TOPICAL HEMOSTATS , GLUES AND LASERS IN NEUROSURGERY

Hemostasis in neurosurgery

- One of the most important aspects of surgery.
- Control of bleeding without ligature
- Unlike in abdominal and other surgeries ligatures and packs rarely useful.
- Many hours lost in bleeding control

Topical hemostats

- Agents that help in controlling bleeding.
- Ideal topical hemostat:
  - efficacious
  - minimal or no side effects
  - affordable
  - available

Sources of bleeding

- Scalp/muscles
- Bone
- Dura and sinuses
- Brain:capillary/venous/arterial.

Topical hemostats

- **Chemical**
  - Microfibrillar collagen
  - Thrombin
  - Fibrin glue
  - Hydrogen peroxide(3%)
- **Mechanical**
  - Surgicel
  - Oxycel
  - Gelfoam
  - Surgicel Fibrillar
  - *Bone wax*
  - *cottonoids*

Surgicel

- Surgicel (Ethicon) is an oxidized cellulose polymer (the functional unit is poly anhydroglucuronic acid) formed by dissolving pure α-cellulose (plant derived) in an alkaline solution.
- Introduced in 1940s.
- It is then regenerated into continuous fiber, knitted into gauze, and oxidized.
- Applied dry, absorbs within 4 to 8 weeks.
- Forms a brownish or black gelatinous mass in contact with blood.

- Oxycel (Becton Dickinson) is another oxidized cellulose polymer product that is similar.
- Surgicel is composed of solid fibers with irregular contours on cross-section, whereas Oxycel is composed of hollow “twisted tubule” fibers.

Surgicel.....

- Acts as a physical matrix to which platelets can adhere which, in turn, aids in clot formation
- Additional pressure of the mass also contributes to the haemostatic process.
- Relatively bacteriostatic because of its relatively low pH, it deactivates and denatures some of the bacterial proteins thus making them more susceptible to antibiotics.
- Needs to be applied dry.

Gelatin sponge(Gelfoam/surgifoam)

- Introduced in the 1940s for neurosurgical procedures.
- Derived from purified pork skin gelatin.
- Absorbs approximately 45 times its weight in blood and can expand to approximately 200% of its initial volume.
- Can be used dry or saline soaked.
- Absorbed in approximately four to six weeks.

SURGICEL Fibrillar

- oxidized regenerated cellulose(1969)
- Layers can be peeled off in desired amounts.
- conforms to irregular surfaces, even hard-to-reach areas
- surgical visualisation is improved by ability to cauterise directly through it
- fully absorbed within 14 days

Microfibrillar collagen(Avitene)

- Collagen which is derived from bovine skin. binds tightly to blood surfaces.
- Causes minimal swelling especially when compared to Gelfoam .
- In addition to being collagen and causing contact activation, it does somehow directly activate platelets with subsequent aggregation.
- May reduce the number of free platelets in normal individuals .
- Loses effectiveness in thrombocytopenia(<10,000).
- It is absorbed in 3 months and needs to be applied dry.

Thrombin(thrombostat/thrombinar)

- Thrombin directly activates fibrinogen and converts it into fibrin monomers.
- Can be used directly or combined with gelatin sponge
- Produced from bovine prothrombin hence antigenic.
- If injected into large vessels can lead to thrombosis and complications.

Complications

- Nidus of infection
- Inflammatory reaction(esp. avitene)
- Antigenicity(animal products)
- Mass effect(esp.gelatin)
- Gossipiboma

Bone wax

- Pioneered by Sir Victor Horsley(1892).
  - Horsley's wax: **bees wax**, 7 parts; **almond oil**, 1 part; **salicylic acid**, 1 part.
- Modern wax:88% refined beeswax and 12% isopropyl palmitate (softening agent)
- Effective in controlling bleeding from bone
- Once smeared across the bleeding edge, immediate hemostasis occurs.

Complications

1) Bone wax inhibits osteogenesis

2) Increases infection rates (the number of bacteria needed to produce osteomyelitis is reduced by a factor of 10^4 (10,000)

3) Remains as a foreign body for many years

Ostene

- Sterile mixture of water-soluble alkylene oxide copolymers.
- Inert artificial material feels and works like wax.
- Does not increase infection rates, does not interfere with bone healing, and is non-inlfammatory.

Fibrin glue(Tisseel/crosseal)

- Commercially available/autologous.
- 2 components:

  a)fibrinogen, factor13, fibronectin, ***aprotinin***, plasminogen, cryoprecipitate

  b)thrombin and calcium
- After mixing, fibrinogen is converted to fibrin
- Aprotinin inhibits premature fibrin degradation

Uses

- For hemostasis and tissue sealing
- To establish hemostasis
- To reinforce dural closure and prevent CSF leak.
- In anastomosis of nerves and nerve grafts

  (Micro neural anastomosis with **fibrin glue** : an experimental study. Suri A, Mehta VS, Sarkar C .Neurology India.2002)
- Fixation of bone fragments to repair skull defects.

Lasers in Neurosurgery

- LASER(Light Amplification by Stimulated Emission of Radiation)
- Precise means of incision and coagulation of biological tissues.
- Each Laser medium has specific wavelengths and hence different absorption, penetration and scatter.
- Carbon dioxide(10.6micrometre),Argon (4888nm),Nd:YAG(1060nm)

Uses

- Removal of extra axial tumors in sensitive areas.
- Neuroablative procedures (cordotomy, myelotomy etc)
- Vascular neurosurgery.
- Laser discectomy.

Conclusion

- Proper surgical principle remains the key.
- Judicious use of haemostatic agents is advised.