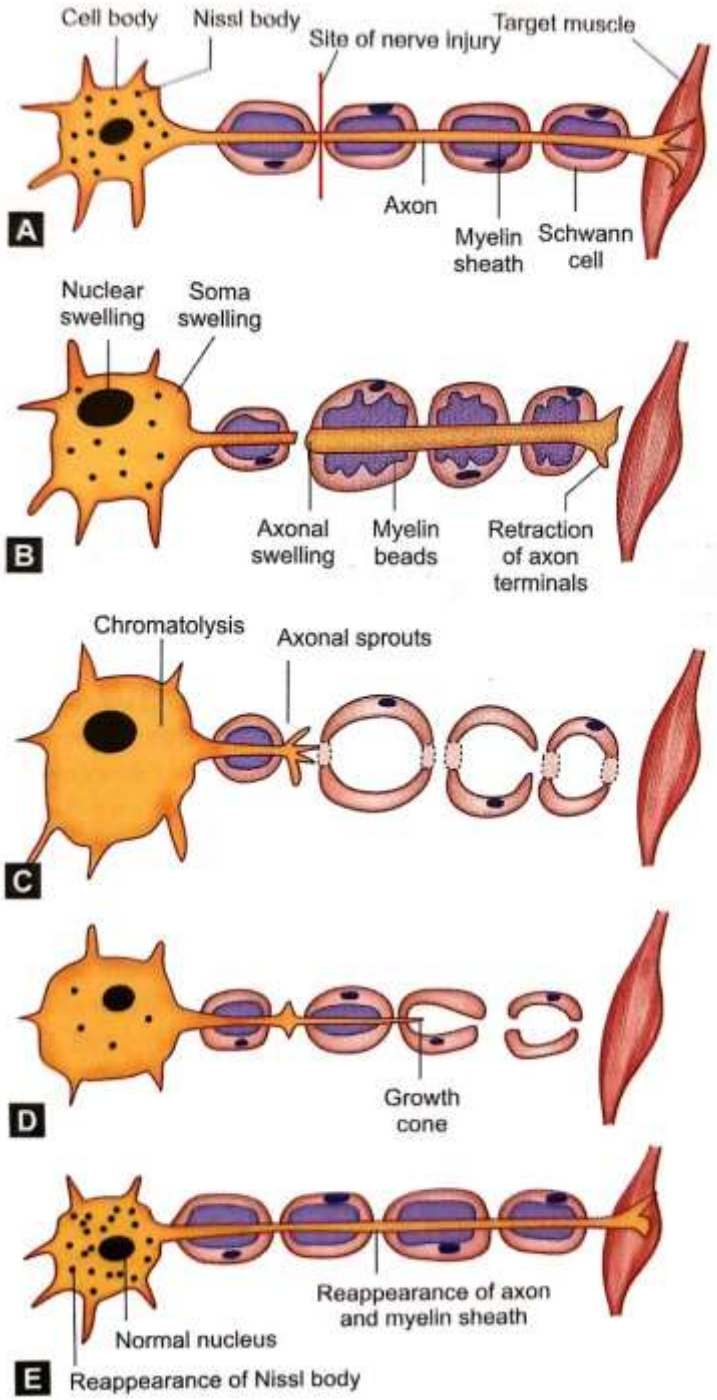
Wallerian (antrograde) degeneration

Degeneration in proximal stump

Retrograde degeneration

Injured neuron can lead degeneration in the other neuron it is connected to

Transneuronal degeneration



Comprehensive textbook of Physiology, Dr. G K Pal.

1,2,3,4 &5 day after injury

-1day- distal stump degenerative changes begin

-2 day- cell body degenerative changes begin

-3 day- the ability of axon to conduct impulse decreases

-4 &5 - nerve or axon fails to conduct any impulse

20 days- 2 to 3 months- 2 years

Degeneration begin at 1 day continue upto 20 days

Regeneration begin from 20 days to 2 to 3 months but functional recovery continue upto 2 years (max upto 80%)

DEGENERATION

Duration-

Start from first day & reach max. in 20 days.

Changes in nerve cell bodies-

- Within 48 hours after the section of the nerve,
- cell body swells
- there is chromatolysis,
- nucleus comes to margin of the cell,
- other organelles also fragments etc.

Changes in proximal stump-

Changes are same as distal stump but they occur only upto nearest node of Ranvier from site of injury.

CHANGES IN DISTAL STUMP-

- Axis cylinder swells & breaks into pieces.
- Myelin sheath breaks into oily droplets.
- Macrophages come from endoneurium to degenerating

  myelin sheath & axis cylinder & clear the debris
- Only empty endoneural tubes called ghost tube remain
- Schwann divide & fill the tube with cords of cells

REGENERATION

- Distance of injury to the cell body.
- Gap bet. two ends:3 mm.
- Two cut ends remain in same line.
- Intact neurilemma is a must for regeneration. Axons in CNS do not have neurilemma, hence cannot regenerate.
- If the type of injury is sharp cut, damage is less compared to crushing injury.
- If the cell body is damaged, neuron dies.

REGENERATIVE CHANGES

- In nerve cell body
- In the distal stump

Factors on which regeneration depends:

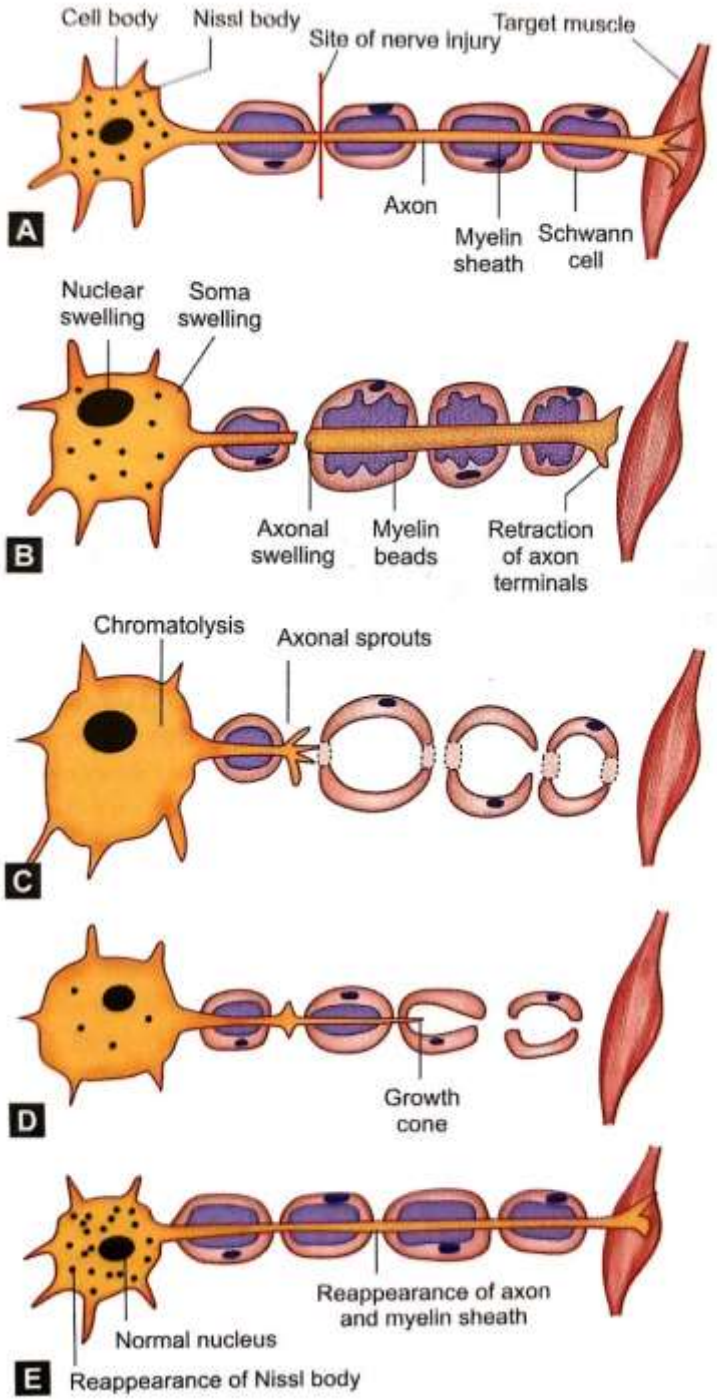
1) Severity of injury
2) Condition of soma
3) Site of injury
4) Neurotropins: nerve growth factors

Regeneration-

I) prerequisites & duration-

- Gap between cut ends should be less than 3 mm.
- Nucleus should be present,
- Neurilemma should be present.

Myelination continue upto 1 year and while functional recovery takes longer time (upto 2 years)



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Changes In proximal and distal stump-

- 100 fibrils elongates from proximal stump (0.25 mm/day)

- 20 fibrils enter into distal stump

- Now only 1 fibrils grow rapidly (4 mm/day) to form axis cylinder all other degenerate.

- Schwann cells fill the endoneural tube form myelin sheath around the successful fiber. 80% of original diameter may be achieved

Changes in cell body-

Nissl's granules & Golgi apparatus reappear. Cell regains its usual size and nucleus returns to the central position.

APPLIED

Neuroma-

If during the regeneration of the nerve fibrils, arising from proximal cut end, not find their way or if the gap is too large,

the fibrils elongate, turn round & form whorl-like painful mass known as neuroma.

Phantom limb-

- When the limb is amputated,
- Neuroma develops at the site which gives the unpleasant sensation of phantom limb,
- Excitation at the site of amputation causes the patient to feel that lost limb is still present.

Tinel's sign

Tingling sensation , when percussion is made over the nerve.

It indicates the beginning of regeneration of the nerve.

THANK YOU