Surgical treatment of head injuries – A Historical perspective

Prof. I.St. FLorian
The history of surgery in TBI - correlated with the history of humanity

Neurosurgery one of the oldest professions of the human race

Proof of human interventions on the skull exist since more than 12 000 years ago

Whatever the reason (therapeutic, mystic, or religious)- there are clear arguments of high rate of survival on this neurosurgical intervention

For a long period the development of Neurosurgery has been correlated with the treatment of head injuries
The first trepanned skull - discovered in 1685 in Cocherril, France - by Bernard de Montfauchon in 1816, Barbrie du Bucarge presents in Société des Antiquaires a trepanned skull with signs of healing.


E. Kovacs (Hungary) described in 1853 a trepanation found at Vereb.

E.G. Squier presented to New York Academy of Medicine a skull discovered in Peru (1863-65) Conclusion (Bulletin of the New York Academy of Medicine): “the hole was man-made”, but that there was no evidence of bone growth, and that it must therefore have been made after the individual’s death.

The same skull examined by Paul Broca: “At one portion of the opening there seemed to be evidence of the attempt on the part of nature to form new bone, to repair the injury done by the operation... we are in either case authorized to conclude that there was ... a surgery already very advanced” - Sur la trepanation du cranne et les amulettes crânnienes à l’époque neolitique” (1876).


***Mo Costandi: An illustrated history of trepanation, Anthropology, History of Neuroscience June 2007
Neolithic period (approx. 10,000-3,000 BC)
Neolithic period (approx. 10,000-1000 BC)

Evidence

- Trepanation as performed by man in prehistoric times across every continent
- More than 1500 trepanned skulls up to now
- The oldest examples (10,000 BC) found in North Africa
  - In the Jericho area (Near East and Asia) up to 8000 BC
  - The earliest European examples are more than 10,000 years old
- In Europe where counted more than 450 skulls with trephinations (France, Austria, Switzerland, Great Britain, Germany, Russia, Poland, Denmark and Sweden, Norway, and Ireland)
- The greatest number of trepanations have been excavated in France (>100)
  - Seine-Oise-Marne region—“surgery center” between 1900 and 1500 BC*
Neolithic period (approx. 10,000-1000 BC) Evidence

- Romania
- 18 trepanned skulls discovered
- In all regions (Transylvania, Moldavia, Muntenia)
- The skull from Livezi, Baia from the Bronze Age (2700 B.C.)
  - *The largest trepanation (12.2/7.3 cm) with signs of survival found in Europe*

*Moldovan E. Cranial Trepanations in prehistorically cultures in Transylvania, Buletinul Cercurilor Stiintifice studentesti, 2003, Alba Iulia, p5-21
Neolithic period (approx. 10,000-1000 BC)
Surgical Techniques

- Methods of trepanation
  - Scraping (1)
  - Grooving (2)
  - Boring (3)
  - Cutting (4)

- Instruments: flaked stone, flint, obsidian, bone

Neolithic period (approx. 10,000–1000 BC) 
Motivations, Hypotheses

- Therapeutic
  - **Broca** (1876) – “trepanations performed for the relief of intracranial maladies”
  - **Horsley** (1888) – “all these surgical interferences were therapeutic”
  - **Lucas-Championnière** (1912) – “done in order to cure a disease or to remove fragments from a fractured skull (decompression)”
  - **Ruffer** - headache was probably the chief indication (most of the operated skulls show no signs)
  - **Kisii tribe** (East African) performs trepanations to alleviate headache after a blow

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Neolithic period (approx. 10,000-1000 BC)
Motivations, Hypothesis

- **Magic-therapeutic**
  - Various intracranial diseases (epilepsy, meningitis, headache) ascribed to evil spirits and therefore cure was obtained by letting these out of the skull
  - *Lugbara tribe* desires to release evil spirits by trepanation

- **Ritual**
  - Prophylactic measure to promote health and well-being during later life or as an initiation
  - Obtain part of the skull as an amulet possessing mystic properties

- **What ever the reason** “these skulls provide a vivid picture of the enormous surgical skills of our neurosurgical forefathers, living 5000 years before modern neurosurgery began”


Ancient Egypt

- “The Egyptians were more skilled in medicine than in any other art” - Homer 800 BC in the Odyssey
- The rise of medicine in Egypt – in the First Dynasty
  - Athotis (second king of the First Dynasty) wrote Practical Medicine and Anatomic Book
- The earliest known practicing physician, Imhotep (2600 BC)
- The earliest painting depicting cranial surgery (tomb of Bany Hassan)
- The earliest known medical text - the Ebers papyrus
- *Edwin Smith Papyrus is the first treatise* describing the treatment of patients with TBI
4.7m long roll an average height of 32 cm

Probably a copy of an older manuscript of the Old Kingdom (3000–2500 BC)

Describes injuries from head to toe (a capite ad calcem) separated into 48 cases

Each case is divided in the sections: “title”, “examination”, “verdict” and depending on it “treatment” is given or not

Occasionally “glosses” - additional explanations (differential diagnostic)


# Ancient Egypt
## Edwin Smith Papyrus

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Title/medical diagnosis</th>
<th>Results of the examination</th>
<th>Verdict</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wound reaching to the bone of his skull</td>
<td>Palpation of the wound &gt; skull is not injured</td>
<td>This is a medical condition I can treat</td>
<td>Binding with grease, honey and lint every day until patient recovers</td>
</tr>
<tr>
<td>3.</td>
<td>Wound in his head, reaching to the bone, perforating his skull</td>
<td>Palpation of the wound &gt; skull is Injured. Stiffness of the neck, patient is unable to look at his shoulder and chest</td>
<td>This is a medical condition I can treat</td>
<td>Fresh meat upon his wound the first day, no bandage, put patient on the ground upon his resting place, until the time of his suffering passes</td>
</tr>
<tr>
<td>5.</td>
<td>Head injury with compound, comminuted and depressed skull fracture</td>
<td>Palpation of the wound &gt; skull deep and sunken under your fingers; swelling of the wound. Patient bleeds from his nostrils and ears. Stiffness of the neck, patient is unable to look at his shoulder and chest</td>
<td>This is a medical condition <em>you will not be able to treat</em></td>
<td>Sitting upright supported by two bricks, put oil on the patient’s head, soften his neck and shoulders, no bandage, put patient on the ground upon his resting place, until the time of his suffering passes</td>
</tr>
<tr>
<td>19.</td>
<td>Zygomatic-temporal stab wound</td>
<td>Examination of the wound. For patient it is painfull to look at his Shoulder. Patient turns his neck only a little. Ipsilateral eye is bloodshot.</td>
<td>This is a medical condition I can treat</td>
<td>Put patient upon his resting place until period of his suffering passes, treatment with oil and honey, redressing every day until patient is well</td>
</tr>
</tbody>
</table>

Recommended clinical examination, prognosis and treatment of neurosurgically relevant cases
<table>
<thead>
<tr>
<th>Case No.</th>
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<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.</td>
<td>Zygomatic-temporal stab wound with skull perforation and basilar skull fracture</td>
<td>Temporal wound with penetration of the bone. <strong>Both eyes are bloodshot. Patient bleeds profusely from his two nostrils by little drops.</strong> Placement of fingers in the mouth of the wound leads to great discomfort of the patient. He is sick and cannot speak. Great tears are falling from his eyes. Patient takes his hand to his face repeatedly, rubs both eyes with the back of his hand like a child does and he realizes not what he does.</td>
<td>This is a medical condition you will not be able to treat</td>
<td><strong>Resting in an upright position,</strong> massage of his head with oil, pour milk into the patients auditory canal</td>
</tr>
<tr>
<td>21.</td>
<td>Temporal split fracture</td>
<td>Swelling protruding the fracture. Patient bleeds from his nostril and from his ipsilateral ear. It is painful for the patient when he hears speech.</td>
<td>This is a medical condition with which I shall content</td>
<td>Put patient upon his resting place until period of his suffering passes</td>
</tr>
<tr>
<td>22.</td>
<td>Temporal smash fracture</td>
<td><strong>Place your thumb upon his chin and your finger upon the end of his zygomatic bone&gt;blood will flow from his two nostrils and from the ipsilateral ear.</strong> Clean the auditory channel with a swab of linen: bony fragments within the interior of his ear. He cannot speak.</td>
<td>This is a medical condition you will not be able to treat</td>
<td>No recommendation</td>
</tr>
</tbody>
</table>
The first description of the brain, contusions, the dura, the CSF and intracranial pulsations

Noted important clinical signs as prognostic factors (meningism or basal skull fractures)

The structure of case presentation remind the sequence in nowadays publications

Clinical examination is a timeless tool that leads to similar results and quite similar diagnosis and classification

Therapeutic options
  - Generally limited
  - In severe TBI the head is elevated!
  - No surgical indication are presented even in depressed fracture
In ancient Peru were performed more trepanations than in the rest of the ancient world combined.

Motivation
- Therapeutic (trauma, mental disease, epilepsy, headache)
- Rituals

Techniques
- Circular cutting, scraping, crosscut sawing, drilling
Pre–Incan and Incan period

- **Instrumentation**
  - Chisels (copper, silver, gold, or champi-Inca bronze)
  - Obsidian knives (escapelos or pedernales)
  - Tumi – T shaped metal instrument with a crescent blade (symbol of Peru),
    - was used to open the scalp
  - **Bone elevators**
  - **Dura protectors**
  - Forceps
  - Suturing needles
  - cotton bandages
  - **Hemostatic wool tourniquets**
Pre-Incan and Incan period

- **Sirkaks** (Inca surgeons) -
  - Demonstrate a good knowledge of anatomy
    - Preserved the SSS
  - Understand the role of surgery
    - Decompressed cranial fractures
    - Removed pathological intracranial collections
  - Restored the normal anatomy
    - Performed osteoplastic craniotomy
    - Implanted prosthetic material

*Marino R Jr, Gonzales-Portillo M: Preconquest Peruvian Neurosurgeons: A Study of Inca and Pre-Columbian Trephination and the Art of Medicine in Ancient Peru, Neurosurgery, Vol. 47, No. 4, October 2000*
Pre-Incan and Incan period

Results

- Survival rate up to 70%
- Cases with multiple trepanations in various stages of healing
- Little incidence of infection

“...our neurosurgical forefathers were not only making holes in the head, they were also repairing them”


Ancient Greek Hippocrates (460–377 BC)

- “Peri Ton En Cephali Traumaton” = “About the head trauma”
- **First systematic approach of head injury**
- Influenced neurosurgery for 25 centuries

**Cranial anatomy**
- cranial construction in adults and child
- bregma - the weakest part followed by the temporal area
- Superficial temporal artery incisions causes contralateral convulsions

"Medical history" - fundamental tool
- Assessment based on clinical examination (inspection and palpation)
  - convulsions and hemiplegia *contralateral to the injured side*

Five types of fractures:
- Linear
- contusion
- depressed fracture
- hedra (or dent)
- contrecoup fracture

Simple skin laceration - no bandage except forehead, eye or eyebrow

Significant injury - *trepanation with terebra* (first 3 days)
- avoided on skull sutures
- multiple holes arranged in a circle
- should not expose the dura (meninges)
- evacuation of pus? hematoma?
- adapted tools for child

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**Dimopoulos VG, et al:** Head Injury Management Algorithm as Described in Hippocrates’ “Peri Ton En Cephali Traumaton” Neurosurgery 57:1303-1305, 2005

De Medicina- the most important after the Hippocratic writings
  - Book VIII, Chapter 4- the earliest descriptions of an epidural hematoma

Recommendation- always operate on the side of greater pain

Spine injury
  - High cervical spine - vomiting and difficulty could cause breathing difficulties
  - Lumbar spine- weakness or paralysis, urinary retention or incontinence

Galen’s writings-unchallengeable medical dogma (including errors or incorrect beliefs) for the next 1500 years

- Argued in favor of elevation of depressed skull fractures, fractures with hematomas, comminuted fractures particularly those pressing into the brain
- Continuous irrigation during trephination
  - dura should never be violated by the trephine

Byzantine Period
Paul of Aegina 625–690 AD

- Epitome of Medicine- (6-th Book, Chapter 90)
- 6 categories of skull fractures
  - Fissure (linear nondisplaced); Incision (diastased); Expression (nondisplaced comminuted); Depression (inward displaced); Arched (outward displaced); Capillary (hair-line, dangerous-often overlooked)
- Specific symptoms
  - Vertigo, Loss of speech, Sudden prostration
- Described the association of neurological symptoms to brain compression

Complications
- Recommends wound debridement, bone fragment removal within 7 days (summer) or 14 days (winter)

Treatment
- Linear nondisplaced fractures - “scraping”
- Comminuted fractures - removal of the bone fragments
- Closed head injury - trephination

Staged trepanation
- 1st stage – X shape incision, debridement and hemostasis (“pledgets moistened in oxycrate” - mixture of water and vinegar)
- 2nd stage – trephination in the sitting position (after occluding the patient’s ears with wool to block the noise)

Proposed surgical instruments
- elevators, raspatories, bone biters
- trephine bits with conical styles

Postoperatively
- use of “balls of wool dipped in “oil of roses and wine” on the dura
- daily dressing changes

Islamic/Arabic Period
Ibn Sina- Avicenna (980-1037)

- **Canon Medicinae**
- Encyclopedic effort based on the writings of Galen and Hippocrates
- *Extended Greek influence into the 18th century*
- Provided highly systematic knowledge on head traumas
- Regarding the treatment of skull fractures, is a real successor of Galen and Paul of Aegina

*Sarrafzadeh SA et al: Ibn Sina (Avicenna); Neurosurg Focus 11 (2): 5, 2001
Islamic/Arabic Period
Albucasis (Al-Zahrawi, 936-1013)

- Father of modern surgery
- *Kitab al-Tasrif*—thirty volumes medical encyclopedia
  - Remained in use for 500 years
- *On Surgery and Instruments* (3 volumes)—illustrated surgical guide
  - Some neurosurgical instruments inspired from Paul of Aegina’s writings
- Firstly described the ligation of temporal artery for migraine (500 before Ambroise Parre)
- In head trauma - promote the writings of Hippocrates, Galen and Paul of Aegina

Knowledge of medicine - kept alive by the Arabs and Turks during the European Dark Ages

All the writings of Paul of Aegina were translated into Arabic by Hunain Ibn Ishaq-Johannitus (809-873)

Haly Abbas
- The “Royal Book”
- Further developed the writing of Greek and Roman-Byzantine surgeons (especially Paul of Aegina’s work)
- Chapters concerning cranial fractures are almost similar to the Paul of Aegina’s Epitome
- Free bone flap craniotomy technique is comparable to nowadays technique

Serefeddin Sabuncuog˘lu
- “Imperial Surgery”
- Illustrative information on various surgical techniques
- Combine knowledge of Greek, Roman, Arabic, and Turkish surgery

Aciduman A et al: The Royal Book by Haly Abbas From the 10th Century - One of the Earliest Illustrations of the Surgical Approach to Skull Fractures; Neurosurgery 67:1466–1475, 2010
**MIDDLE AGES**  
The School of Salerno

- **Constantinus Africanus**  
  (1020-1087)
  - Introduced the scholarship of Islamic/Arabic medicine in Salerno and to all of Europe
  - Provided the *earliest transfer of Arabic/Islamic medical literature to Europe*

- **Roger of Salerno** (Ruggiero Frugardi, fl. 1170)
  - *Practica Chirurgiae* - the first medieval European book on surgery
  - Introduced the *Valsalva maneuver to detect a posttraumatic CSF leak.*
  - Introduced the concept of "*laudable pus*" in wound healing

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MIDDLE AGES
The School of Salerno

- Theodoric of Cervia (Borgognoni, 1205-1298)
  - Principles for good wound healing
    - Control of bleeding
    - Removal of contaminated or necrotic material
    - Avoidance of dead space,
    - Wound dressing bathed in wine
  - **Primary closure of wounds!!**
  - Avoiding “laudable pus.”
  - Head injury
    - *Parts of the brain could be removed with little effect*
    - Elevating depressed fractures

- Lanfranchi of Milan (d. 1306)
  - Considered the father of French surgery
  - **First modern characterization of cerebral concussion**
  - Argued for using the trephine only when absolutely necessary, the “Holy Ghost” will provide the cure

Goodrich JT, Flamm ES: Historical Overview of Neurosurgery in Youmans neurological surgery /
Guy de Chauliac (1300-1368)
Leading surgeon at the school of Montpellier
The most influential surgeon of the 14th and 15th centuries

- Shaving of the hair
- Primary skin closure
- Egg albumin as a hemostatic agent
- Wine-soaked cloths into the injured site

Categorized head injuries into 7 types
- Scalp wounds
  - cleaning and débridement
- Compound depressed skull fracture –
  - trephination and elevation

Hieronymus Brunschwig (ca. 1450-1512)
- Buch der Cirurgia (Strasbourg 1497)
- The earliest printed surgical work
- First discussion on the management of gunshot wounds

Hans von Gersdorff (1455-1529)
- Feldtbuch der Wundartzney, (1517)
- Earliest illustrations on surgical technique
- Original drawing depicting III-rd. and XII nerves paresis

Ambroise Paré (1510-1590)

- Book X - diagnosis and management of skull fractures
  - 5 Indications for trephining:
    - *elevate bone fragments* compressing dura and the brain
    - *to remove blood* and bloodstained between the cranium and dura
    - to release blood-stained matter to prevent infection
    - to instill drugs
    - to prevent bleeding or inflammation
  - Advocated débridement, removal of foreign bodies
  - Replaced boiling oil with dressing of egg yolk, rose oil, and turpentine for primary treatment of gunshot wounds
  - “I bandaged him, God cured him”

Renaissance
Berengario da Carpi* (1460–1530)

- Combined his medical experience with engineering knowledge
- Tractatus de Fractura Calvae sive Crani (Treatise on Fractures of the Calvaria or Cranium) the first book on head injuries (Bologna 1518)
  - Physiopathology, diagnosis, treatment, and prognosis of head injuries
  - Entire set of surgical instruments to be used for cranial operations
  - Based on personal experience and on the entire classical and contemporary literature (Hippocrates, Plato, Aristotle, Galen, Paul of Aegina, Celsus, Avicenna, Abulcasis, Lanfranc)

• Types of cranial fractures
• Clinical signs of a head injured patient
  • redness of the eyes, bilious vomiting, loss of speech, impaired vision, vertigo, fever, vomiting, falling down, and “stupor of mind”
  • “...one eye appears less large that the other” = anisocoria (dangerous or fatal sign)
• Described subdural, epidural hematomas, contre-coup lesions, subdural empyema
• Recommend emergency treatment (within the first hour) - patients “had little sensation” to surgery
• On prognosis
  • “even a minor lesion can cause apprehension because it occurs in the noblest member of the body”
  • “If imperfect handling occurs in a human being the individual is destroyed and cannot ever be restored”

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**TABLE 1: Classic terminology used by Berengario to describe the “broken continuity of the head”**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>capillary</td>
<td>a small incision of the head that does not penetrate the inner covering of the cranium, or penetrates it but without lesioning the membrane (meninges)</td>
</tr>
<tr>
<td>abera or angin</td>
<td>the bone is cut superficially and its outer surface is removed</td>
</tr>
<tr>
<td>apostatimos or cutomatos</td>
<td>the bone is removed as far as the membrane</td>
</tr>
<tr>
<td>empyasma or antiaca</td>
<td>the cranium is broken into many parts, and the lesion descends to the membrane below the healthy bone</td>
</tr>
<tr>
<td>marusis or monesis</td>
<td>the bone is broken more deeply toward the membrane</td>
</tr>
<tr>
<td>haesena*</td>
<td>especially in children, the bone is depressed toward the intracranial cavity “as happens to a pliable or malleable vessel when a hard body strikes it and makes a dent”</td>
</tr>
</tbody>
</table>
- Described “complete corpus instrumentorum” of neurosurgical practice
  - Trepanning and perforating devices
  - Elevators
  - Extractors
  - Chisels
- 2 different surgeries:
  - direct gentle approach on depressed bone fragments
  - perilesional craniotomy
- Postoperative care – assure surgical success
  - changing medications
  - dressings
  - Avoiding pus
**Renaissance**

- **Andreae della Croce** (1509?-1580)
  - Illustrated Textbook on surgery (1573)
    - “operating theatre” – the bedroom of patient
    - Proposed technique for removal of various types of arrows, spears, and bullets in warfare
    - Various trephine bits proposed and illustrated
    - “Penfield”-style elevators for lifting depressed skull fractures

- **Andreas Vesalius** (1514-1564)
  - “De Humani Corporis Fabrica”
    - Book VII- Anatomy of the brain
    - Protective role of bone and membranes
    - Mechanisms of brain injury

17-18-th Centuries

- Dr. Nicolaes Tulp (1593–1674)
  - *Observationum Medicarum*
    - Case report on the surgical treatment of an acute epidural hematoma
    - “...by lifting out some bone, to remove, without any delay, all that was compressing either the brain or the membranes...”

- Wilhelm Fabricius von Hilden (1560-1634)
  - *Observationum et Curationum*—monograph including over 600 surgical cases
    - Skull fractures, encephalocele, intracerebral hematoma

- Johann Schultes (Scultetus) of Ulm (1595-1645)
  - *Armamentarium Chirurgicum*
    - Surgical techniques for treating fractures and dislocations
    - Bandaging techniques for wounds

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van Alpen AH: Elective Trepanation for Acute Epidural Hematoma by Dr. Nicolaes Tulp (1593–1674; Neurosurgery 48:401–405, 2001)

17-18-th Centuries

- **Percivall Pott (1714-1788)**
  - clearly appreciated that the clinical findings of head injury were due to injury to the brain and not the skull
  - differentiate between “compression” and “concussion” injury of the brain

- **Jean Louis Petit (1674-1750)**
  - “delayed loss of consciousness could serve as an indication for surgical intervention”
  - Major shift in surgical indication

- **Henri Francosi Le Dran (1685-1770)**
  - Described the “lucid interval”- most commonly in epidural hematoma

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17-18-th Centuries

- **James Hill** (1703-1776)
  - *Cases in Surgery*
    - 18 cases of cranial trauma
    - Overall mortality of only 25%
    - Great understanding of head injury management
      - Cerebral pulsation and/or tension at surgery
      - Avoided compressive dressings
      - Importance of cerebral lateralization

- **John Abernethy** (1764-1831)
  - Brain could tolerate mild degrees of pressure - early trepanation should be avoided
  - Cerebral lateralization
  - *Dilated pupils - a dangerous sign*

- **Lorenz Heister** (1683-1758)
  - Recommend early removal of compressing bone fragments
  - Adherent fragments must be left in place
  - Epidural clot removal trough the aperture

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Surgery of the brain was possible due to three discoveries:

- **On 16 October 1846 in Boston**, *Morton* and *Warren* used **ether to induce anesthesia**.

- In **1847** (in UK), *Simpson* used **chloroform** - another method of inducing surgical insensibility.

- In **January 1847** in Iasi, *Ludovic Russ Senior* was the first to use ether anesthesia in this part of Europe.
19-th Century- Pre-modern neurosurgery

- Surgery of the brain was possible due to three discoveries*
  - Anesthesia
  - Asepsis

- Holmes and Semmelweis - hand washing before and after each case markedly reduce puerperal infection

- Louis Pasteur and Robert Koch - concept of bacterial contamination

- Lord Lister - infection was due to contamination and only thorough antiseptic techniques could dramatically reduce it
19-th Century-Pre-modern neurosurgery

- Surgery of the brain was possible due to three discoveries*
  - Anesthesia
  - Asepsis
  - Cerebral localization

- In the 1860s Fritsch and Hitzig, Paul Broca and Carl Wernicke - each part of the brain corresponded to a particular function

*Goodrich JT: A millennium review of skull base surgery
19-th Century- Pre-modern neurosurgery

- Sir Charles Bell (1774-1842)
- **Illustrations of the Great Operations of Surgery**
  - Illustrated techniques of trepanation
  - Localized safe and dangerous places for trepanation
- Jonathan Hutchinson (1828-1913)
  - Recognition of *third nerve paralysis* dilated pupil was likely to be **on the side of the hematoma**
From trephination to craniotomy

For centuries hammer, chisel and trephine where the main tools.

In 1889 Wilhelm Wagner performed the first osteoplastic flap using hammer and chisel.

"The osteoplastic method of trepanation is no more difficult or dangerous than an explorative laparotomy."
Jean Toison (1891) used of a chain saw to divide the bone between burr holes from within outward to facilitate raising of osteoplastic skull flaps.

Leonardo Gigli (1894) used a wire saw to divide bone between two openings.

Karl Dahlgren (1896) - designed a new bone-cutting forceps for making linear cuts in the skull bone from the inside out.

Alfred Obalinski (1897) used the Gigli saw for elevating a bone flap by using a slightly banded cannula as an inserter.

19-th Century Pre-modern Neurosurgery

- **Victor Horsley (1857-1916)**
  - Among many other priorities in the neurosurgical field he used **beeswax** to stop bone bleeding

- **Leopold Ollier (1830-1900)**
  - performed trephination and **bone grafting experiments** in animals
  - He clearly distinguished autograft, allograft and xenograft

- **William Macewen (1848-1924)**
  - Considered the **founder of the modern practice** of bone grafting
19-th Century
Pre-modern Neurosurgery

• Ernst Gustav Benjamin von Bergmann (1836–1907)

• The doctrine of head injuries (1873)
  • Indications for a trepanation
    • Posttraumatic intracranial abscesses
    • Distinguishable rupture of the middle meningeal artery
    • Sunk compression fractures should be elevated
    • Gunshot injuries should be cleaned surgically

• Traumatic brain injury with general and with focal symptoms (1881)
  • Underlined the possibility of a intracranial pathology without external signs of injury
  • Promoted surgical action from the development of progressive neurological symptoms

19-th Century Romanian Contribution

- LUDOVIC RUSS- SENIOR (1816-1888)
- In 1847 in Iasi, he performs the the first ever Romanian mentioned trepanation for an clinically diagnosed extradural hematoma
  - In 1879, William Macewen, performed a successful craniotomy for a subdural hematoma*
19-th Century
Romanian Contribution

- **Leonte Anastasievici**
  - Between 1886 and 1891 he performed 22 “trephinations” for severe trauma, neglected skull fractures, epilepsy and ICH

- Along with N. Bardescu published article “Intervention chirurgicale dans les affection cerebrales” - *First Romanian neurosurgical article* (Revue de Chirurgie [vol IX, Octomber 1891, p.813, Paris]
C.D. Severeanu (1840-1932)
Graduated of National School of Medicine in Bucharest and faculty of medicine in Paris (1864)
During the Independence War (1877) he introduced the listerian asepsis of wounds
In 1896, along with his assistant Eisenecher and Brohem construct an X Ray device and perform the first X ray examination in Romania
He reports 85 trepanations in 2370 patients
19-th Century Romanian Contribution

- Thoma Ionescu (1860-1926)
- First sectorial corticectomy for epilepsy (1887)
  - Sir Victor Horsley is credited with performing the first craniotomy for epilepsy in 1886
- In 1897 promoted *dural opening in temporal craniectomy* to prevent the devastating consequences of brain edema (one year before Jaboulay)
- Demonstrate the superiority of *osteoplastic craniotomy*, original technique
Modern Wars and Neurosurgery

- **American Civil War**
  - First conflict in which *gunshot wounds outnumbered* puncture wounds
  - *“Medical and Surgical History of the War of the Rebellion”* – detailed descriptions of 983 brain injuries - *the largest case series of any kind to date*
  - The largest experience with traumatic spinal cord injuries (SCIs) to date

Based on his three month experience in WWI (from July 31 to November 1917) on 133 operated soldiers with brain injuries

“Notes on penetrating wounds of the brain. BMJ, 221–226, 1918”
  • Decline in operative mortality from 54,5% (first month) to 28,8% (third month);
  • Overall operative mortality rate - 41%.


Matson: “the operative mortality in acute penetrating missile wounds of the head was reduced principally due to the operative techniques introduced by Harvey Cushing from 50 to 60 percent early in the war to 28.8 percent”

Brandvold: “the originator of brain wound care”
## WWI-Cushing’s contributions

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<th>Cushing’s original (?) contributions</th>
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*Carey ME: Cushing and the treatment of brain wounds during World War I; *J Neurosurg* 114:1495–1501, 2011*
Modern Wars Contribution to Development of Neurosurgery

**WWI**
- Emergency operation close to the operating field
- *70 days training in Neurosurgery*

**WWII**
- Spinal Cord Injury management
- *Neurosurgical training-4 to 6 month*
  - 1 month cadaveric dissection and lectures
  - 3- 5 month clinical and surgical practice
- *Mobile Neurosurgery Units (MNSUs)*
- Cranioplasty development (tantalum)

Modern Wars Contribution to Development of Neurosurgery

- Korean and Vietnam Wars
  - Triage and battlefield evacuation (Helicopter)
- Lebanese-Israeli conflict (1980-s)
  - Introduction of routine CT use
- Iraq and Afghanistan Conflicts
  - *Early Decompressive Craniectomy*
  - Endovascular treatment
  - Studies on posttraumatic vasospasm

Conclusions

• “Only the man who knows exactly the art and science of the past and present is competent to aid in its progress in the future”
  • C. A. Theodor Billroth

• “Since these very first attempts by Neolithic humans, surgery of the brain and its coverings has evolved slowly during some 12,000 years, with elements of refinement in instrumentation but with similar end results”

• History is a chain of significant moments.... But behind every single moment there is at least a MAN
Thank you for your attention