

The Eye at War

Preventing and treating combat injuries a 2000 year history



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Gresham College
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Corinthian helmet

Pilos helmet: πῖλος =felt. Common travelling cap

Bronze Version for light infantry and cavalry

Worn by Spartan Army

No Face protection:

Corinthian Helmet

Goddess Athena is shown wearing this helmet on Corinthian coins (3rd-7th BC).

Frequently featured on vases.

one of the first achievements of European material culture that had no stylistic antecedent in Asia Minor or North Africa.

Two main problems

covered the ears impeding hearing
secondly, unfitted and cylindrical, spinning when struck blinding the wearer.

'**Attic**' helmet, preferred choice of Greek warriors by the time of the Peloponnesian Wars (431-404 BC).



Castor wearing a pilos-helmet, Attic red-figure calyx-krater, ca. 460 BC.



460 BC

Each Greek city-state was defended mainly by its own citizens.

Hoplites: could afford the best armour, single piece of bronze by skillful metalworkers.

"THE PEOPLE WHO LIVED IN ARGOS WON THIS HELMET IN BATTLE FROM THE CORINTHIANS".

Roman eye protection

Gladiator's helmets (except Retiarius a net and trident)

Bronze, heavier than Roman infantry Galea.

Murmillo. elaborate helmet with visor

Andabatae: Noxii sentenced to death in the arena.

Comic relief. Helmets without any openings
Fought completely blind, manoeuvred
together by arena attendants.

Oplomachus: Greek hoplite: Lance and short sword, small round bronze shield



4AD: **Retiarius** Kalendio fighting **Secutor** Astyanax. Ø
: killed after surrendering.

National Archaeological Museum Madrid



c80AD: Jamahiriya Museum, Tripoli, Libya



OPLOMACHUS NUNC ES,
FUERAS OPTHALMICUS ANTE. FECISTI
MEDICUS QUOD FANIS OPLOMACHUS.
(Martial, Epigrams 8.74



Early mediaeval

Spangenhelm, C6th Iranian origins.

Plates held together with strips, spangers

Nasal Helmets

Western Europe late C9th,
predominant form of head protection,
end of C12th century lost popularity
amongst the higher classes of knights
used by archers wide field of vision

Coppergate helmet: C8th English

Based on Late Roman.

Iron. Brass

IN NOMINE : DNI : NOSTRI : IHV :
SCS : SPS : DI : ET : OMNIBVS :
DECENVS : AMEN: OSHERE : XPI

"In the name of our Lord Jesus, the Holy
Spirit and God; and to all we say Amen /
Oshere / Christ"



Battle of Dun Nechtain:
Pictish memorial stone
Aberlemno Kirkyard C8-9th
Northumbrian cavalrymen.
Ecgfrith killed
Pictish victory: independence

Nasal helmets

Disadvantage

No eye protection



"I live, and with God's help will conquer yet!"



The English army flee, the final surviving scene of the Bayeux Tapestry. "Et fuga verterunt Angli" added 1814 anti-English feeling

Vulnerable to missiles



~1160 David and Goliath: medieval shepherd vs. knight in full regalia. Winchester Bible

Need for greater facial protection

lances used in the closely packed "conrois" formation 20-40 knights stirrup to stirrup with couched lances

Enclosed helmet: flat-topped cylindrical helm

Face-protecting plate, pierced for sight forming *ocularia*

only used by knights.

Restriction to sight and hearing

Great Helm developed early in the 13th century.

Medieval soldier for 300 years.



Murder of Thomas Becket, manuscript c. 1200



enclosed helmet. C13th fresco scene from "Iwein" by Hartmann von Aue: Rodenegg Castle, South Tyrol



Maciejowski Bible, Leaf 35



Mediaeval Eye Protection

Bascinet

The open-faced bascinet left the exposed face vulnerable

Sallet variant of bascinet

Visors

Cangrande della Scala (1291-1329) Verona
Patron of Dante



Sallet 1470 Milan (Italian celata)
Several types C15th helmets open faces or, visored, lower face and neck exposed. This tall form of sallet is typically Italian "barbute"



Visored sallet, ca. 1470–85
Hans Blarer the Younger
German sallets have long pointed tails

Mediaeval Eye Protection

1330, 'face guard' or movable visor.
"klappvisier" on bascinets

Single hinge in the centre of the brow

Crucifixion painting: Chapter House of the Dominican Monks of Santa Maria Novella in Florence, c.1367

C16th: chapel and burial place for the Spanish courtiers of Eleanora of Toledo wife of Grand Duke Cosimo de Medici

Fresco cycle begun in year of the Black Death, 1348, finished in 1355.

It is the only known work of this artist, thought to be from Siena.

1347: Bascinet double pivoted visor
Sir Hugh Hastings: Brass St. Mary's Church, Elsing, Norfolk

Via Dolorosa, Crucifixion, and Descent into Limbo Frescoes by **Andrea di Bonaiuto** (Andrea da Firenze) and assistants (c. 1365), Spanish Chapel, Santa Maria Novella, Florence



Master A", Milan, c. 1400-1410.
Bascinet.



Sir Hugh Hastings, d.1347 of dysentery during siege of Calais



C15th manuscript Chroniques de Jean Froissard,
bascinet with the rounded visor used from c.1410

Artillery and eye injuries

1289: Siege of Almazán **Martin Pérez Puerto Carrero**: killed instantly by arrow to his eye

1343: Siege of Algeciras: **Per Álvarez** shot in face, taking 3 days to die in agony

1434: Siege of Álora: Arab crossbowman shouts in Catilian from the battlements. **Don Diego** lifts his visor and is promptly shot in the face

1477: Siege of trera: **Juan de Guzamán** killed by a sniper shot into his face

1522: **Don Juan de Cardona**, Count of Colosa Sicily, battle of Biocca
raised his visor to survey the field killed by arrow in eye



Battle of Shrewsbury (1403)

1403, **Percy Northumberland** revolt **King Henry IV**
Son; **Henry “Hotspur” Percy** marched south Recruited
Cheshire Archers (bodyguard of Richard II)

Bloodiest Middle Age battle in England. Both lost 1600
men in the field, another 3000 wounded.

Longbowmen on both sides: arrows flew:

*“so fast and thick that it seemed to the beholders like a
thick cloud, for the sun, which at that time was bright and
clear then lost its brightness so thick were the arrows”*

Thomas Walsingham: King's men "fell like leaves in
Autumn, every arrow struck a mortal man”

Percy, killed when he lifted up his visor

16 yr old **Prince Henry** lifted his visor shot below the eye
Waited until victory then retired to Kenilworth

John Bradmore, London surgeon treatise Philomena (The
Nightingale), written 1403 -1412.

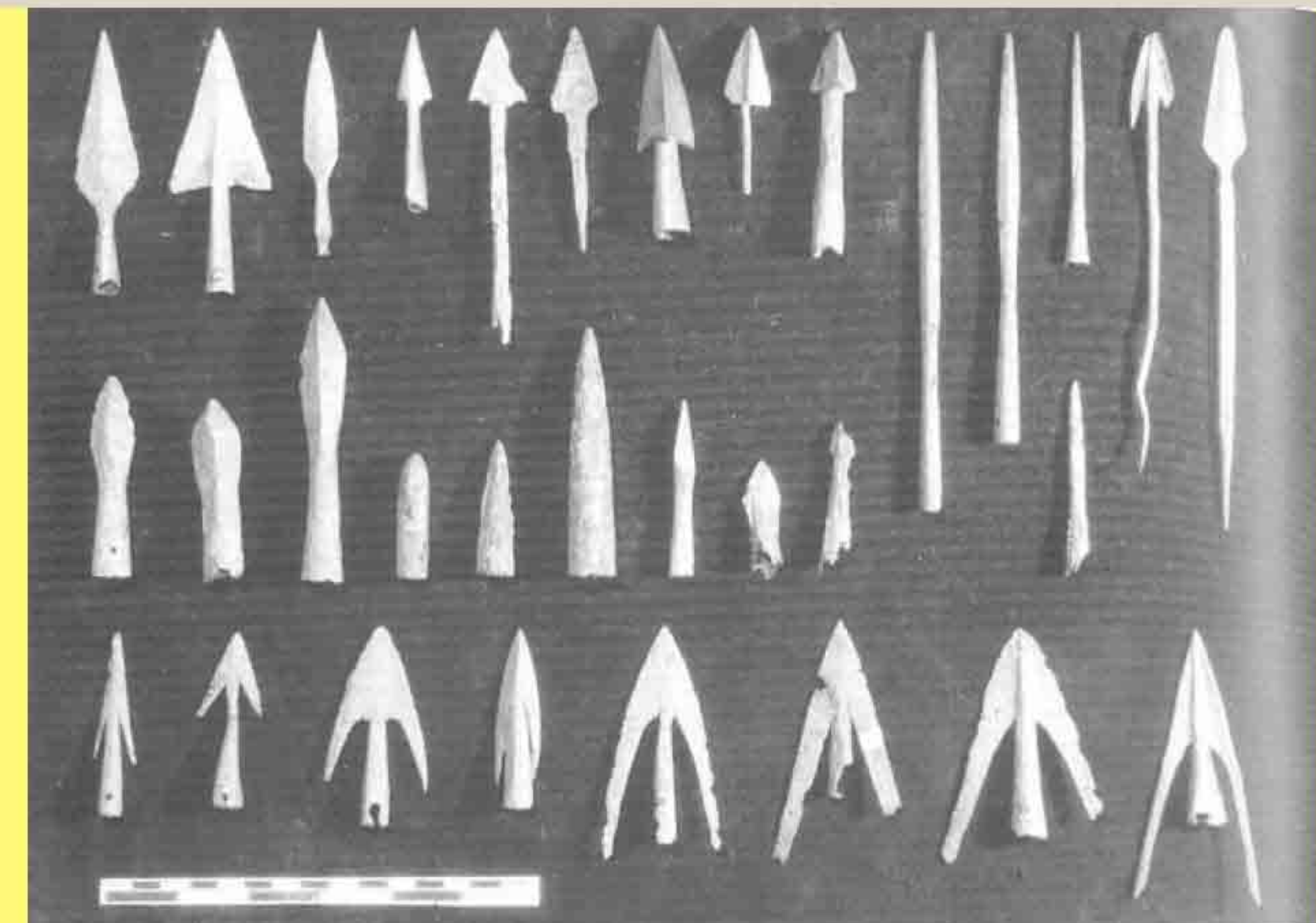
struck by an arrow next to his nose on the left side which
entered at an angle (ex traverso), and after the arrow shaft
was extracted, the head of the aforesaid arrow remained in
the furthestmost part of the bone of the skull for the depth
of six inches.

Probed enlarged and arrowhead extracted

Drain made of honey and flax fibres cleaned daily for
3wks.



Cheshire loyalist, **Sir John Stanley**, wounded by arrow in throat,
asked what should be done about his rebellious home county
“speke rattelynge in the throate” advised "Brene and sle!
(Burn and slay)



Jousting

Tournament Helm (*Stechhelm*), ca. 1500

German (probably Nuremberg)

Steel, brass

The helm formed part of a highly specialized tournament armor worn solely for the *Gesteck*, or German joust, fought with blunted lances.

The object was to break lances or unhorse the opposing rider.

Part of a series of armours kept in the Nuremberg arsenal for use in tournaments.



Hausbuch (Schloss Wolfegg) *The Housebook*. German secular manuscript middle Rhine near Mainz, c 1475



Eye injuries in Jousts

1572 Dall'Agocchie Dell' Arte di Scrimia: the jouster focuses on the eye slits of the opponents helm, not the tip of the lance

Since field of vision so poor Jouster might as well fill in the left eyeslit for protection

Menaguerra: Lo Cavieller: Striking head gets lots of points

Duarte 1st of Portugal: Livro da ensinanca de bem cavalgar:

Risk of eye injury greater because instinct to close eyes on impact.

Impossible to survive injury of a splinter 1 digit that penetrates visor

Diego de Bazin: Lucky Castillian survived



a joust in traditional or "high" armour, based on then-historical late medieval armour (Paulus Hector Mair, *de arte athletica*, 1540s)

Eye injuries in Jousts

1445: Phillipe de Lenoncourt struck in visor by a lance of Gaston de Foix and unconscious and dangling had to be extricated

1448: Frederico de Montefeltro Duke of Urbino 1422-82 lost his right eye and bridge of nose in a joust

Pass of Honour of Suero de Quiñones

Suero de Quiñones (1409-56), *Él del Passo* ("he of the pass") the pas d'armes.

10 Jul-9 Aug **1434** Órbigo bridge 10 companions challenged all passing knights to fight

Swore to "break 300 lances" before leaving

After 166 battles so injured could not continue declared mission complete.

1605: mentioned in **Don Quixote**, satire on chivalry

Diego de Bazán 3" (4 digits) splinter penetrated his visor and eye. Lucky to survive "tis nothing"

Asbert de Claramunt fatally injured by a lance thrust through the eye slit Denied ecclesiastical burial.



Frederico da Montefeltro.
Piero della Francesca.
After the loss of the eye,
had surgeons remove the
bridge of his nose
improved his field of vision
rendered him less
vulnerable to assassination
attempts



Ban **Council of Clermont** (1130) had been lifted by Pope John XXII (1316-34) but in Castille the bishops interpreted the law based on Councils not decrees (extravagants) made by individual Popes

Jousting in Medieval and Renaissance Iberia: By Noel Fallows

King Henry II France (1519 - 1599)

Tournament to celebrate the Peace Treaty of Cateau-Cambresis and marriage of his daughter Elizabeth of Valois to King Philip II of Spain.

Son married to Mary Queen of Scots

Wore the favour of Diane not his wife

Gabriel Montgomery, captain of King's Scottish Guard. The eye of King pierced by a sliver
Surgeons removed the splinter bled the King who lapsed into unconsciousness.

Royal surgeon, **Ambroise Paré**,

Andreas Vesalius, sent from Brussels by King Philip of Spain

Catherine de Medici refused to allow Diane de Poitiers into the room.

July 9th the last rites king died next day aged 40yrs

Montgomery prudently retired to his estate in Normandy.

became a Protestant

Hated by Catherine, had him beheaded in 1574.



Diane de Poitiers by François Clouet.



The jousting match in Paris in 1559, with Henri II of France

Eye injuries in modern jousting

UK: *Daily Mail*.

The 54-year-old former teacher was performing the stunt, at short notice, for a television history program which wanted to re-enact a clash at Rockingham Castle between two mounted knights from the C14th.

fatally wounded when a splinter sheared off from a 2m lance and pierced through his eye and brain

Newly wed lawyer sued Medieval Times themed dinner theater - left eye was irreparably injured when a sliver of metal flew toward him during one of the show's trademark swordfights.

In mediaeval era making the striking sparks was part of the spectacle.

Lord of Saynt Dym sawe hym comyng, he
dashed forth his horse to encountre hym:
eche of them strake other on their helmes,
that fyre flasshed out

(The great Tournament Roll of Westminster Vol1 p49)



End of mediaeval warfare

1537: **Francesco; Marquis of Saluzzo**:

Lt General for King Francis I in Piedmont.

Changed sides to fight for emperor Charles V

Siege of Carmagnola rode out in front of the walls lance at rest.

Expected a harmless barrage of arrows or a challenge to a duel

Instead blasted out of his saddle by close range arquebus.

After the fall of the town the Spanish commander **Del Vasto** had the sniper hanged from the window he had shot out of.

Arquebus accurate 50-90m: Low-velocity firearm

Partial protection by steel-plate armour: usually stop an arquebus ball at long range.

"proof" (test) armour by firing arquebus at a new breastplate.

Close, pierced even the armour of knights.

Led to changes in plate design, three-quarter plate and eventually abandonment of plate armour.



Francis I:
1494 – 1547)



Charles V:
1500 –1558
Holy Roman
Emperor



Forums obsidian.net



Nelson

1793 Captain of *Agamemnon*

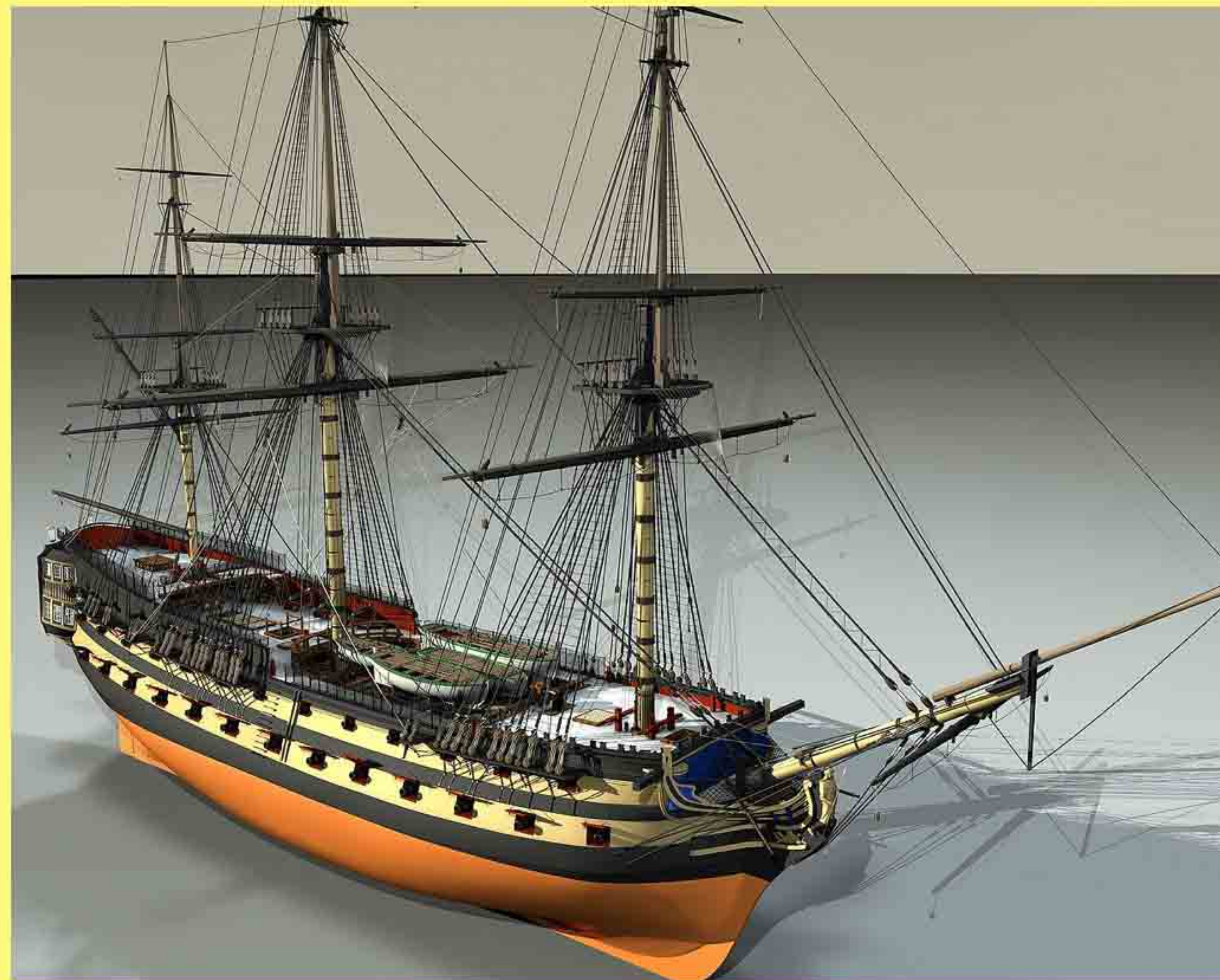
Command of operations against **Corsica**

1794: **Siege of Calvi.**

wounds to his face and right eye caused
by fragments of stone struck from the
works at Calvi by a shot

complains of being nearly deprived of
sight of the right eye.

wrote three weeks later that his eye was
"as far recovered as to be able to
distinguish light from darkness, but as to
all purpose of use it is gone.



Horatio Nelson, by Sir William Beechey,
1801

1794: Two Hurt Certificates were raised on board HMS Victory referring to the loss of an eye,

9 Aug 1794: On board HMS Victory John Harness Physician to the fleet & Michael Jefferson Surgeon attending on shore

10th day of July 1794, while Commanding the Seamen before Calvi, receive a wound of the iris of the right eye which has occasioned an unnatural dilatation of the pupil and a material defect of sight.

Hurt Certificate Private Court of the Examiners, the Royal College of Surgeons, described the results of his eye wound as equal to the loss of an eye

Did not lose the eye nor did he wear an eyepatch.

January 1801 Nelson's doctor was concerned with Nelson's habit of spending much of the day writing letters with only a candle for light and gave him a green eyeshade, made him bathe his eye in cold water each hour and forbade letter-writing and alcohol.



Lord Nelson (1758–1805) (after Arthur William Devis). by G. Cadogan · National Museum of the Royal Navy, Portsmouth

These are to Certify that Captain Horatio Nelson of his Majesty's Ship Agamemnon, now serving on Shore at the Siege of Calvi, was on the 10th day of July last, wounded in the face and right eye, much injured by stones or splinters, struck by shot from the Enemy. There were several small lacerations about the face; and his eye so materially injured, that in my opinion, he will never recover the perfect use of it again.
W. Chambers, Surgeon to the Forces in the Mediterranean. Calvi, August 12th, 1794.



Horatio Nelson by Sir William Beechey 1800

General Mikhail Kutuzov

Charismatic Russian general,

July 1774, Lt--Colonel Kutuzov commanded the Grenadier Battalion of the Moscow Legion. During the battle near the village of Shumy not far from Alushta, he was seriously wounded in the head. The bullet went through left temple and eye and out near the right eye.

The wound was considered to be mortal,

Catherine II awarded St. George Order, Fourth Class

left side facing forward, presumably to hide his disfigured right eye.

He lost the Battle of Austerlitz & Borodino.

Beginning of the end for Napoleon's Grand Armée.

They entered a deserted Moscow,

Kutuzov's scorched earth policy; Russian winter
Napoleon began his long retreat from Russia.

French misery retreating army harassed from the rear.

Of 450,000 French soldiers, only 10,000 returned to France.



George James Guthrie

Distinguished British army surgeon

Aged 26 3000 wounded under his care
after the battle of Albuera,

wrote extensively on gunshot wounds
(1815),

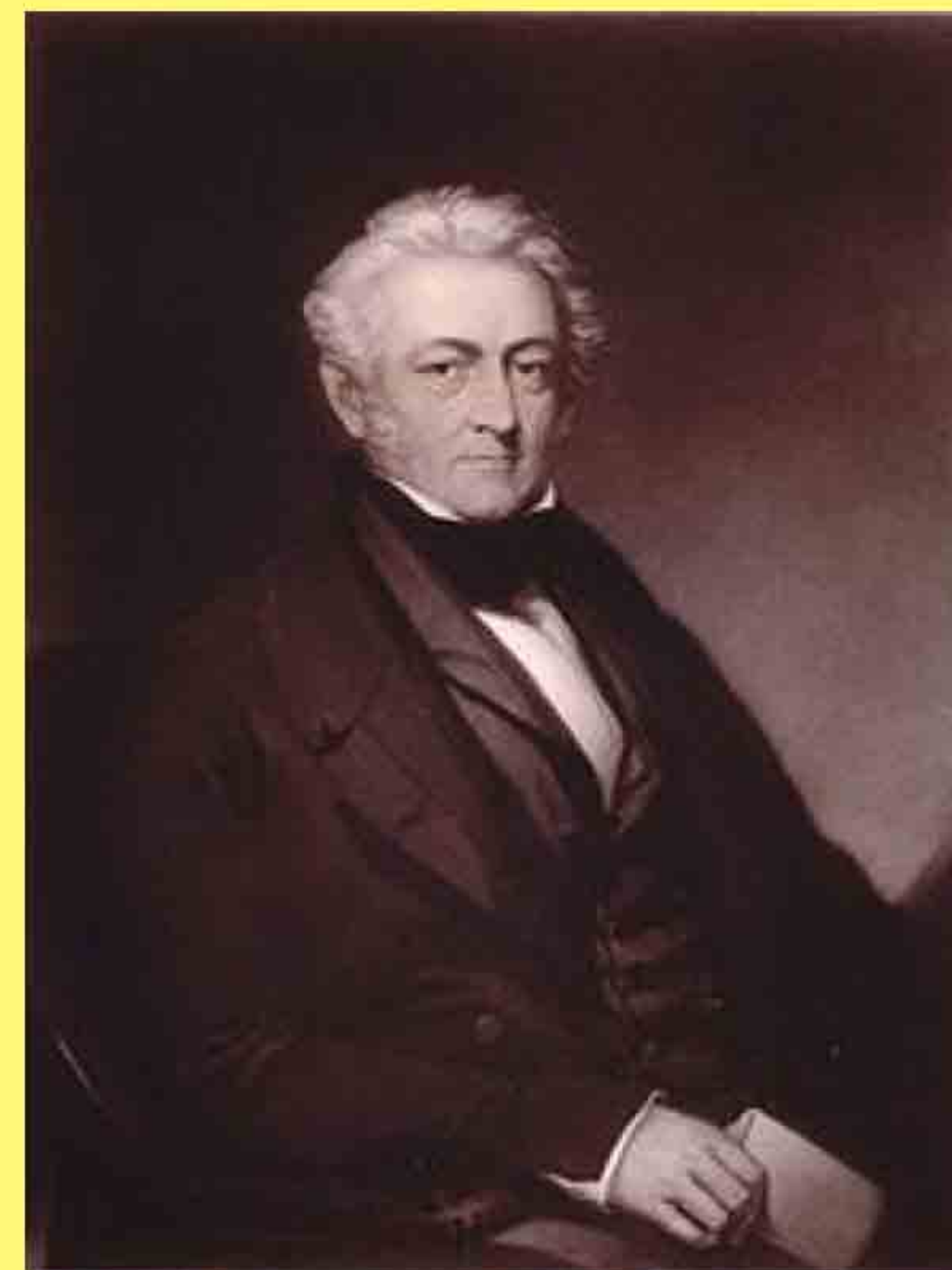
On operative surgery of the eye (1823),

On diseases and injuries of arteries
(1830)

1855: **Commentaries on the Surgery
of War.**

Recommended amputation for
compound limb injuries within 24
hours, accepting a mortality rate of
50%.

Founded the Royal Westminster
Ophthalmic Hospital



No. I.
RETURN of SURGICAL CASES treated, and CAPITAL OPERATIONS
performed, in the General Hospital at TOULOUSE, from April
10th to June 28th, 1814.

DISEASES AND STATE OF WOUNDS.	Total treated.	Died.	Discharged to duty.	Transferred to Bordeaux.	Proportion of Deaths to the number treated.
Head	95	17	25	53	1 in 5 $\frac{1}{2}$
Chest	96	35	14	47	1 in 2 $\frac{3}{4}$
Abdomen	104	24	21	59	1 in 4 $\frac{1}{2}$
Superior extremities ...	304	3	96	205	1 in 101
Inferior ditto	498	21	150	327	1 in 23 $\frac{3}{4}$
Compound fractures ...	78	20	...	49	1 in 2 $\frac{3}{4}$
Wounds of spine	3	3	1 in 1
Wounds of joints	16	4	...	12	1 in 4
Amputations—					
Arm..... 7 }	48	10	...	38	1 in 5 $\frac{1}{2}$
Leg and thigh... 41 }					
Total.....	1242	146	306	790	1 in 8 $\frac{1}{2}$



La bataille de Somosierra 1808: by Louis-François,
Baron Lejeune (1775–1848).

Non combat disease

John Butter (1791-1877)

1814 surgeon to the South Devon Militia, providing the guard at the Napoleonic War Prison at Princetown

1821: founded the Plymouth Eye Dispensary

lost the sight in one eye through ophthalmic rheumatism contracted Millbay Barracks while examining recruits for Crimean War.

In 1856 he became totally blind forced to retire.

Baron Dominique Jean Larrey

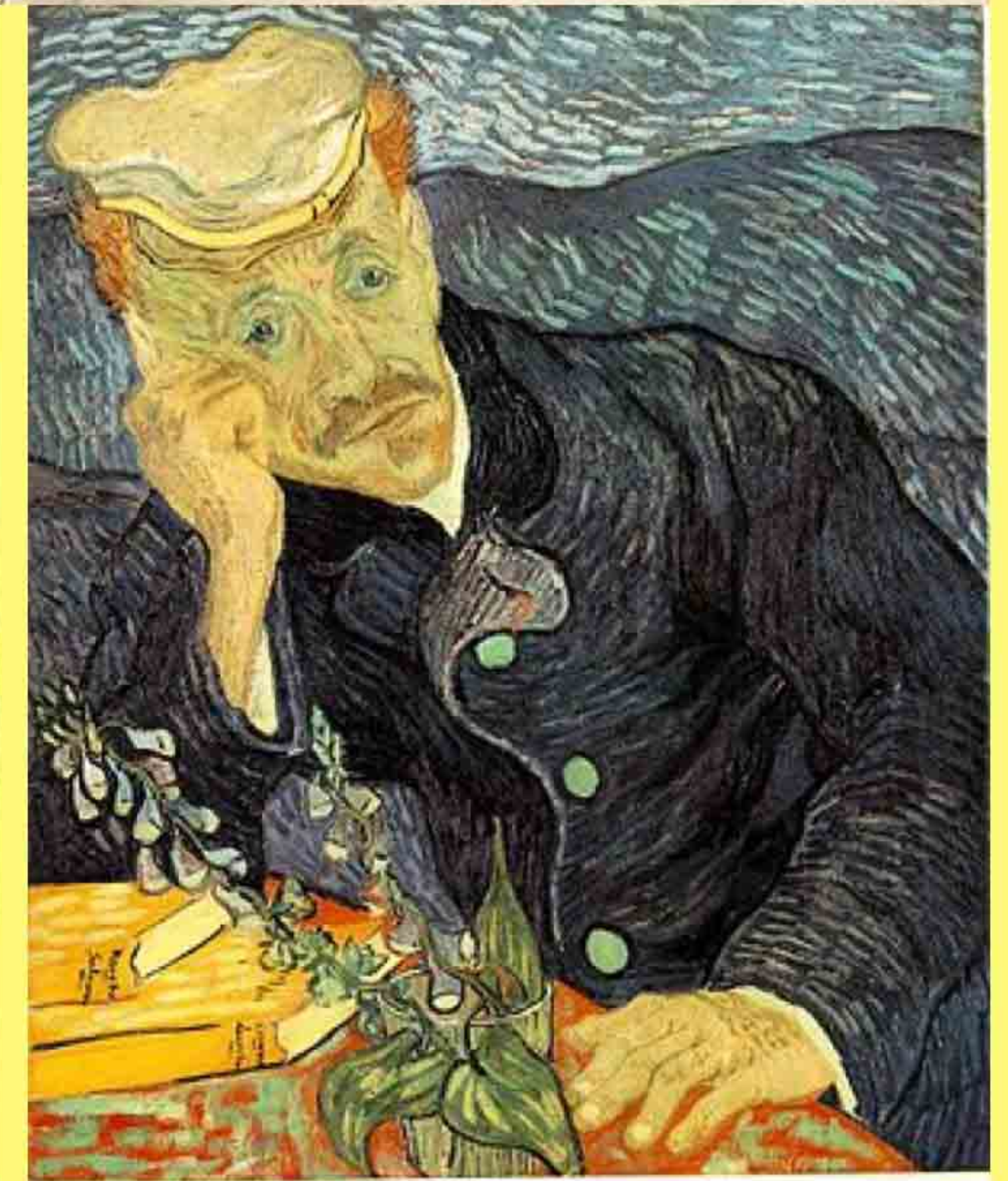
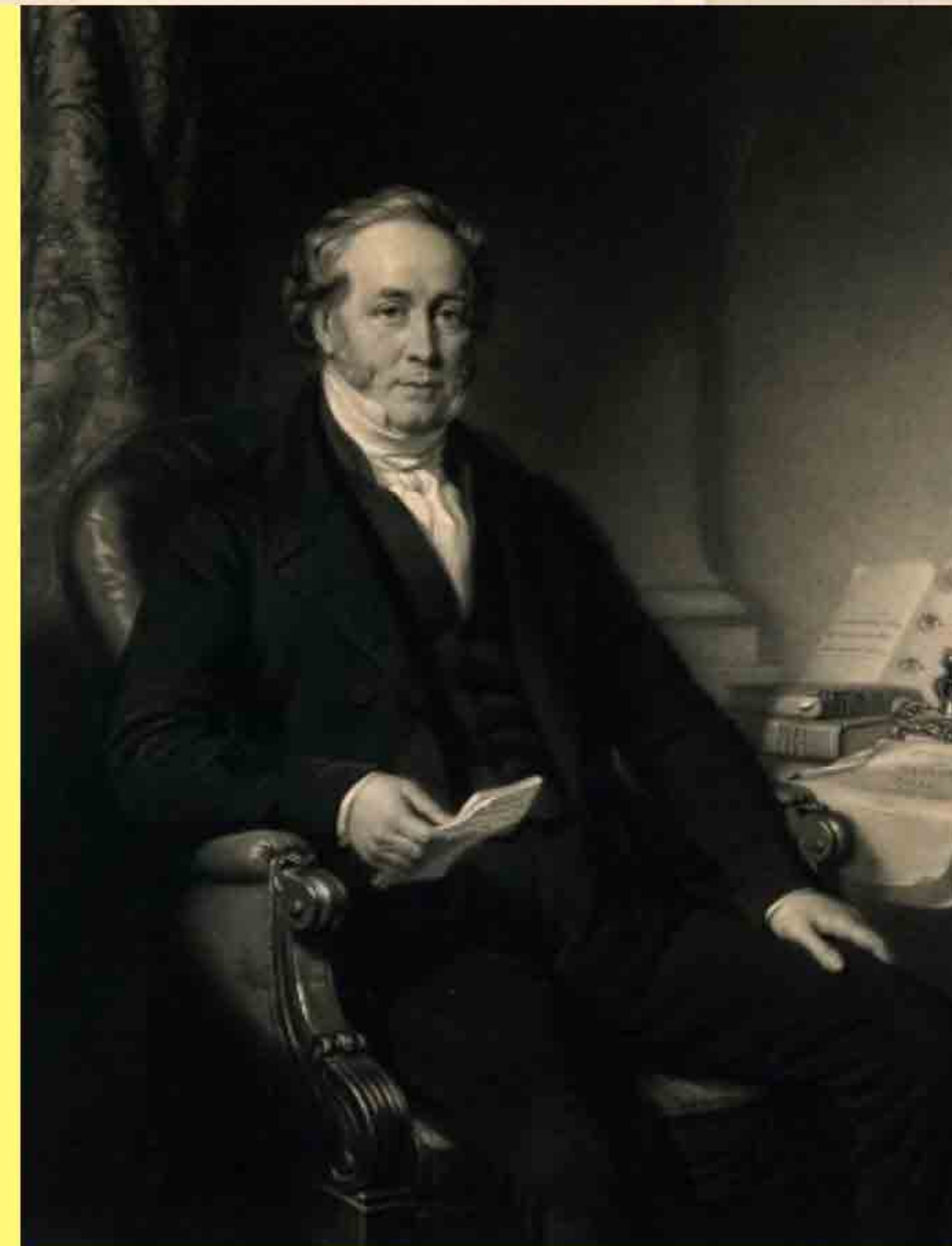
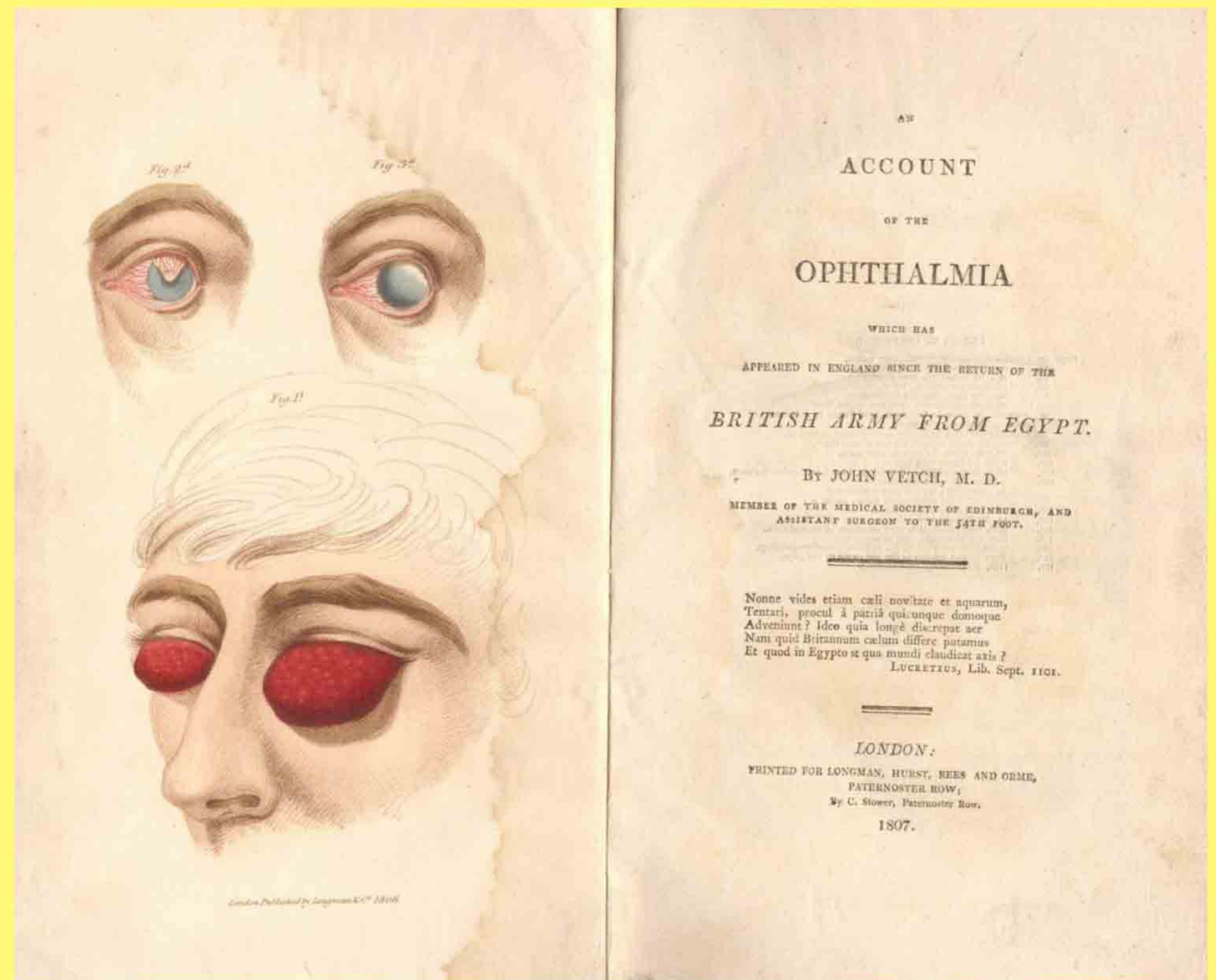
Claimed success with his management and no cases of blindness were reported in the French army.

Superior results than British Army.

Nine years later 2,500 men suffering with trachoma and blindness in the army.

Memoirs of Military Surgery, and Campaigns of the French Armies ..., Volume 1

Paul-Ferdinand Gachet physician of many famous artists who lived in France toward the end of the 19th century. He was van Gogh's last physician, manuscript on the subject of military ophthalmia never published. Only one copy is known to exist.



Eye injuries increasing in frequency

Penetrating eye injury appears to be increasing.

Crimean war

incidence of eye injury was reported as only 0.65% as a percentage of all injuries (British)

1.75% French

US Civil War: 0.5%

Franco Prussian: 0.86%

Russo-Japanese:1904-5 2.22%

WW1: 1917-18: American 2%

Korean 1950-53: 2.8% American:

Arab-Israeli wars of 1967, 1973, 1982 6.7%

Vietnam: 9.1%.

Desert Storm 13%

Unlike in peacetime the ocular injuries of war are bilateral in 25% of cases.



Battle of Balaclava

Private James Olley: 4th Light Dragoons 16yrs old f
'My horse was shot down - I caught one of the horses which was coming back without its rider who had been shot out of his saddle. 'I turned it round facing the enemy - I mounted it and rode down to the Guns, when I was attacked by a Russian Gunner who I cut down with my sword. 'I received a severe wound on my forehead which went through the skull bone.' a bullet from the Russians 'took away' his left eye, adding: 'I still rode on and fought through the lines of the enemy.'

hardship on his return to England, begging with a placard around his neck in the streets

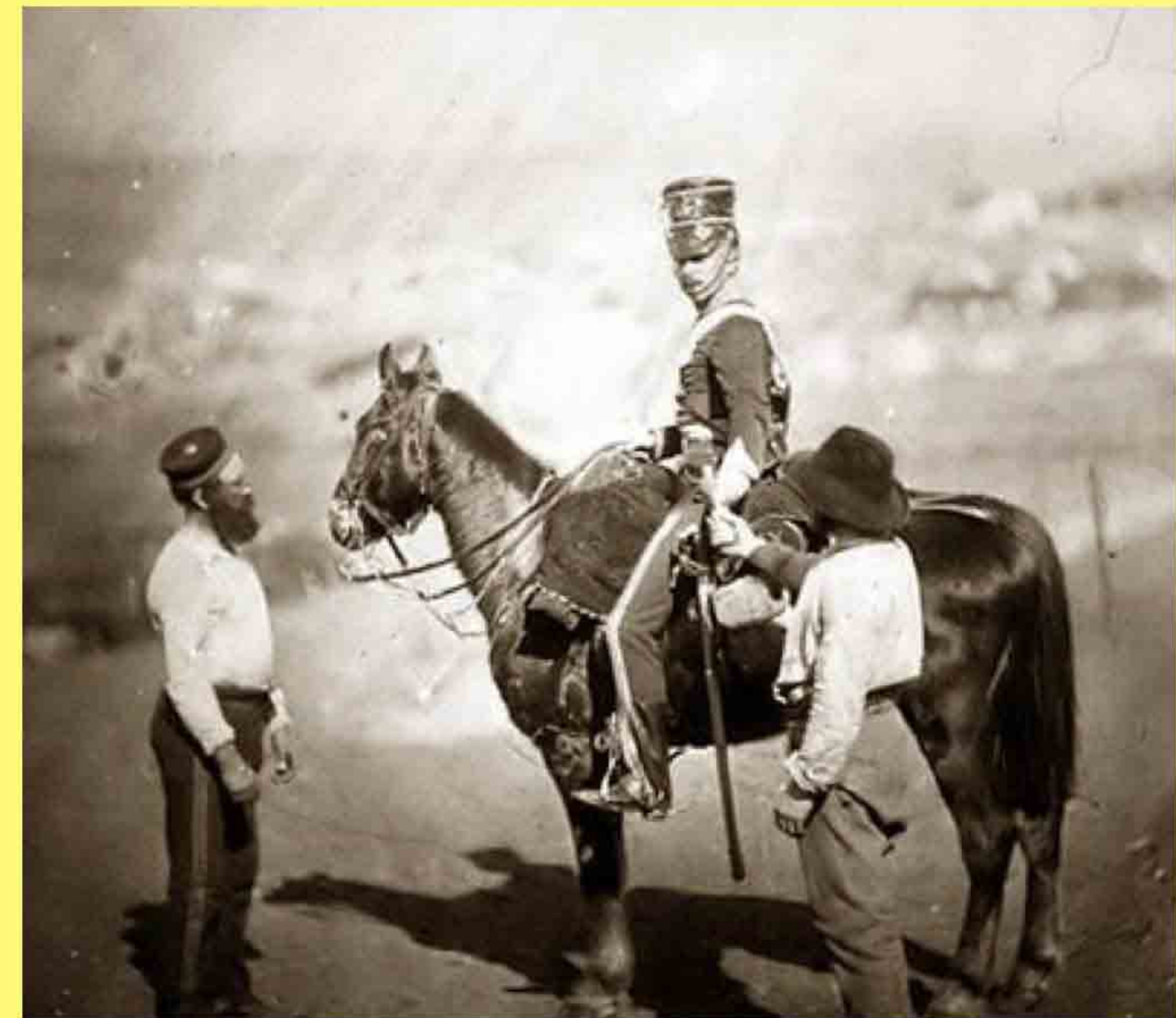
Robert Brudenell Carter

London Hospital. M.R.C.S. 1851; L.S.A; F.R.C.S.

Staff surgeon in Turkey during War.

Became authority on ophthalmology.

Ophthalmic surgeon to St. George's and other hospitals



*The Charge of the Light
Brigade*

*the night before the battle, I was
Guard - On the morning of the
day I was on outpost duty. At*



James Collinson (1825 - 1881)

Returning Home (Home Again) Tate Gallery:

Painted in the final year of the Crimean War.

Popular demand for staged homecomings.

soldier of Coldstream Guards returning home to his rural cottage.

When exhibited caption explained that the soldier had been discharged because of an accident leading to blindness.



American War Between the States

1861-5

Jefferson Davis, President of the Confederate States

Seriously ill winter of 1857-1858, relapse of a chronic inflammation of his left eye.

Photos of Davis are in right profile, hiding his left eye.

1858, Ophthalmologists—Robert Stone and Isaac Hayes.

“ulceration of the cornea,” “abscess of the eye,” and “hypopyon”. couldn’t see why eye had not already burst.

Herpes simplex kerato-uveitis,

Minie ball injuries

Confederate soldiers with eye injuries specialty ward established at Forsythe, Georgia, in 1864,

Bolling A. Pope: Ward director founds Eye hospital Athens, Georgia.

Severely wounded eligible for a monthly pension of \$6.00.

awarded to amputees and those blinded in both eyes.

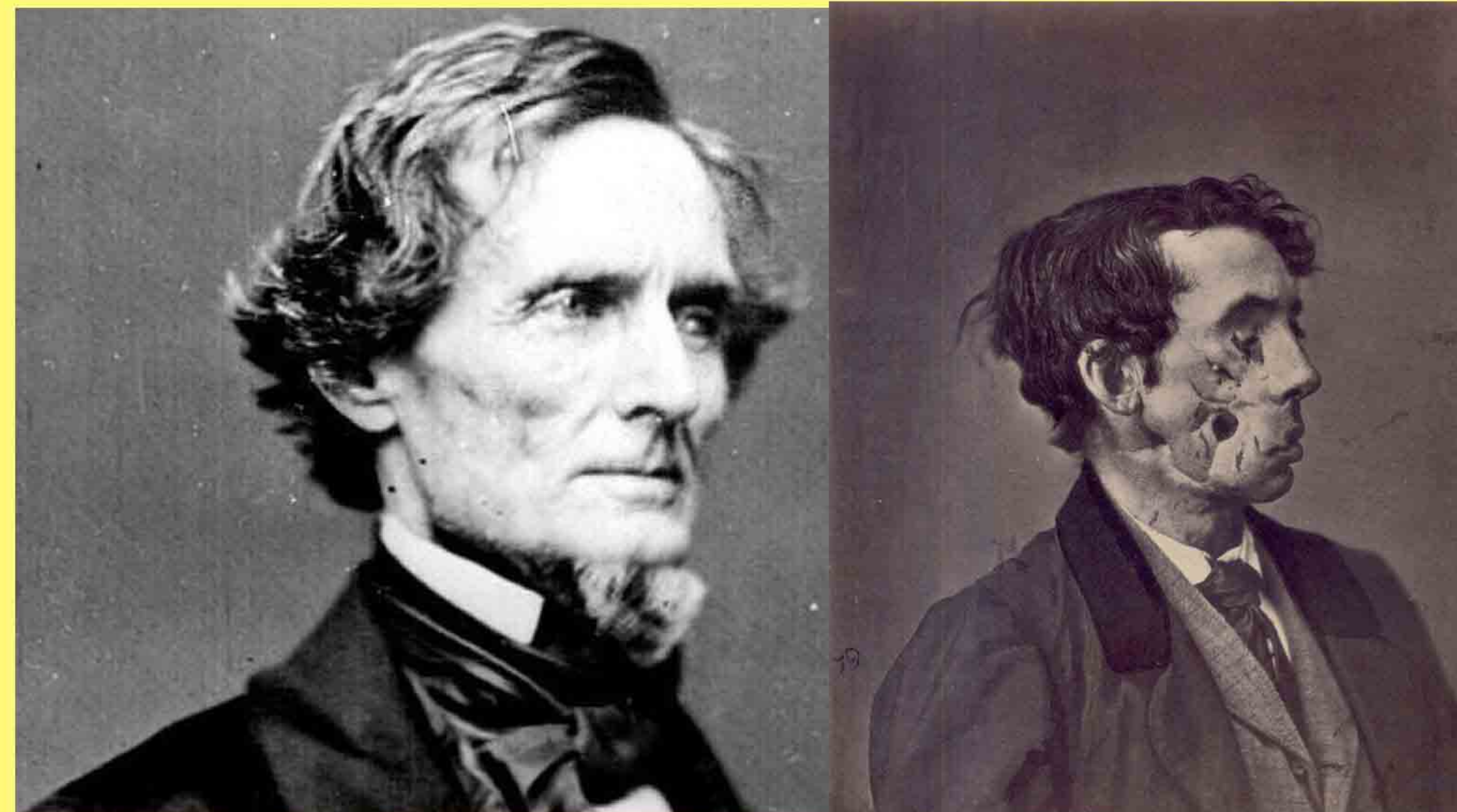
Great advances in prosthetic eyes as a result of the War.

Eye injury and loss less frequent than loss of limbs.

Between July 16, 1862, and May 4, 1867

49 prosthetic eyes, compared to 61 hands, 2,391 arms, 4,095 legs, and 14 feet

However enucleation crude and often lead to death



soldier from New York before and after his battlefield wounds to the eyes were treated. Dr. Bontecou: surgeon in charge at Harewood U.S. Army Hospital in Washington, D.C. **CREDIT: Dr. Stanley B. Burns**

Ophthalmic Injuries And Civil War Medicine: Richard Hertle

WWI

Sir Adrian Carton De Wiart

born into an aristocratic family in Brussels,
May 1880

First World War broke out, De Wiart was en route to British Somaliland where a low level war was underway against the followers of **Mohammed bin Abdullah**, "Mad Mullah".

De Wiart had been seconded to the Somaliland Camel Corps.

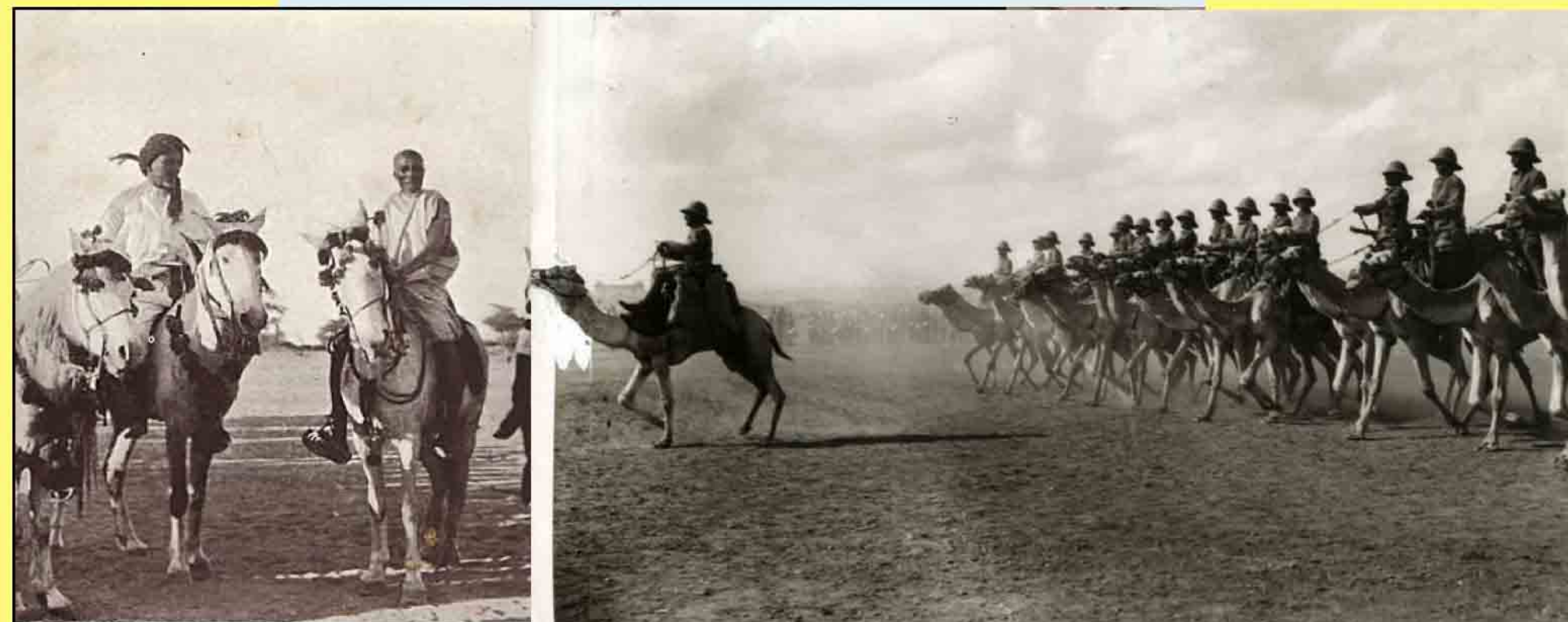
In an attack upon an enemy fort at Shimber Berris, shot twice in the face, losing his eye and also the portion of his ear.

He was awarded the DSO in May 1915

Trench warfare, increased facial injuries:
Dr. Fred Albee, American surgeon
"The soldiers failed to understand the menace of the machine gun,"



Sir Adrian Carton de Wiart,
by Sir William Orpen



Tank Warfare

September 15, 1916: Somme Offensive,
British Mark I tank, crushed paths through barbed
wire entanglements,

9/49 tanks reached German trenches. drove over
the tops of trenches up to nine feet wide and laid
waste

Reversed Bullets: normal slugs twisted off,
additional propellant reinserted reversed into the
casing.

fired from standard Mauser rifle but would not
shatter.

At very short range could penetrate a tank's armor,
if they hit head-on, about 30% of the time, killing
or disabling tank crew members.

a spray of metal fragments, inside the tank.

'splash' - molten lead from the core of spent bullets
that found its way through gaps in the armour to
burn exposed skin and damage eyes.

Goggles with a chain mail face mask.

worn by British tank drivers Battle of Cambrai in
1917.



First anti-tank weapons

1917: British Mark IV tank thicker armour
No bullet could effectively penetrate.

Battle of Cambrai: Nov 20, 1917 476 massed tanks, six infantry divisions and 14 Royal Flying Corps squadrons tore a hole seven miles wide through the German Hindenburg Line.

1918: **Mauser T-Gewehr**, history's first anti-tank rifle.

single-shot bolt-action rifle fired a 13.2-mm (.525-in) armor-piercing bullet with an effective range of 500 meters

penetrate the armor of any tanks.

a firer and a loader; the recoil was known to break collar bones and dislocate shoulders.

Almost 16,000 were made during the war.



British officers with a captured German anti-tank rifle.



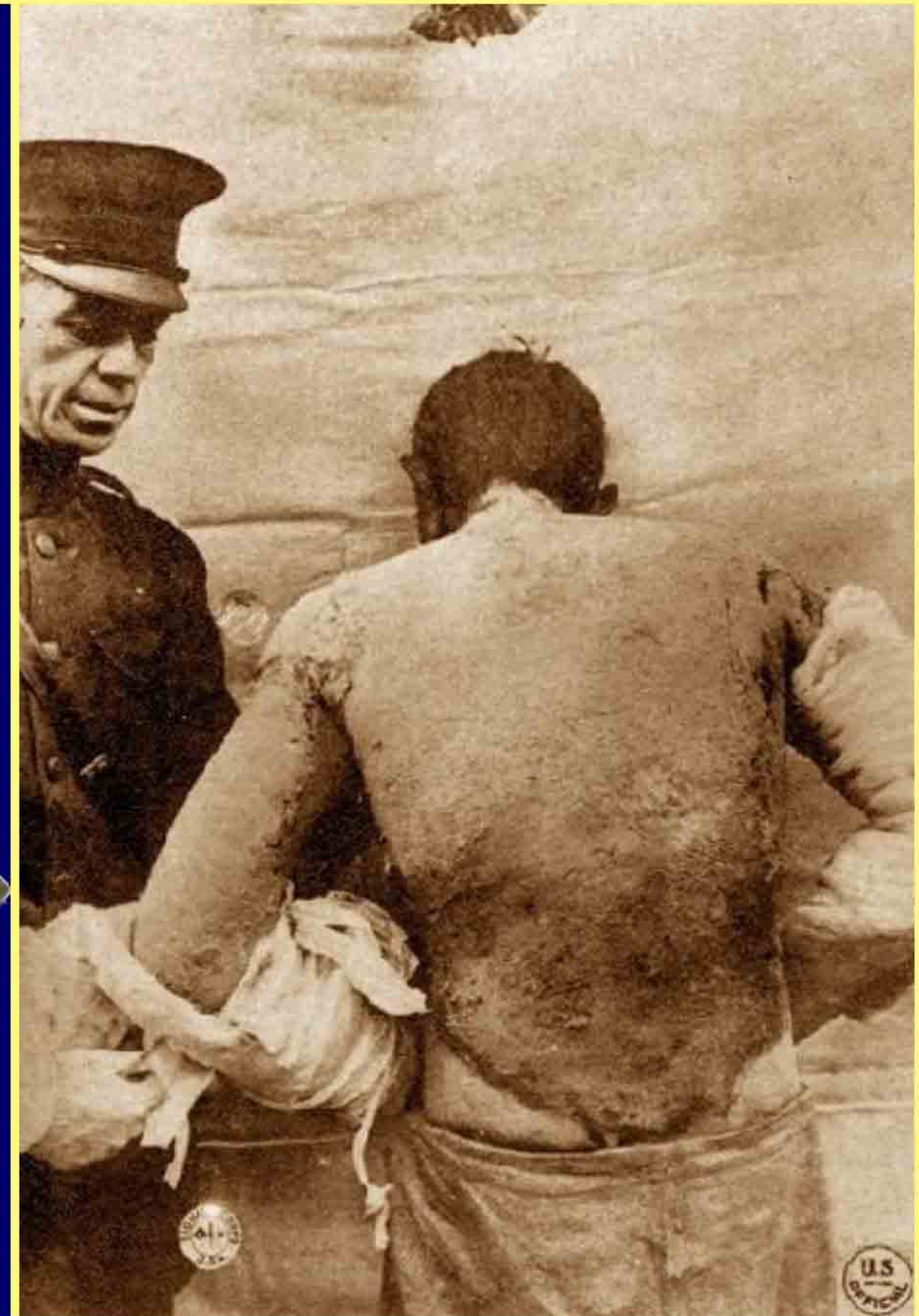
Armour-piercing K bullets, hardened steel core, specifically designed for use used against sniper shields, effective as reversed bullets up to about 100 yards



U.S. Marines in action at the Battle Belleau Wood in June 1918. Tom Lovell



WWI Gas Mask German lightweight chamois cloth or leather. Two clear lenses are surrounded by a heavy duty metal frame.



American soldier with life-threatening mustard gas burns in 1918.

John Singer Sargent

Son of eye surgeon at the Wills Eye Hospital in Philadelphia 1844–1854.

His wife Mary (née Singer), suffered a breakdown, after the death of their 2 yr old daughter.

Emigrated; small inheritance and savings, generally avoided society and other Americans

1856: John born in Florence

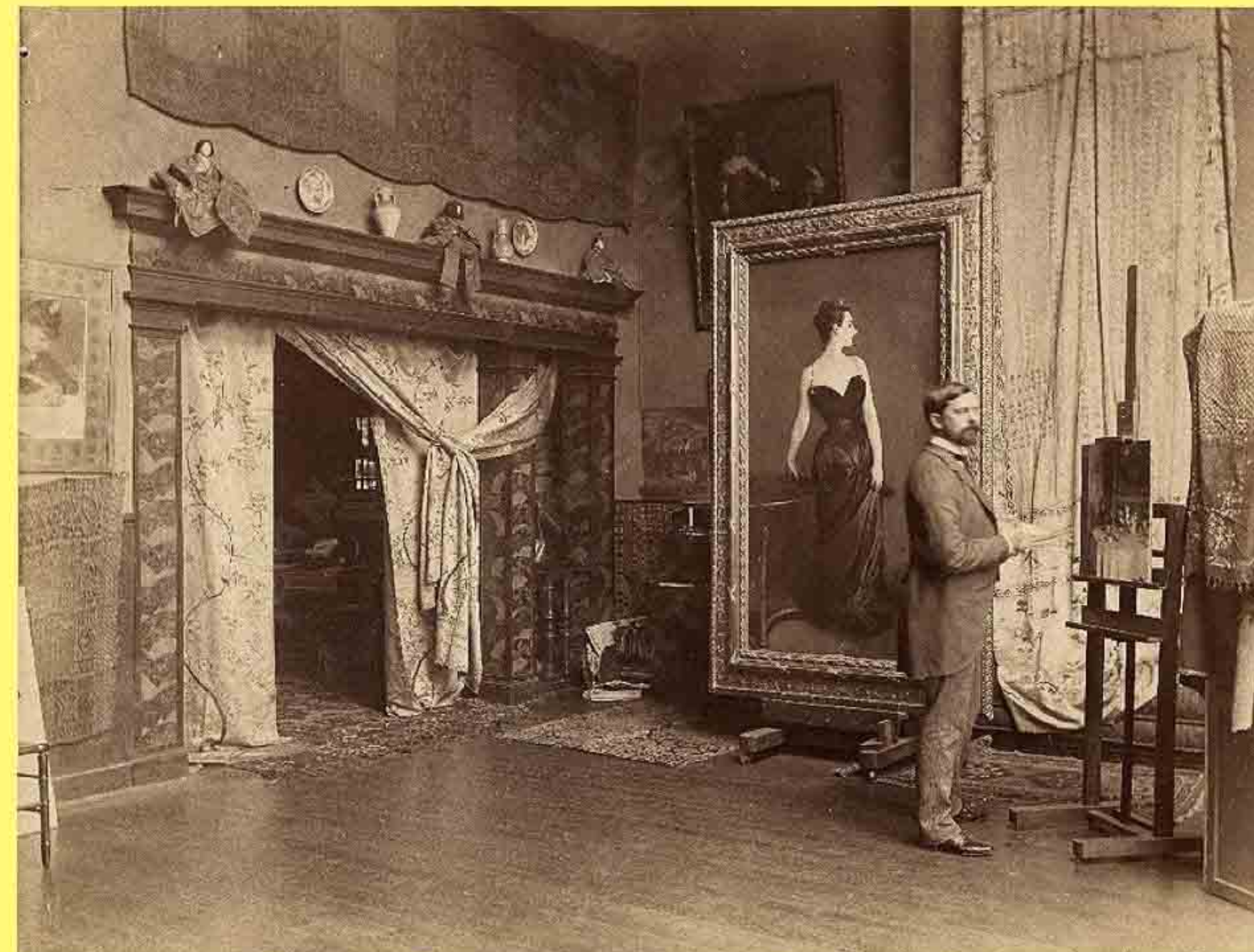
Unruly: Educated at home then in École des Beaux-Arts

1884: Portrait of Madame X (Madame Pierre Gautreau) (1884) Controversial

1915, "I suppose it is the best thing I have done."

Shocks Parisian Society at the 1884 Salon

Sargent moves to London



New Orleans-born high society Judith Avegno (Madame Pierre Gautreau)

strapless dress except slender gold threads; money and sex
Sargent shocks with the secrets of high life, Manet, low life

Tonks & Sargent war artists in France

After tea we heard that on the Doullens Road at the Corps dressing station at le Bac-du-sud there were a good many gassed cases, so we went there. The dressing station was situated on the road and consisted of a number of huts and a few tents. Gassed cases kept coming in, lead along in parties of about six just as Sargent has depicted them, by an orderly.

They sat or lay down on the grass, there must have been several hundred, evidently suffering a great deal, chiefly I fancy from their eyes which were covered up by a piece of lint.

Sargent was very struck by the scene and immediately made a lot of notes.'



"Study for Gassed Soldiers," charcoal and graphite
John Singer Sargent. 1918.
Yale Center for British Art

Gassed

Sargent, John Singer (RA) (1856- 1925)



Pieter Bruegel the Elder.
The Parable of the Blind, 1568.

1914 the majority of transport horse-drawn
Wounded managed by 'chain of evacuation'
moved back series of relays;
the regimental aid post,
the collecting post,
the advanced and main dressing station,
the casualty clearing station
finally the general hospital in France or
England via hospital ship.

Casualty Clearing Stations expanded into
forward areas could take up to 1,000 pts.
From the mud of battle to first-aid station; to
field hospital; to evacuation, to Paris or to
England

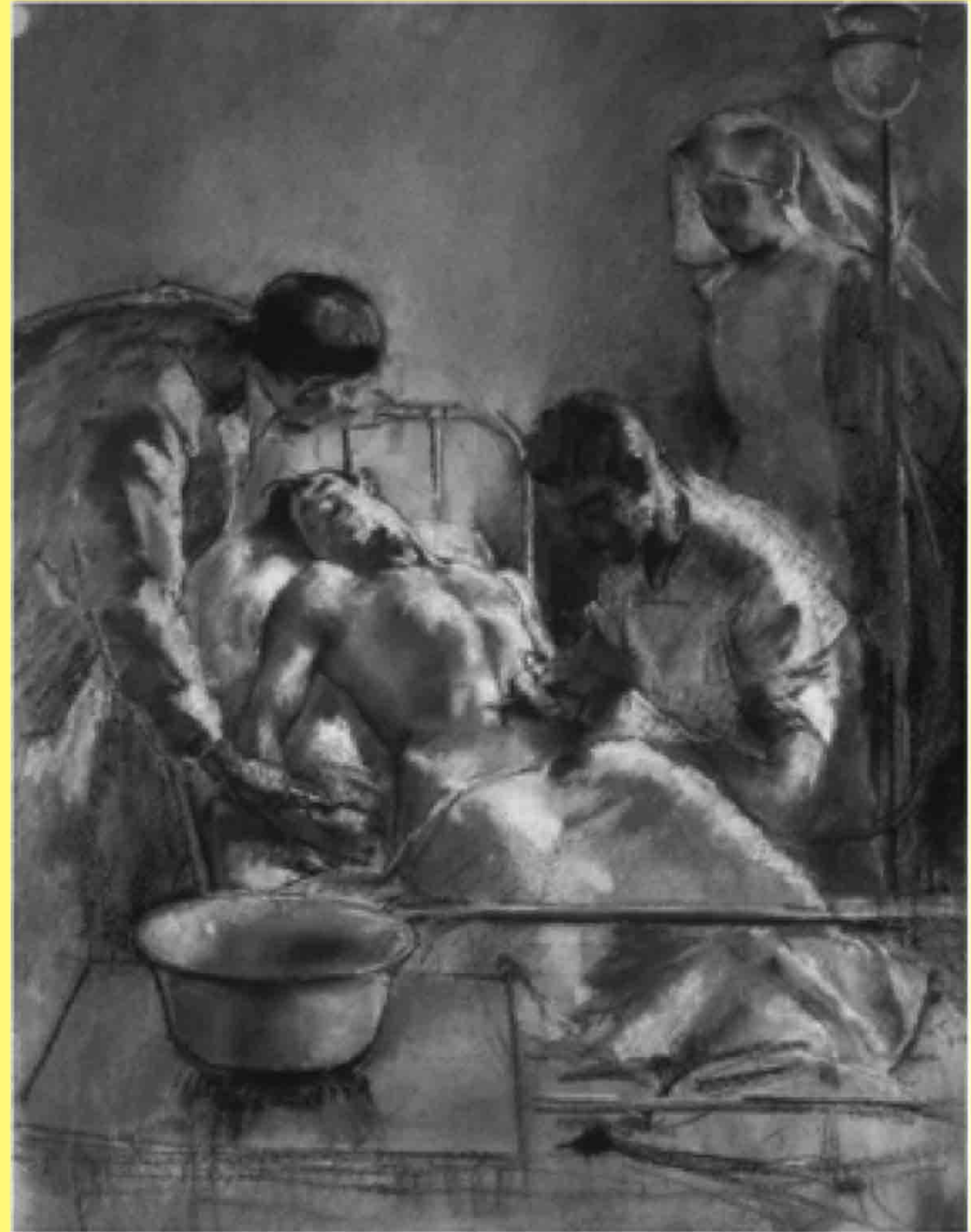


Army Medical Services Museum

Most field surgeons, faced with blasted faces, simply stitched together the edges of wounds to stop infection.

As wounds healed and scar tissue contracted, the skin of men's faces would become twisted and not only disfiguring, but disabling.

Men returned from the horrors of the front terrified to face their loved ones.



Saline Infusion:
An Incident in the British Red Cross Hospital Arcen-Barrois, 1915

Enid Bagnold, volunteer nurse (Later author of *National Velvet*),

"He lay with his profile to me,
Only he has no profile, as we know a
man's.

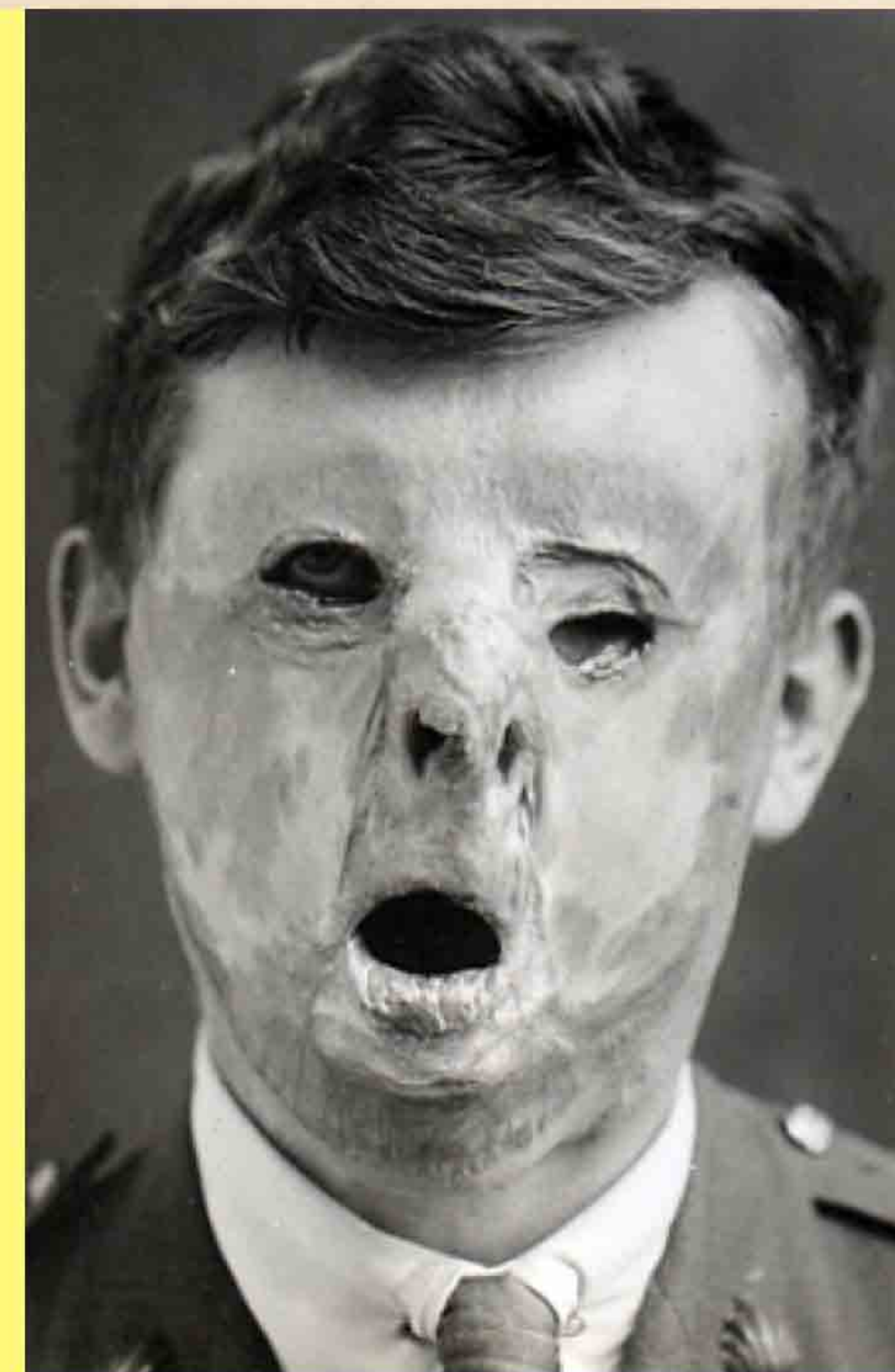
Like an ape, he has only his bumpy
forehead and his protruding lips—the
nose, the left eye, gone."

15% of those who survived had received
facial injuries. Gunshot wounds of the
face gross soft tissue damage and
shattering of the underlying bones.

loss of both bone and overlying soft
tissue, extensive difficulties for repair.

Multiple operations inevitably followed.

treatment to restore adequate function
and replace missing tissue to improve the
appearance took many months or years.



Queen's Hospital

The Queen's Hospital was opened in 1917 in the grounds of Frogmal House.

It comprised a group of prefabricated buildings, and initially provided pioneering plastic surgery to First World War soldiers with facial injuries, under the auspices of Sir Harold Gillies, until 1925.

First World War's major centre for facial and plastic surgery,

Hospital and its associated convalescent hospitals provided over 1,000 beds, and between 1917 and 1921 admitted in excess of 5,000 servicemen.

Medical staff contingents from Great Britain, Canada, Australia and New Zealand.

Each detachment removed its records after the war
Canadian records have disappeared.

New Zealand records saved by Sandy Macalister,
Professor of Oral Surgery Dunedin

British records (the Gillies Archive) Queen Mary's
Hospital, almost untouched, since 1925

Saved by Dr Bamji: Rheumatologist



THE QUEEN'S HOSPITAL "FROGMAL," SIDCUP. Showing Plastic Theatre.

Pioneering surgery

Sir Harold Gillies NZ born Father of plastic surgery
St Bartholomew's Hospital

1908-1909: House Surgeon, 32yr old surgeon in London as war began,

Serve in field ambulances in Belgium and France.

Observed the renowned plastic surgeon, Hippolyte Morestin, and dentist Charles Auguste Valadier photographs of techniques used by German surgeons.

“The uglier the scar the more honourable the wound’
specialize in facial reconstruction.

Plastic surgery, crude, not aesthetic.

Developed techniques, still used in modern plastic surgery:

1920: '**Plastic Surgery of the Face**'

WW2: responsible for setting up plastic surgery units throughout Britain.

1946, sex reassignment surgery from F-M on Michael Dillon.

1951 male to female using a flap technique on Roberta Cowell

1957 '**The Principles and Art of Plastic Surgery**', still a major work on this subject.



The Plastic Theatre, Queen Mary's Hospital, 1917.

Harold Gillies: seated on the right

11,572 major facial operations by the time the war ended

"Unlike the student of today, who is weaned on small scar excisions and graduates to harelips, we were suddenly asked to produce half a face."

Henry Tonks

1862 – 1937: born in Birmingham. Clifton College, medicine at Brighton and London Hospital (1885–1888).

1888 he studied under **Frederick Brown** at Westminster School of Art in the evenings.

1918 to 1930: Slade Professor of Fine Art
Paul Nash, recalled Tonks' withering manner:

In cold discouraging tones he welcomed me to the Slade. It was evident he considered that neither the Slade, nor I, was likely to derive much benefit.

Official War Artist accompanied John Singer Sargent on tours of the Western Front.

August 1918, they both witnessed a field of wounded men near Le Bac du Sud, Doullens, which became the basis for Sargent's , *Gassed*.



a qualified surgeon, from 1916 to 1918, Tonks worked for Harold Gillies producing pastel drawings recording facial injury cases at Aldershot and the Queen's Hospital, Sidcup

Tonks wrote to art critic D.S. MacColl:

‘I am doing a number of pastel heads of wounded soldiers who had had their faces knocked about.

A very good surgeon called Gillies who is also nearly a champion golf player is undertaking what is known as the plastic surgery necessary. It is a chamber of horrors, but I am quite content to draw them as it is excellent practice’

worked with artists who created likenesses and sculptures of what the men had looked like before their injuries, strove to restore a mutilated man's original face.

at Aldershot and Sidcup



Portrait of Gunner William Cholmondeley by Henry Tonks, 1916-1918. patients treated by Harold Gillies at Queen's Hospital, Sidcup,. Frederick Cholmondeley was wounded in 1917 and was still undergoing surgical operations in 1922.

Second Lieutenant Henry Lumley

Pilot in the Royal Flying Corps.

July 1916. major burns to his face

Admitted to QMH in Oct 1917.

Despite several operations it proved impossible to make a successful skin graft to cover the burns.

Lumley died on 11 March 1918, a few days before his 26th birthday.



Observer 2nd Lieut **Norman Eric Wallace** Canadian artillery officer attached to the RFC terrible facial burns when crashed in France in September 1917.

Pilot Payne died.

shoulder pedicle tube to chin and nose
Grafts from his buttocks to replace the
scarred skin on the facial cheeks

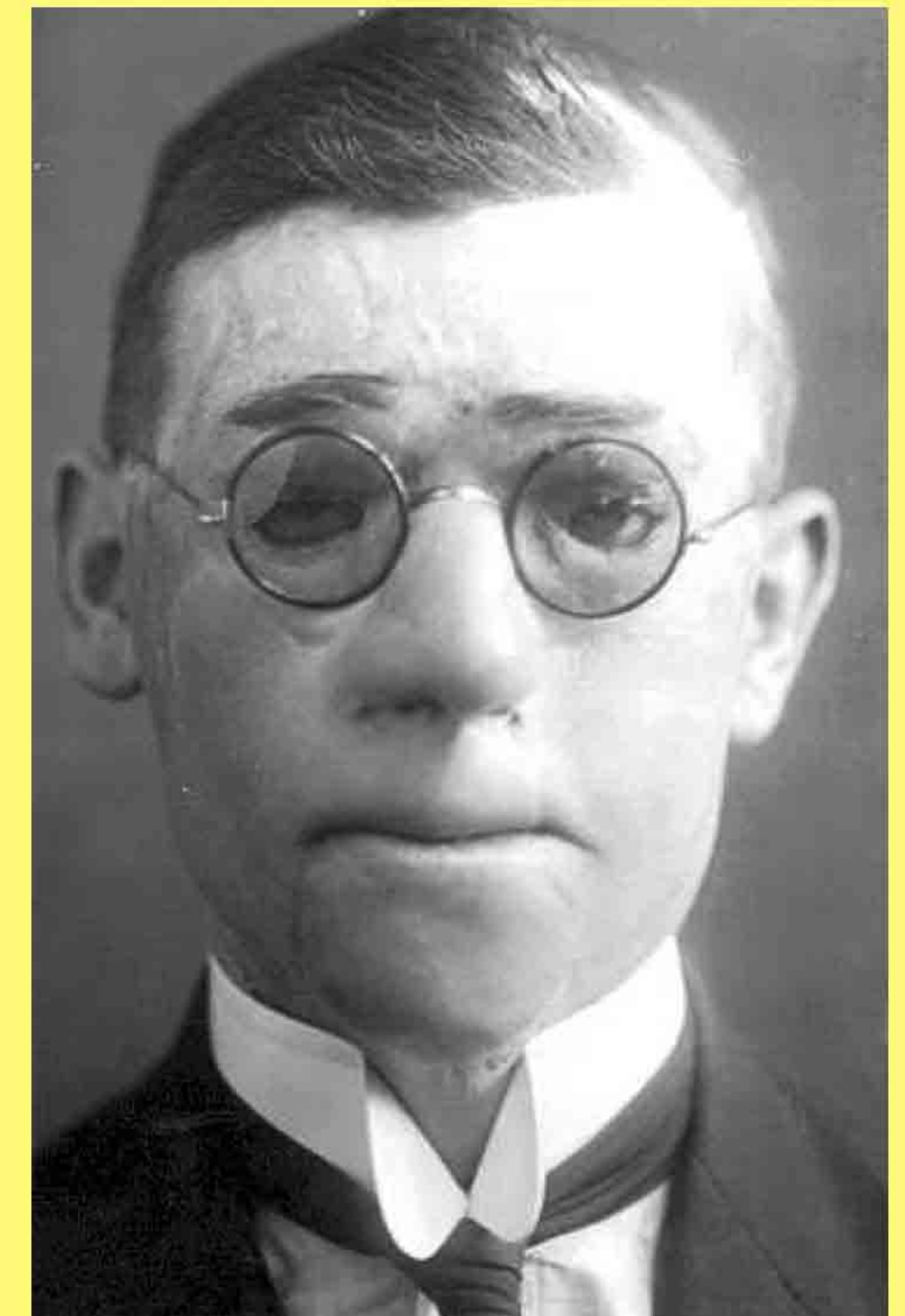
years in surgery, married one of the
nurses, widowed a year later.

Wales to recuperate

Lake Hotel, Llangammarch Wells,
Breconshire.

Grandson of owner recalled In 1925 a
RFC Pilot came to stay at the hotel for a
weekend.

He stayed for 35 years.



Techniques used bones and cartilage to reconstruct faces

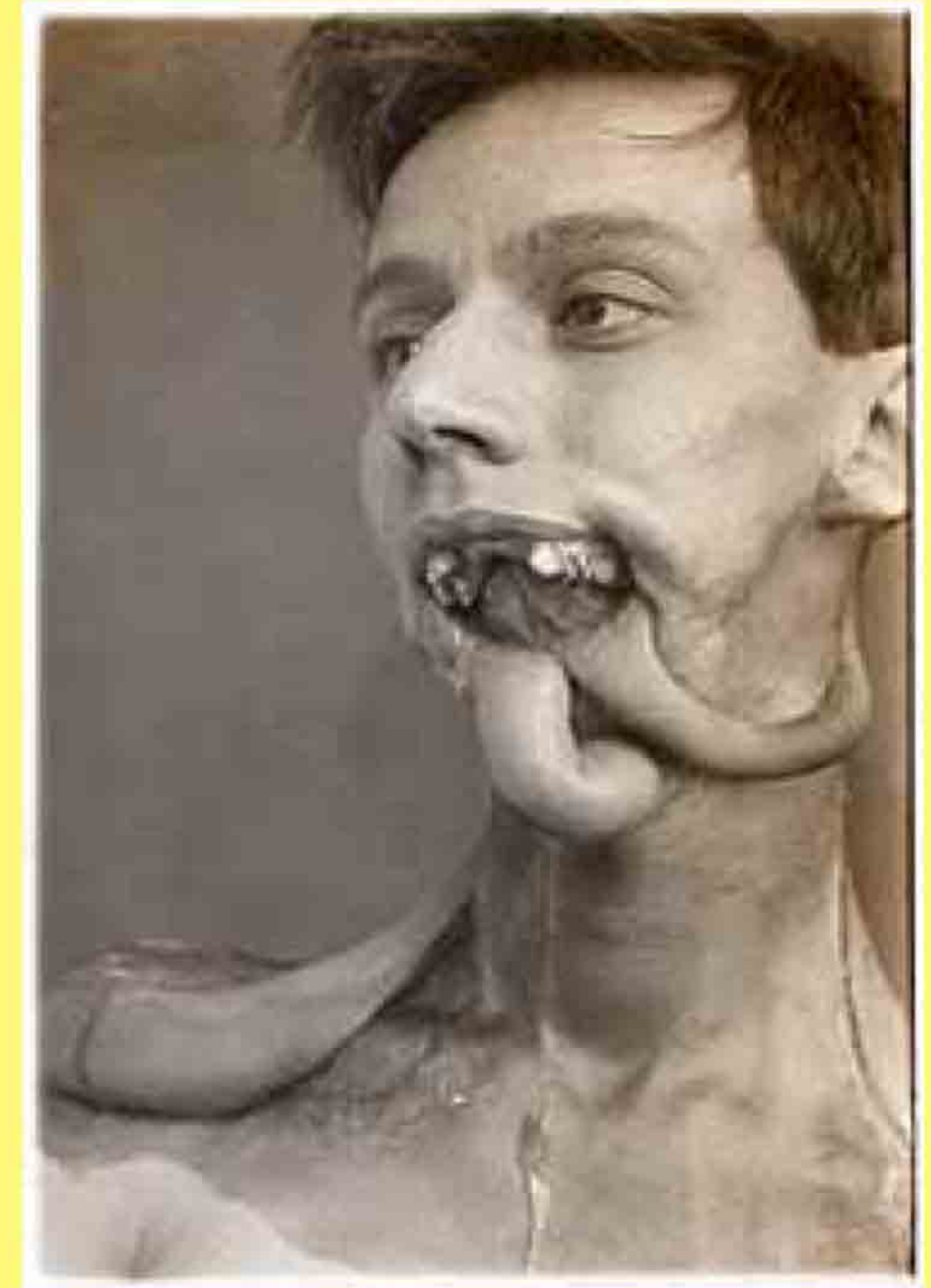
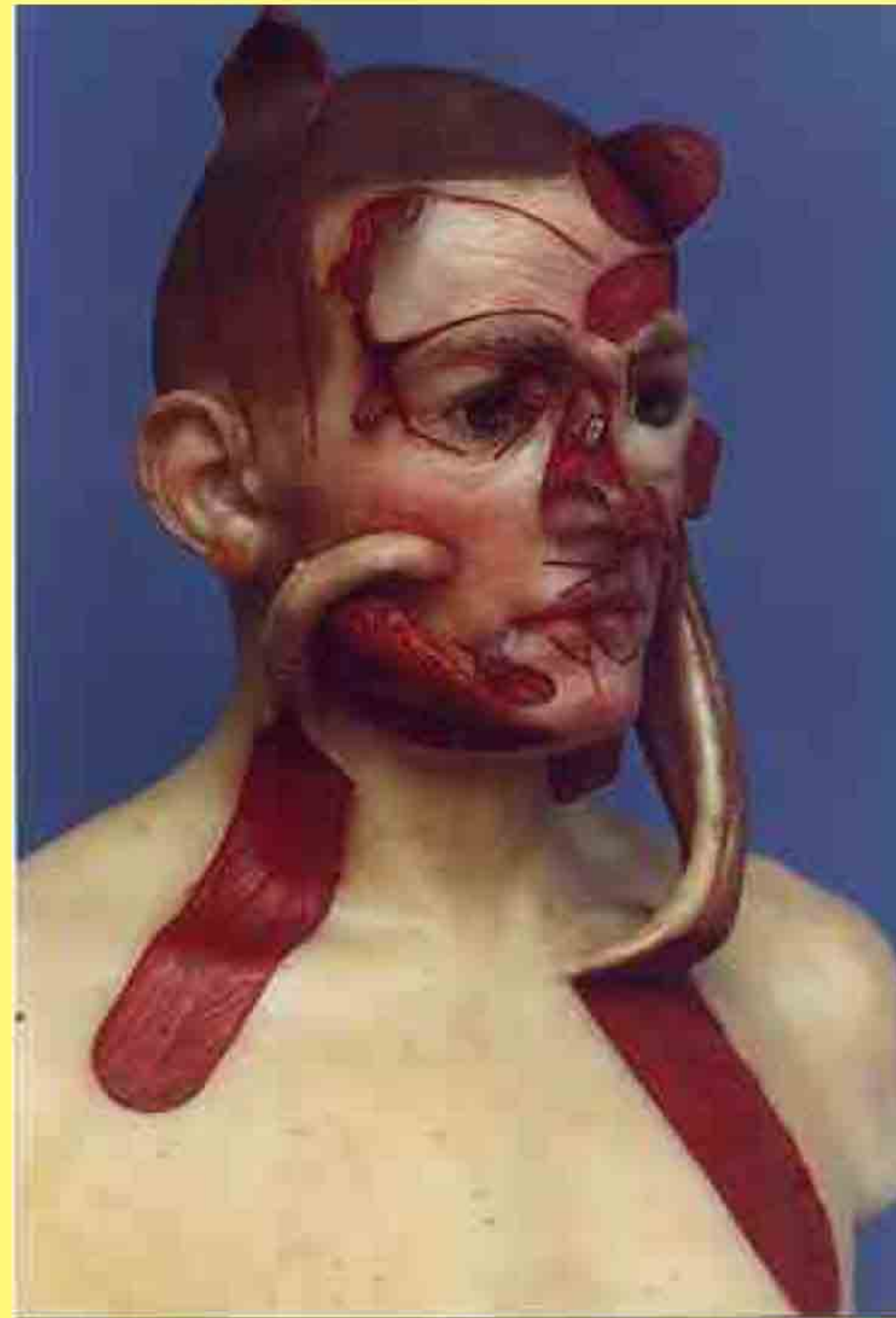
‘tubed pedical’ method of skin grafting, in the days before skin grafts were possible.

Multiple surgeries were required and the patients were kept in hospital for years at a time

“Contemporary society glorified its war dead but recoiled from its war wounded.

In Sidcup, benches were painted a different colour to warn locals that disfigured hospital patients might sit there.”

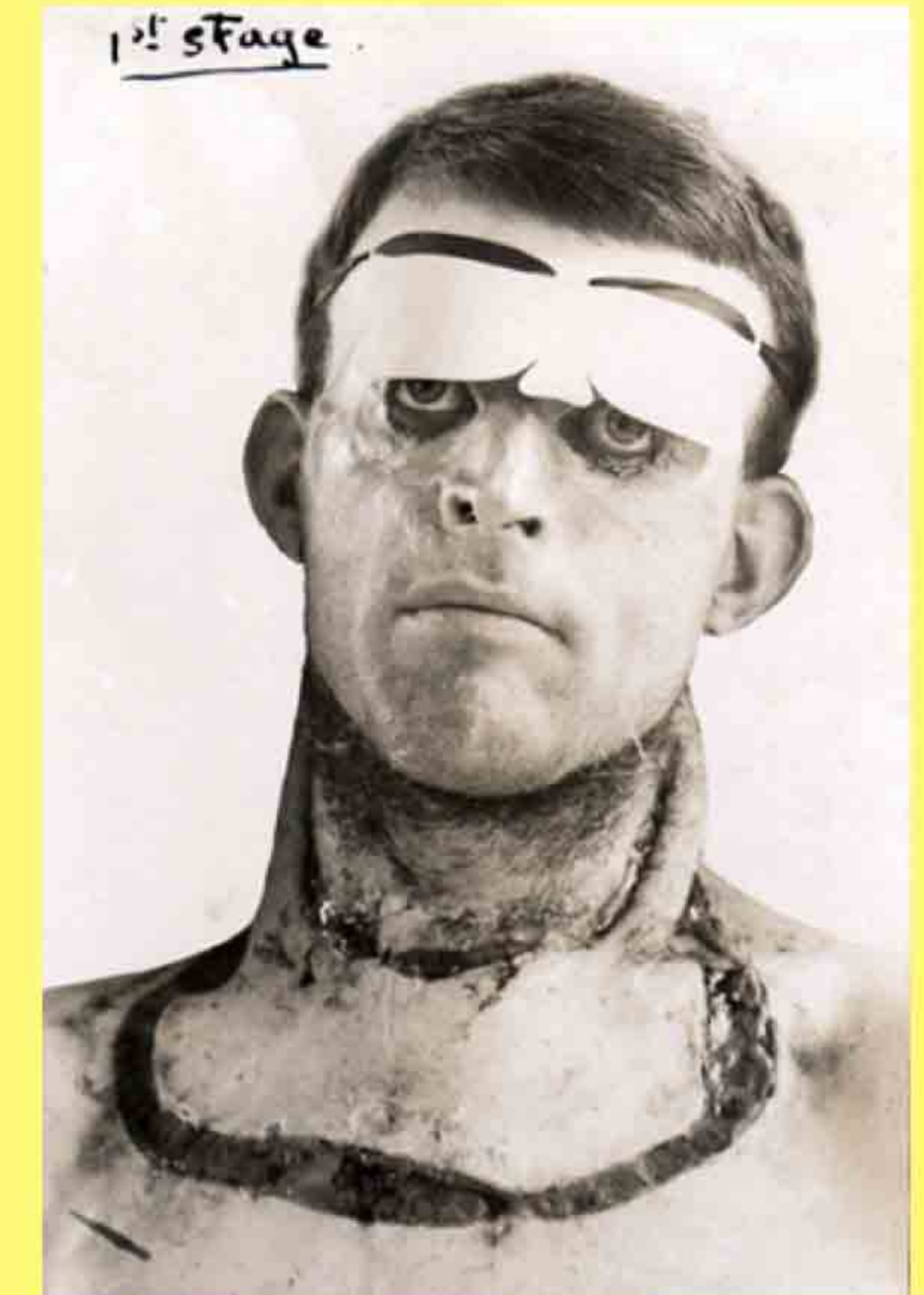
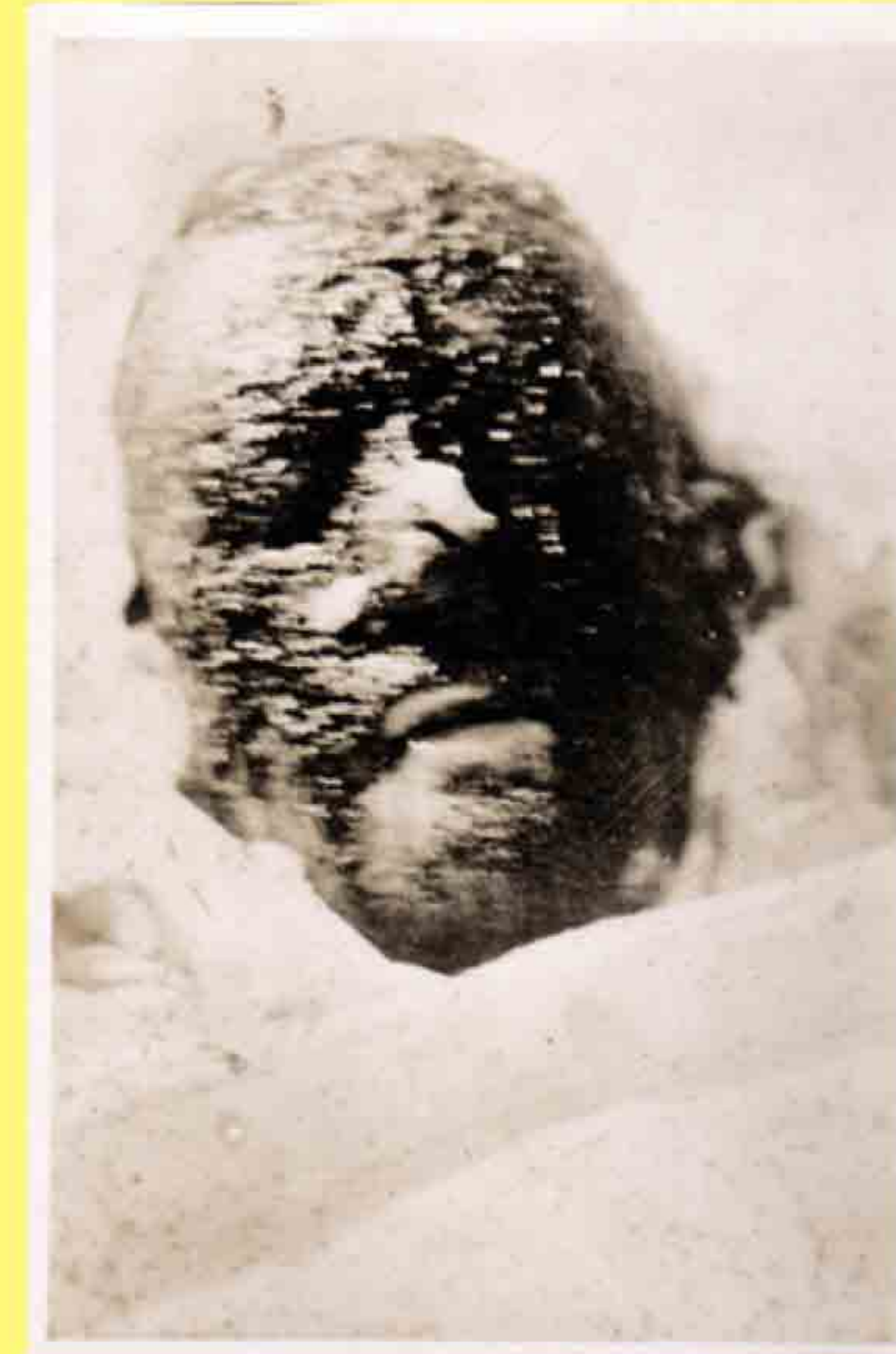
Dr Andrew Bamji Curator



July 1916, Battle of the Somme—a day when *Times* casualty list covered not columns, but pages

200 extra beds at Aldershot for facial casualties.

2,000 patients arrived: ‘Men without half their faces; men burned and maimed to the condition of animals’.



Walter Yeo, sailor injured at the Battle of Jutland, lost both his upper and lower eyelids.

1917: Skin flap surgery performed by Gillies

Uses a chest flap to graft the whole area of skin across the eyes.

The result was a graft that resembled a skin ‘eye mask’. scars improved with time



Invention of tubed pedicle

William Vicarage: 20 year-old watchmaker from Swansea cordite burns H.M.S. Malaya Battle of Jutland. loss of most of his nose and part of his ears.

severe ectropion of the lips and eyelids (scar tissue turns the inner surfaces outwards).

Gillies 'Masonic collar skin flap' from the chest to the lower part of the face with connecting pedicle flaps maintaining the blood supply.

edges of the connecting pedicle flaps curled
Gillies stitched the long edges inventing
Tubed pedicle flaps: better blood supply and reduced infection.

Instead of returning the connecting tubed pedicles of skin to their donor site, Gillies severed their connection at the shoulder.



NAME	VICARAGE, W.	NO. ON REGISTER	284.
RANK	A.B.	REGTL. No.	2324.
REGT.	H.M.S. 'MALAYA'		
ADMITTED	2.8.17.		
DISCHARGED	8.9.20.		
PARTICULARS OF WOUND OR INJURY BURNS OF FACE & HANDS.			
QUEEN'S HOSPITAL, SIDCUP.			

Sir Ernest Daryl Lindsay (1889–1976).

family of artist's and writers

keen watercolorist

enlisted in the Australian Army Service Corps in 1915 as a driver.

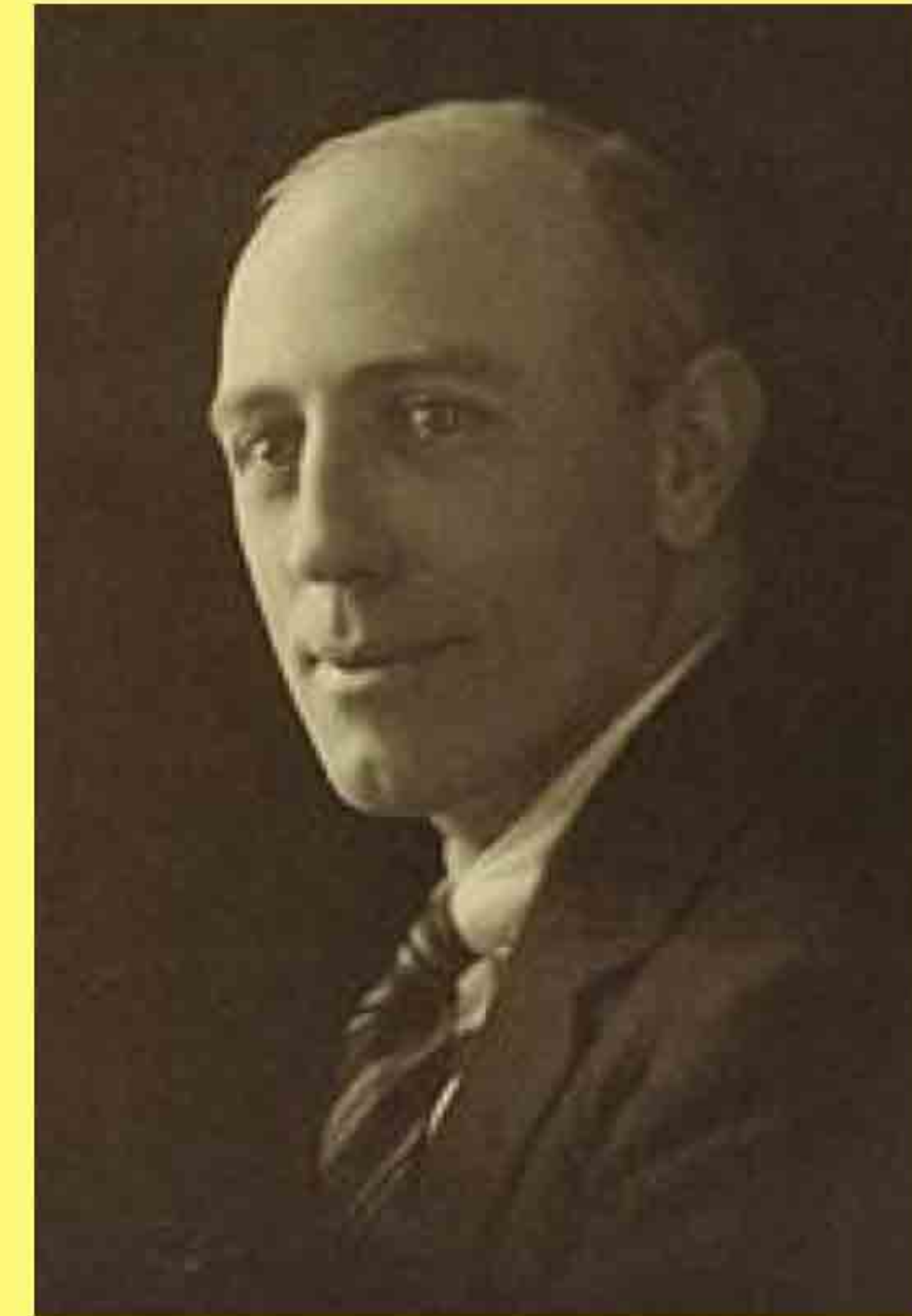
recording daily life of camps and trenches

1918 he was posted to Queen Mary's Hospital, as Honorary Lieutenant to the Australian section for wounds to the face and jaw.

'how was I going to translate what looked like a mess of flesh and blood into a diagram that a student could understand?

After World War I, Lindsay trained at Slade School, before returning to Australia

knighthed for "services to art" on 31 May 1956.



Pte Randy before & after operation Watercolour 1918



*Pte Briant after
operation Watercolour
ur 1918*

Severely disfigured soldiers
remained in hospitals and
convalescent units

In Sidcup, some park benches
were painted blue;

a code that warned townspeople
that any man sitting on one would
be distressful to view



photographer E.C. Cook Fulham Road London.

the Royal Victoria Patriotic School Wandsworth

Prince Albert's Royal Patriotic Fund, Royal Victoria Patriotic Asylum, architect M Rhode Hawkins, pupil of Thomas Cubitt

1857: foundation stone Queen Victoria
'Education and Training of three hundred Orphan Daughters of Soldiers, Seamen and Marines who perished in the Russian War

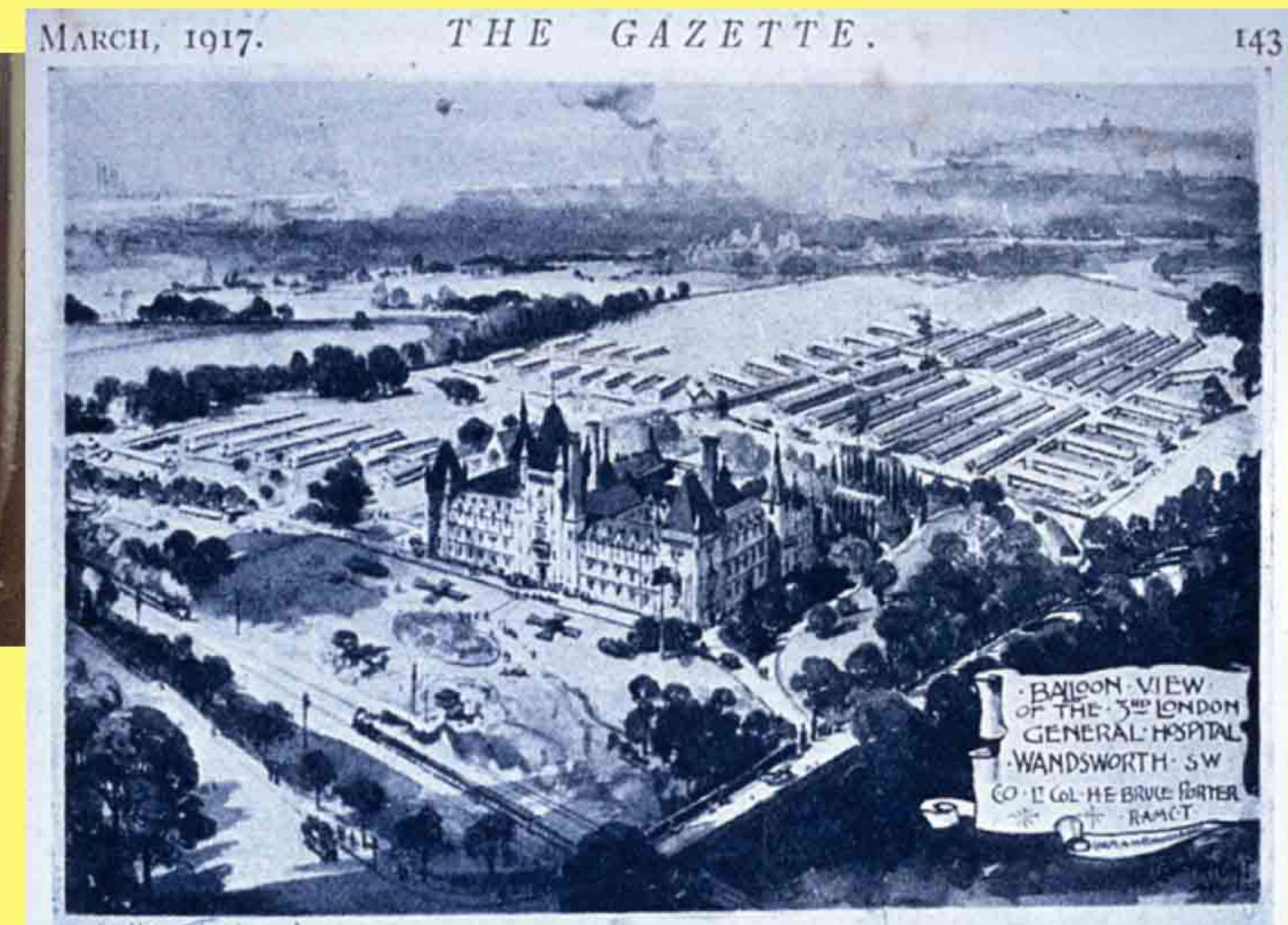
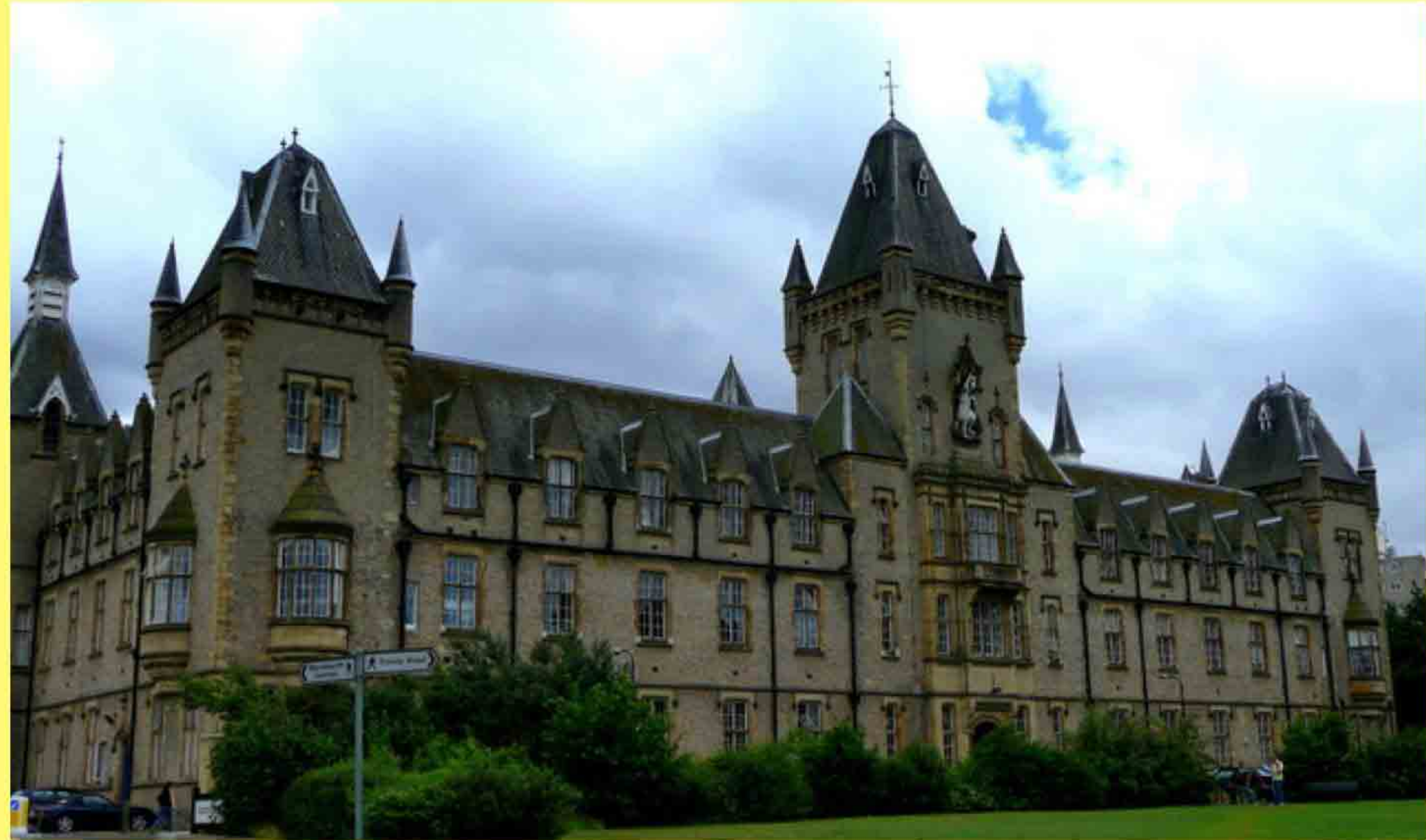
In August 1914 became the Third London General Hospital.

Four Territorial General Hospitals in London

Temporary railway station was built in front of the building wounded to be brought from the south coast.

The medical staff were seconded from the Middlesex, St Mary's and University College Hospitals.

1917: 2,000 beds, including 208 for eye cases, RAMC orderlies recruited from the Chelsea Arts Club.



Francis Derwent Wood RA (1871–1926)

American father; educated in Switzerland and Germany

Too old for active duty, enlisted, age 44, as a private in the Royal Army Medical Corps. Assigned as an orderly to the 3rd London General Hospital.

March 1916: gruesome injuries opens a special clinic:

**Masks for Facial Disfigurement
Department, Tin noses shop**

(More than 20,000 men were injured in the face during the war.)

1926 d. London age 55.

Professor of sculpture at the Royal College of Art from 1918 to 1923

postwar work war memorials



1906 portrait of Francis Derwent Wood by George Washington Lambert

ERECTED TO / COMMEMORATE / THE GLORIOUS / HEROES /
OF THE / MACHINE GUN / CORPS / WHO FELL IN / THE
GREAT / WAR / Saul has slain his thousands / but David his
tens of thousands / MCMXIV - MCMXIX

Kathleen Scott:

Scottish royalty on father's side and Phanariot aristocracy on her mother's. Orphaned at 8yrs

1900-2: Slade School of Fine Art, poor sculptural education enrolls at the Académie Colarossi, Paris.

1903: Turkish atrocities in Macedonia assists with child relief.

1908: London met Captain Robert Falcon Scott

1916: Commissioned to create a replica of Waterloo Place Bronze.

Carved in Carrara March 1916, importation of marble banned

Helped establish an ambulance service in France, 1917 secretary to Sir Matthew Nathan, permanent under-secretary at the Ministry of Pensions.

1918 volunteered to help "men without noses are very beautiful, like antique marbles."

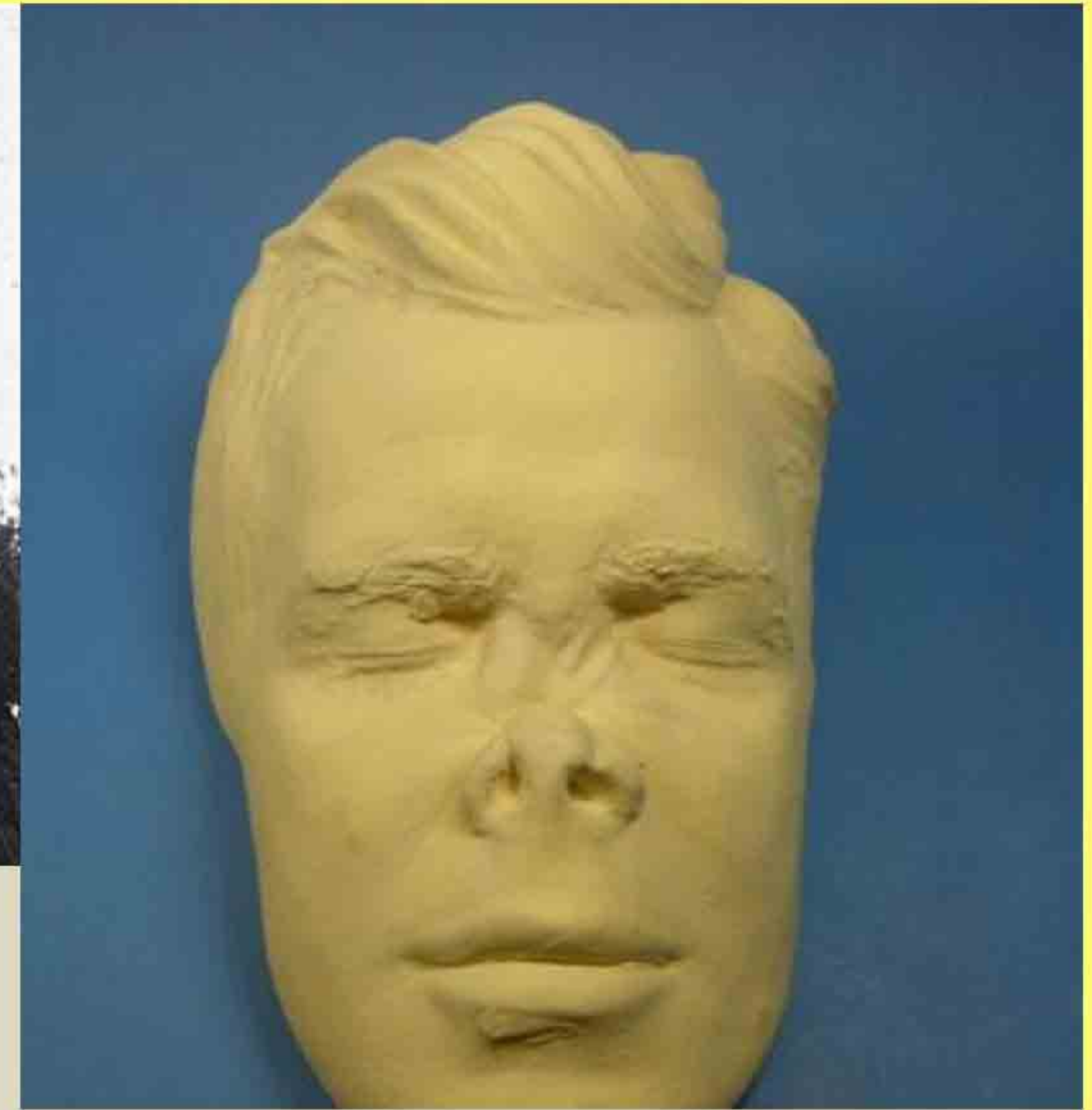
sculpted reconstructions of faces wounded, acting as a basis for the plastic surgery which followed.

Opposition to women's suffrage, dislike of special pleading

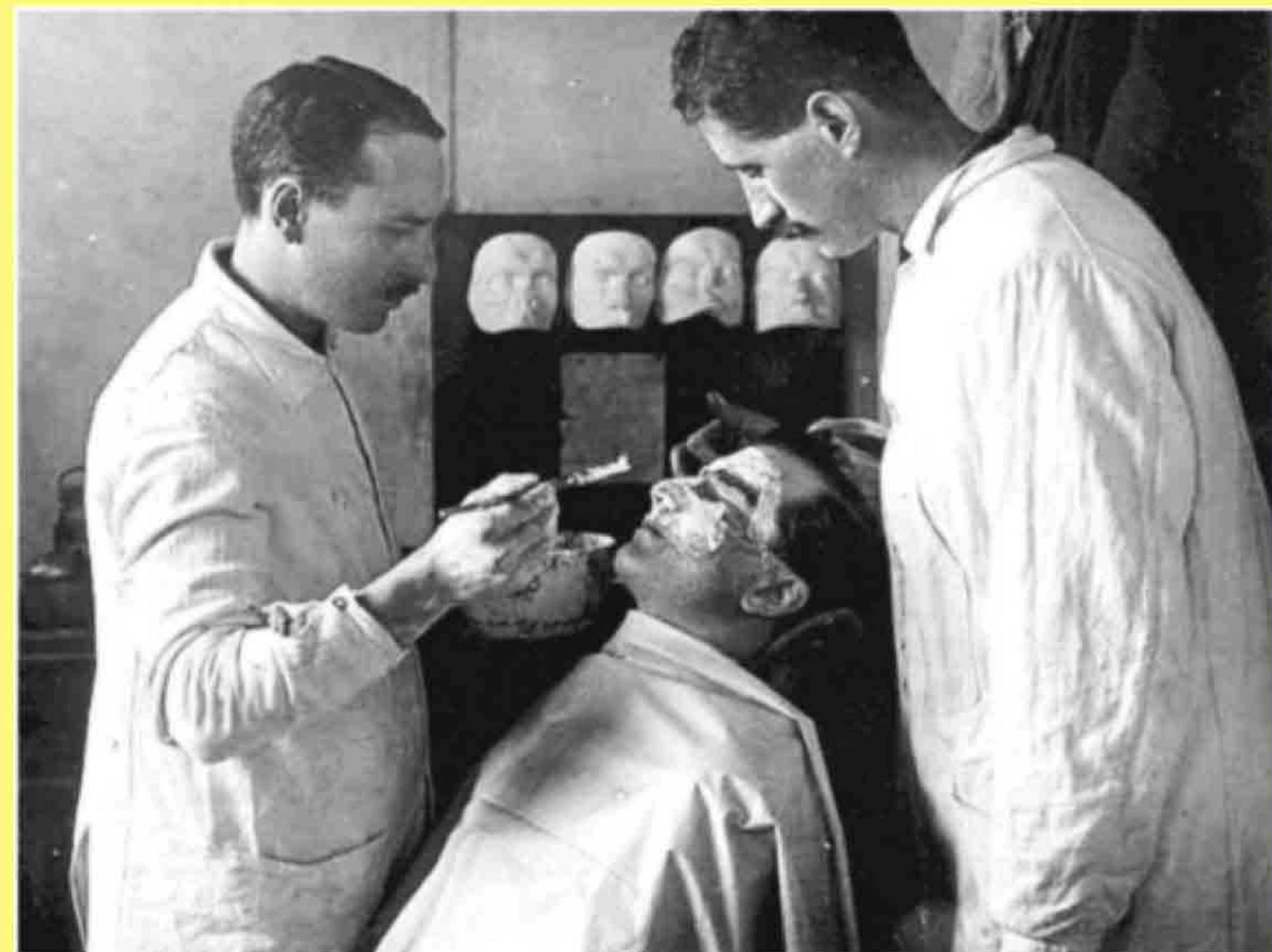
died of leukaemia on 24 July 1947



I do not regret this journey, which shows that Englishmen can endure hardships, help one another, and meet death with as great fortitude as ever in the past.



Plaster cast of the face of Private S Carne
By Lt John Edwards, Sidcup



Prosthetic faces

Facial disfigurement most traumatic of horrific damages "Always look a man straight in the face," one nun told her nurses. "Remember he's watching your face to see how you're going to react."

Hideous is the only word for these smashed faces: the socket with some twisted, moist slit, with a lash or two adhering feebly, which is all that is traceable of the forfeited eye; (Ward Muir's *The Happy Hospital* 1918)

June 1917, *The Lancet*, "When the surgeon has done all he can to restore functions I endeavour by means of the skill I happen to possess as a sculptor to make a man's face as near as possible to what it looked like before he was wounded,

New metallic masks, lightweight and more permanent than the rubber prosthetics previously issued,
Custom designed to prewar portrait

Henry Brooks lost part of his nose 1917

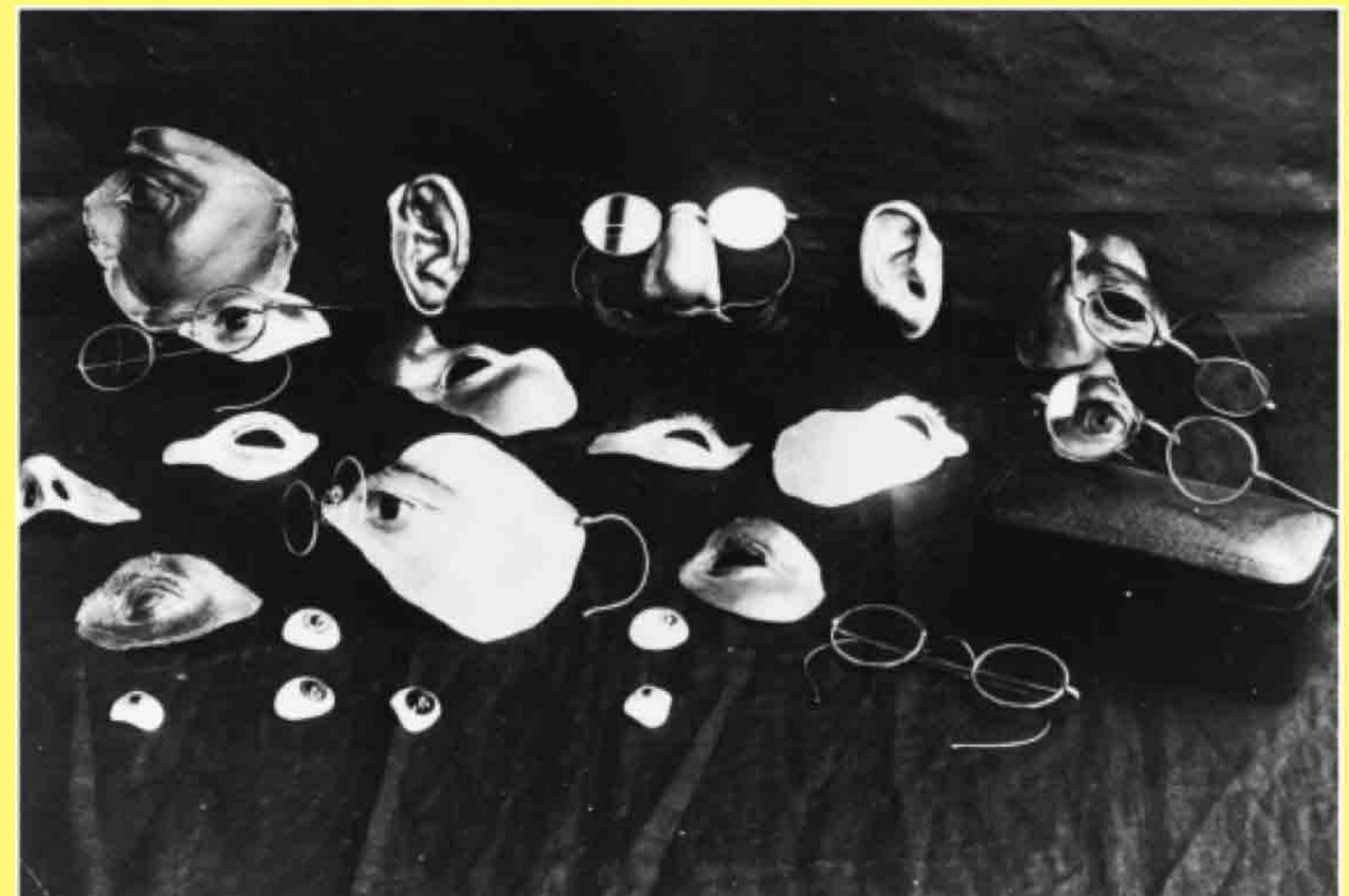
As optical technician made his own nasal prosthesis. 1919 Brooks ran a facial prosthetic service based at Queen Mary's Hospital in Roehampton for 30 years, continued by his son John until 1961.

His ocular prosthesis was made from aluminium etched with acid to produce a pitted appearance. Coated with skin coloured enamel, baked, then attached to a spectacle frame. RCS



Between 1918-19 sculptors and artists in 3rd London General Hospital's "Masks for Facial Disfigurement Department" created 220 prosthetics for gravely wounded soldiers

Cast of the disfigured face, mask of silvered copper, sculpted to resemble a portrait before injury. Painted to match the patient's colouring, held in place by spectacles. Uncomfortable, but enabled return home



Anna Coleman Ladd

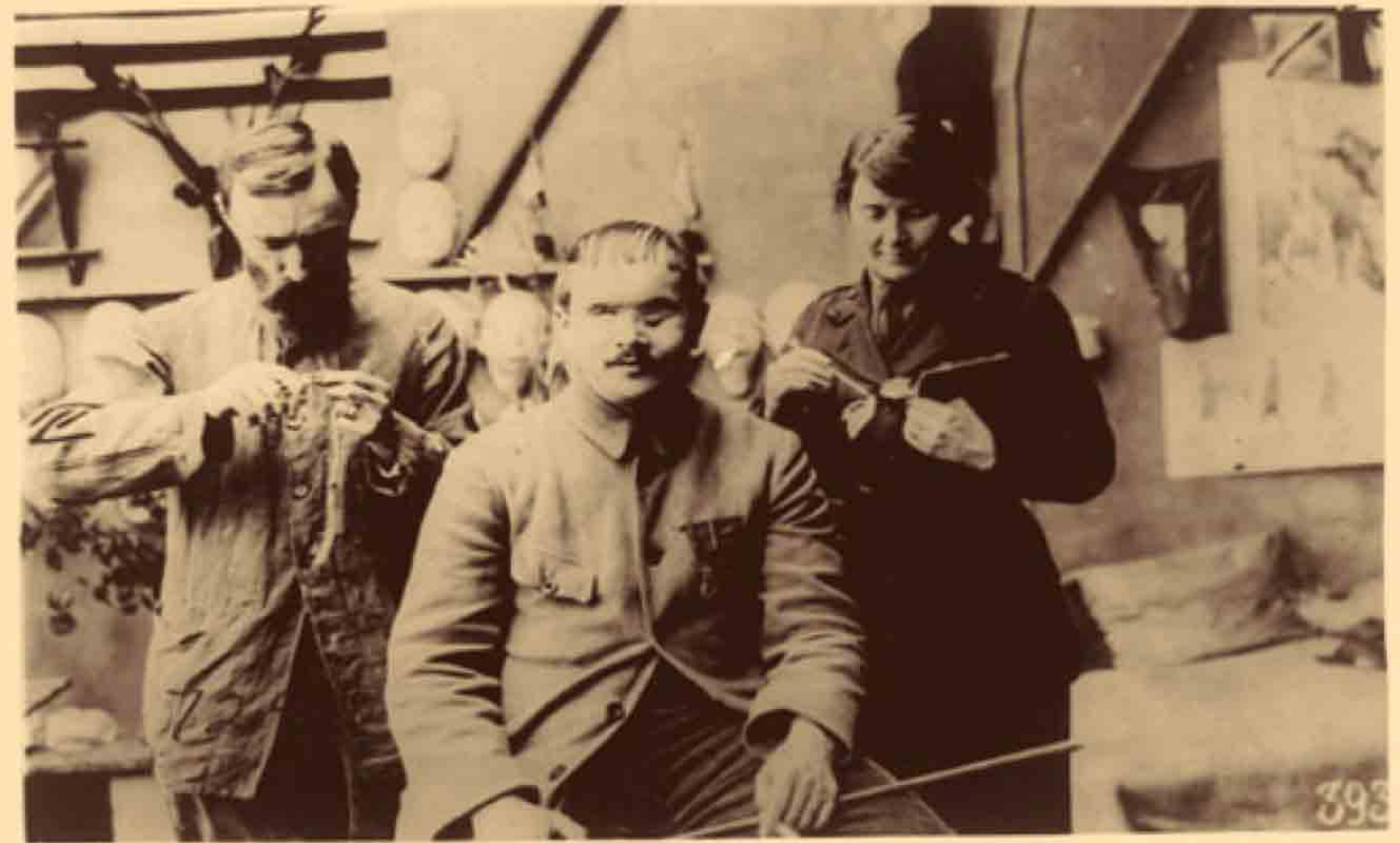
Sculptor:

Husband appointed to direct the Children's Bureau of the American Red Cross in France medical adviser in French advance zones.

1917: Consults Captain Francis Derwent Wood's

Studio for Portrait Masks in Paris.
administered by the American Red Cross.

"Mrs. Ladd is a little hard to handle as is so often the case with people of great talent"



mask-making in her Paris studio.
"We give the soldiers a warm welcome,"



Prosthesis

WWI Facial Prosthetic hand-made of copper 1/32” and then galvanized.

artistic challenge lay in painting skin colour onto metal

painted while wearing it to match complexion.

Oil paint chipped

Hard enamel that was washable and had a dull, flesh-like finish.

By end of 1919, Ladd's studio had produced 185 masks

By 1920, the Paris studio had begun to falter;
died at age 60 in Santa Barbara in 1939.

Caroline Alexander

Smithsonian magazine, February 2000



Ladd prosthetic

The eye glass and was also custom made to match the wearers eye.

4-9 ounces held on by spectacles.

Eyebrows, eyelashes and mustaches were made from real hair, or, in Wood's studio, from slivered tinfoil, in the manner of ancient Greek statues.

Thanks to you, I will have a home," one soldier had written her. "...The woman I love no longer finds me repulsive, *as she had a right to do.*"



Infections

(John) Edgell Rickword, MC 1898-1982

outlived all other poets but Robert Graves.

published three volumes and among them was a small batch of poems which focused on his experiences of the War.

'Winter Warfare'

1916: Age 17 enlisted with the Artists' Rifles
reached the Front in January 1918, awarded
Military Cross.

Two months after the Armistice, while still in France, he developed septicaemia and lost his left eye.

He was charged three guineas for the glass replacement.

collected his early verse in *Behind the Eyes* (1921)

Becomes leading communist



Trench Poets

*I knew a man, he was my chum,
but he grew blacker every day,
and would not brush the flies away,
nor blanch however fierce the hum
of passing shells; I used to read,
to rouse him, random things from
Donne—
like "Get with child a mandrake-root."
But you can tell he was far gone,
for he lay gaping, mackerel-eyed,
and stiff, and senseless as a post
even when that old poet cried
"I long to talk with some old lover's
ghost."*



Over The Top, 1918, John Nash. The 30 December 1917 Welsh Ridge counter-attack, 1st Battalion Artists Rifles pushed towards Marcoing near Cambrai. 68/80 men killed or wounded during the first few minutes.

Blind Veterans, Düren

August Sander German, Düren,
negative about 1930 – 1931

August Sander portrait visiting a home
for the blind.

These men blinded during WW I.

Series created to represent German
civilization.

ordered according to a theory of cultural
development

First rank: People close to nature--such
as farmers, followed by "The Working
Man," "The Professions," "The Artists,"

This portrait categorized in "The Last
People," images of the ill, disabled, and
insane.



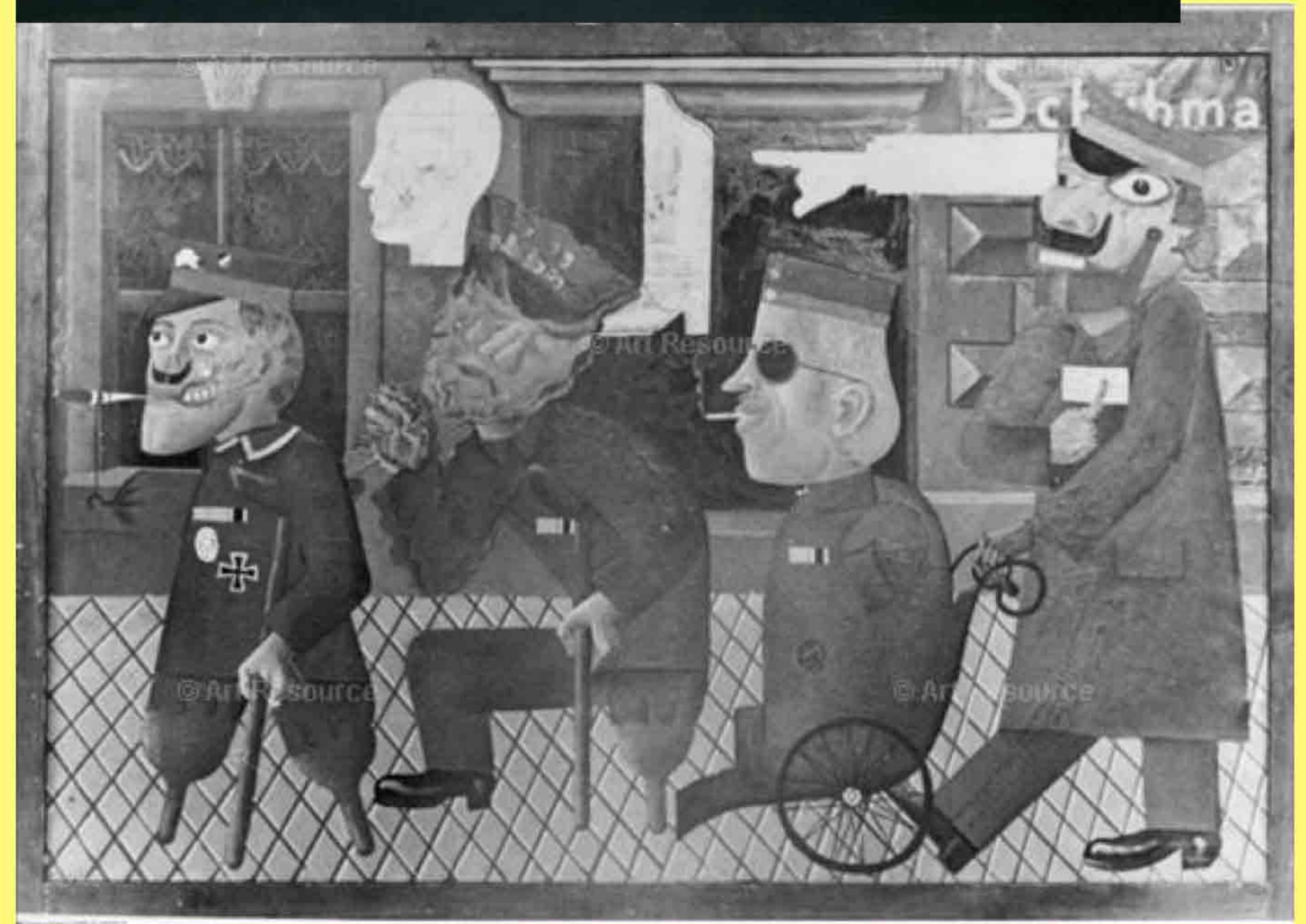
Otto Dix: (1891-1969)

The Match Vendor I. 1920.
Kunstmuseum, Stuttgart

War Cripples (45 % Fit for Service),
1920.

Oil on canvas.

Shown at the Nazi Exhibition
"Degenerated Art" in the
Galeriegebäude am Münchener
Hofgarten (July 19, 1937),
later destroyed



Civilian blast injuries

The **Halifax Explosion**: Canada, Dec 6, 1917.

French SS Mont-Blanc: cargo explosives, collided with Norwegian SS Imo

20 mins: largest man-made explosion before nuclear weapons 2.9 kilotons of TNT

devastated Halifax.

2,000 killed, more Nova Scotians than died in combat

600 people suffered eye injuries, and 38 of those lost their sight permanently.

Recently formed Canadian National Institute for the Blind.

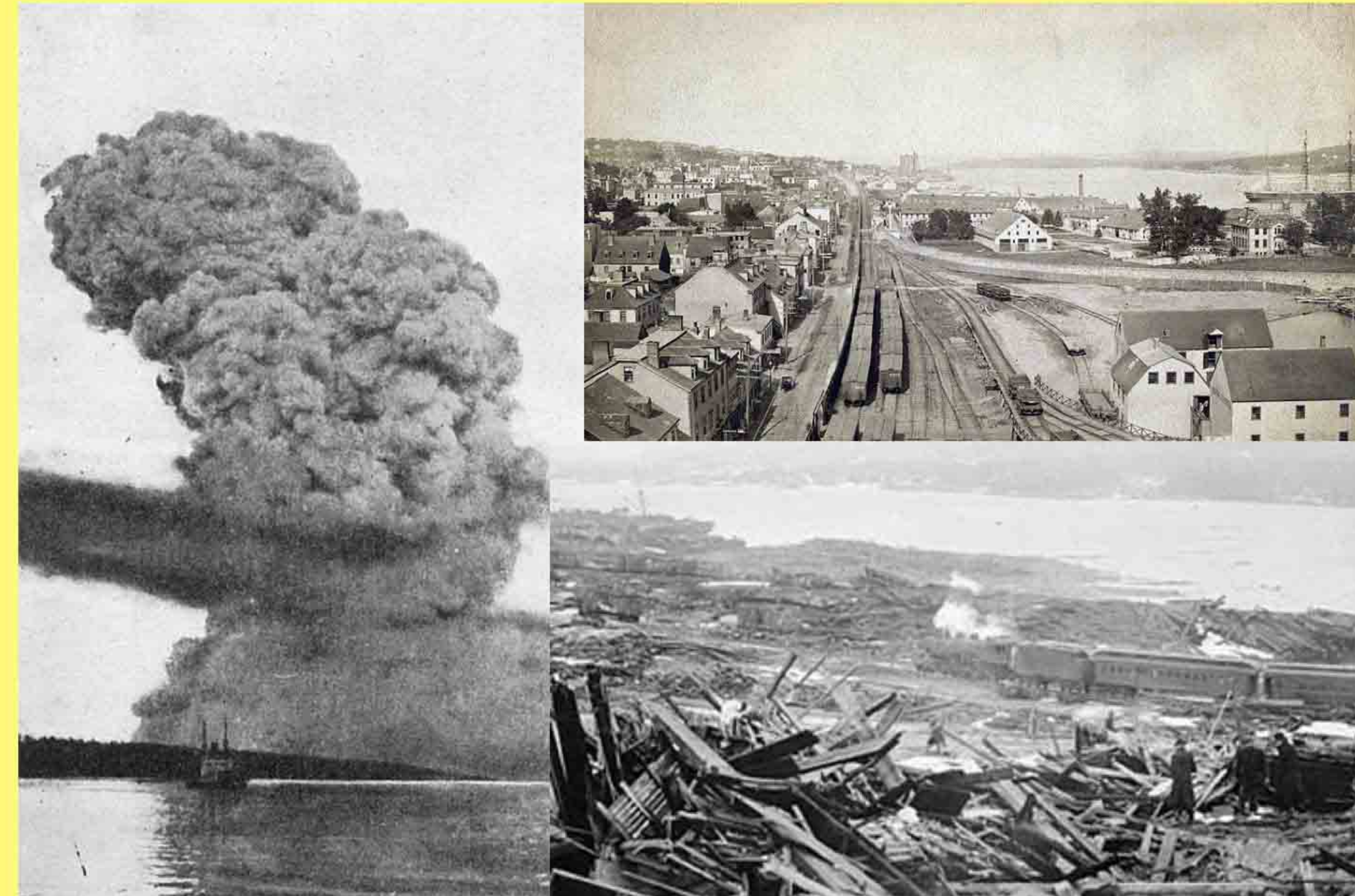
The significant advances in eye care

Eric Davidson 2 half yrs old: playing with toy train.

Blinded shattered window

Despite his disability went on to be a mechanic for the City of Halifax until his retirement in 1980.

the explosion was the last thing he ever saw.



Adolf Galland

1935: aerobatic training, crashed Focke-Wulf Fw 44 biplane

coma for 3d, damaged eye, fractured skull and broken nose

Unfit for flying

1936 he crashed an Arado Ar 68 damaging his injured eye

Admitted having # of glass in his eye, but convinced the doctors he was fit for flying duty.

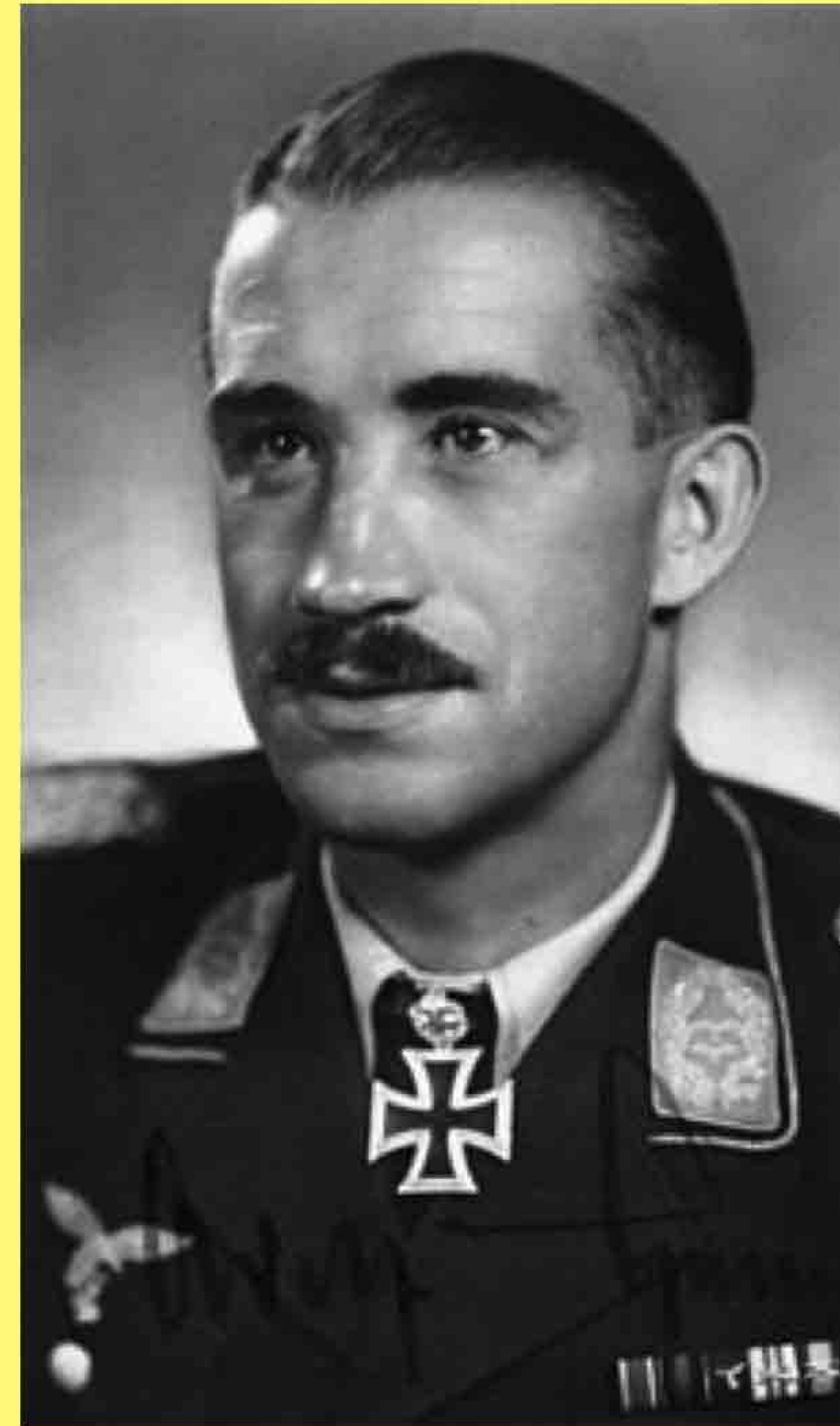
Ordered to undergo eye tests to validate his claims.

His brother obtained the charts.

Memorised the letters passing the test and was permitted to fly again

104 aerial victories

"Der Galland-Zirkus"



WW2

World War II "spread death and devastation cost the lives of over 19 million people.

Innovations changed Ophthalmology

3% of battle casualties suffered eye injuries, 15,000 US soldiers were blinded.

During battles, it took an average of 36-48 hours for an injured soldier to be seen by an ophthalmologist.

This led to having ophthalmologists on the front lines and in forward hospitals, and to the improvement of support services to evacuate soldiers faster and get them appropriate eye care to save their vision.

Observations by doctors that 50-90 percent of eye injuries could be prevented with proper eye protection sparked ophthalmic innovation



High Visibility Wrap by Joseph Hirsch.
Army Art Collection, Washington, DC.

Sir (Nicholas) Harold Ridley (1906-2001)

House Surgeon and Ophthalmic Consultant at the Royal London Ophthalmic Hospital at Moorfields in 1939 when England declared war on Germany.

joined the Emergency Medical Service.

Previously served a year in the Royal Navy

Observations of eye injuries to pilots

Perspex appeared inert within body tissues.

1934 by ICI as trademark for their polymethylmethacrylate acrylic sheet.

total production of Perspex was reserved for the aircraft industry and specifically developed for the use of fighter aircraft

Rayner Brighton,



August 1940, Mk II Spitfire built at the Castle Bromwich factory
266 Squadron: Wittering and Hornchurch transferred to 603 AuxAF Squadron at Hornchurch, to replace older Mk 1s.



Civilian Casualties

Giulio Douhet, Italian military aviator: future wars could be won by bombers alone. 'Normal life would be impossible in this constant nightmare of imminent death and destruction,'

7 Sept 1940- 21 May 1941

major air raids on 16 British cities.

London was attacked 71 times

Sept: German Air Force dropped 5,300 tons of high explosives on London in 24 nights

November 14 1940: Coventry 500 bombers dropped 500 tons of explosives and 900 incendiary bombs on the city in ten hours

40,000 civilians were killed

Eye injuries common

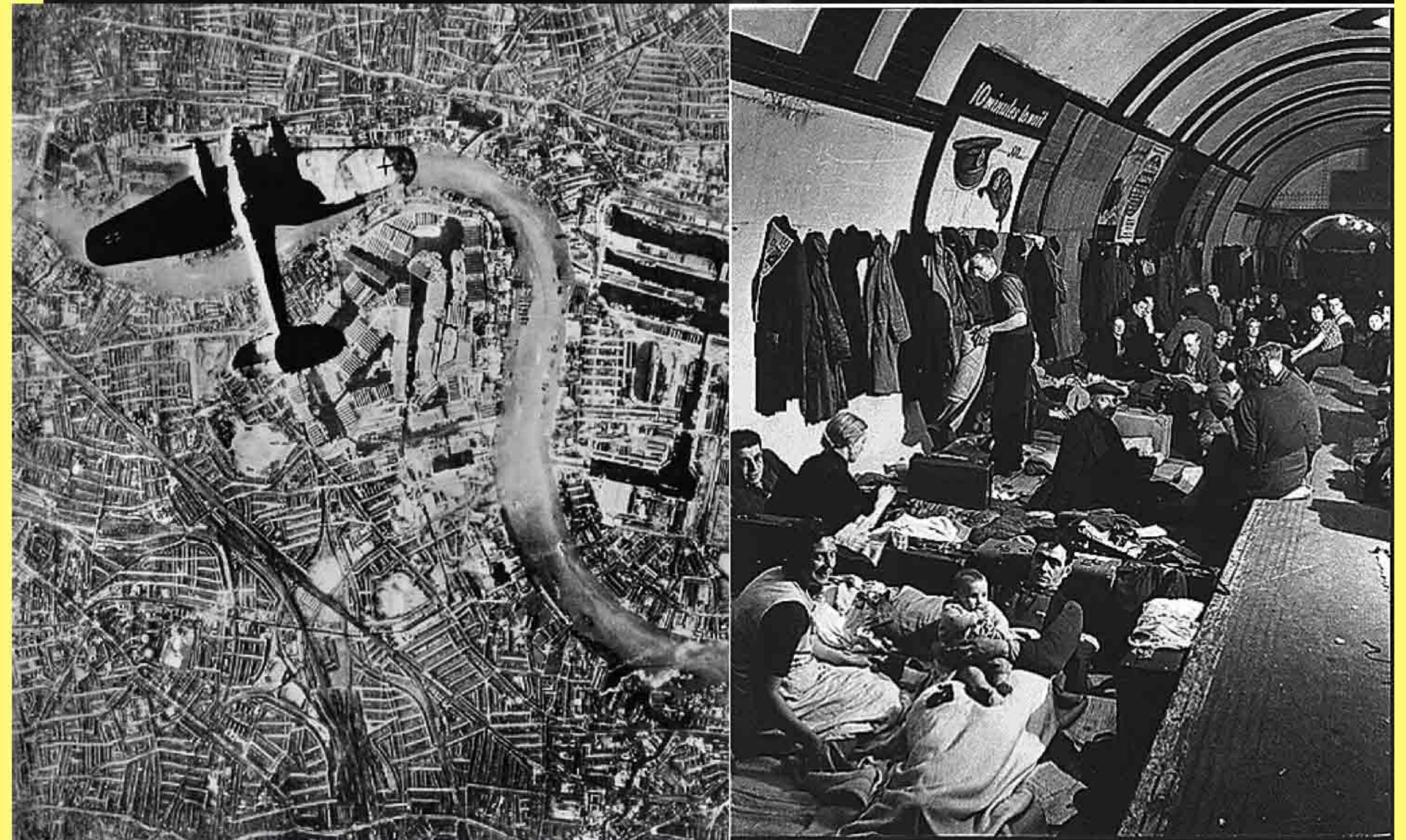
Moorfield's moved large part of routine work to Edgware

Dec 29, 1940, 128 firemen were seen as casualties corneal or conjunctival foreign bodies.

Delayed treatment norm

Staff and patients in underground shelter

The Medical Press and Circular, January 27, 1943.



Saburō Sakai 1916-2000

Ace with 60 kills:

August 1942: Battle of Guadalcanal:
targeting a VB-6 Dauntless flown by Ens.
Robert C. Shaw. dive bombers rear-
mounted twin 7.62 mm machine guns,
shattered and blew away the canopy of
Sakai's Zero

Blinded in the right eye paralysed on his
left side.

The Zero rolled over dived to sea.

Unable to see he was able to pulled out
and heads to airfield at Rabaul.

4 ³/₄ hours later he makes it and gives
report before treatment.



Archibald McIndoe 1900-1960

University of Otago; 5yrs at the Mayo

1930 Gillies invited his cousin, to join the practice, and apply for a post at St Barts

1930. Plastic surgeon to Croydon General, Tropical Disease and other Hospitals.

1938 consultant plastic surgeon RAF in rebuilt Queen Victoria Hospital in East Grinstead, treated deep burns and serious facial disfigurement; loss of eyelids.

Guinea Pig Club: serving airmen who had gone through at least ten surgical procedures. By the end of the war the club had 649 members.

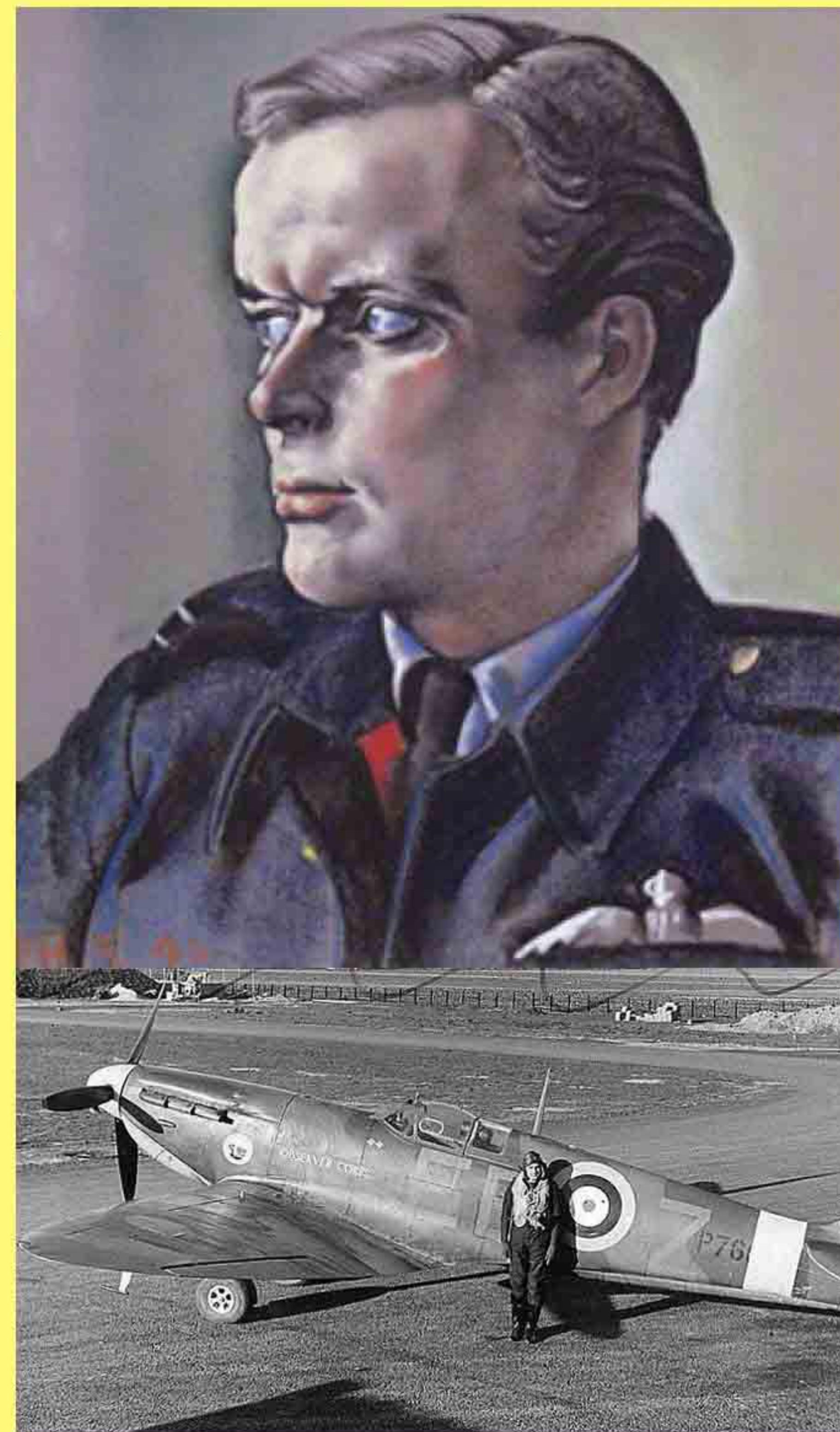
Patients normal a life as possible.

Wore clothes not "convalescent blues".

barrels of beer in wards East Grinstead became "the town that did not stare".

American pilots weren't as fortunate.

Studs Terkel's *The Good War*, military nurse Betty Hutchinson civilians demanded burned American pilots be isolated. "Why can't they be kept on their own grounds and off the streets?" letter to a newspaper.



Richard Hillary by Eric Henri Kennington pastel, 1942
1940 603 Squadron Spitfires. Hornchurch, Battle of Britain.
Shot down returned to duty and in the space of a week destroyed five enemy planes. 3 Sept shot down by a Messerschmitt Bf 109 flown by Hauptmann Helmut Bode of II./JG 26 badly burned

He took a scalpel and tapped lightly on something white showing through the red granulating knuckle of my right fore-finger. "Four new eyelids, I'm afraid, but you are not ready for them yet. I want all this skin to soften up a lot first."

returned to active service killed in a night-flying exercise accident.

Later C20th: Vietnam, Middle East

Eye casualties 9% highest of any US war to that date

Israeli defence force: If eye is hit 50% chance it will be lost

Commonly complex and multiple: eg lid laceration and perforation of globe

Both eyes injured 28% patients

FG La Piana 1997: Military ophthalmology in the Vietnam War.



Eye and adnexal injuries US military

Wounded 1962-72	308,178
Battle injuries admitted	50,849
Eye and adnexal injuries	4,585
Estimated total eye/adnexal injuries	37,736
Known enucleations	1,043
Known eviscerations	175

Iraq Wars

First Iraq War Desert Storm: Jan 1991-Feb 1991

13% casualties ocular

Iraq war: invasion 20 March 2003

a longer phase of insurgency opposed occupying forces and newly formed Iraqi government.

Operation Iraqi Freedom Mar 2003- Dec 2004.

22.5% 368 pts (451 eyes) evacuated for eye problems.

15.8% of all medical evacuations were battle eye injuries

Ari AB. Optometry. 2006;77:329. **Eye injuries battlefields of Iraq**

The U.S. completed its withdrawal of military personnel in December 2011

797 severe eye injuries were treated.

The most common cause of the eye injuries was explosions with fragmentation injury.

438 open globe injuries, of which 49 were bilateral.

116 eyes were removed: 6 bilateral enucleation.

Injuries to other body systems were common.

Thatch: Ophthalmol. 2008:377 Severe eye injuries in the war in Iraq, 2003-2005.

Eye 2011 :218 Ophthalmic injuries in British Armed Forces in Iraq and Afghanistan. Blanch RJ, Bindra MS, Jacks AS, Scott RA.

Academic Department of Military Surgery and Trauma, Royal Centre for Defence Medicine, Birmingham, UK. 10% of casualties Eye



Iraq/Afghanistan

1,100 eye injuries required surgery:

13% of all serious casualties

highest percentage for eye wounds in any major conflict

Major eye injuries have accumulated at twice the rate as wounds requiring amputations.

one of the most devastating consequences of wars with roadside bombs, mortars and grenades as weapons.

Troops routinely wear protective eyewear, but it doesn't always work.

Captain Castro: paratrooper with the 82nd Airborne Division, September 2006, relieved troops on an exposed roof

Mortar round, killed comrades and severely wounded Castro in shoulder, breaking an arm, fracturing face and blast lungs.

Drove the frame of his protective eyewear into his face

Sgt. Luis Martinez, roadside bomb in Baghdad blew a hole through the heavily armored vehicle

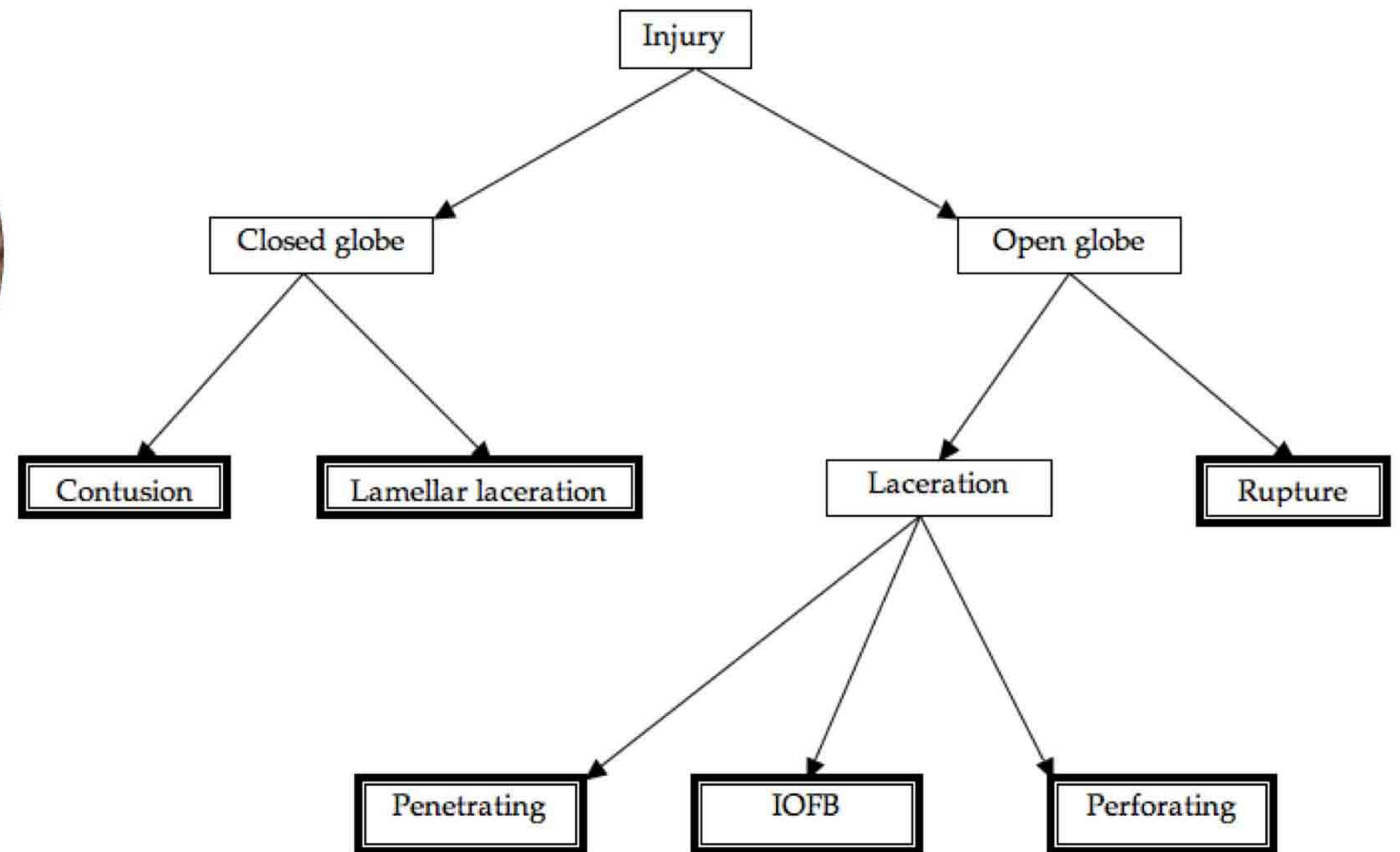
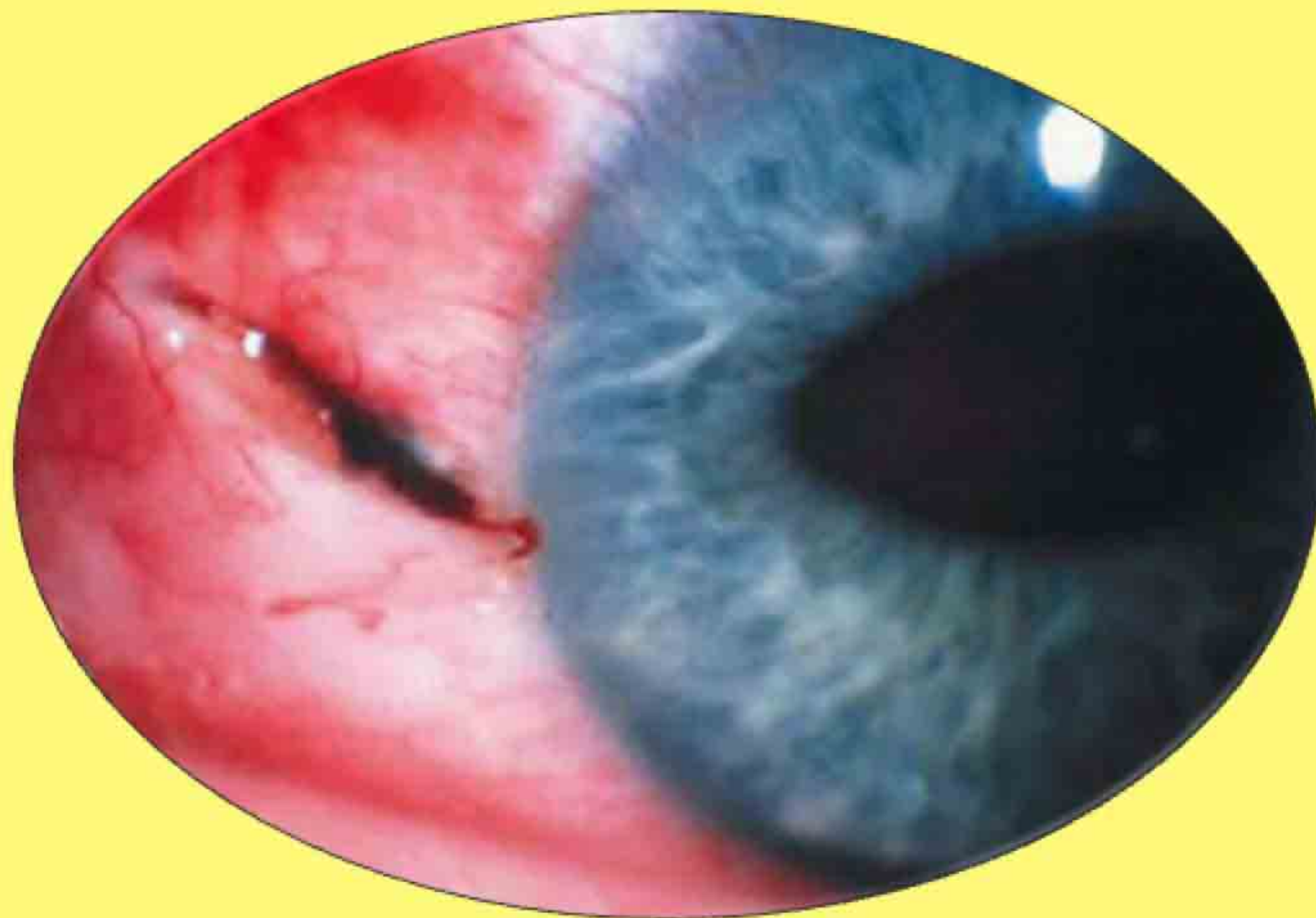
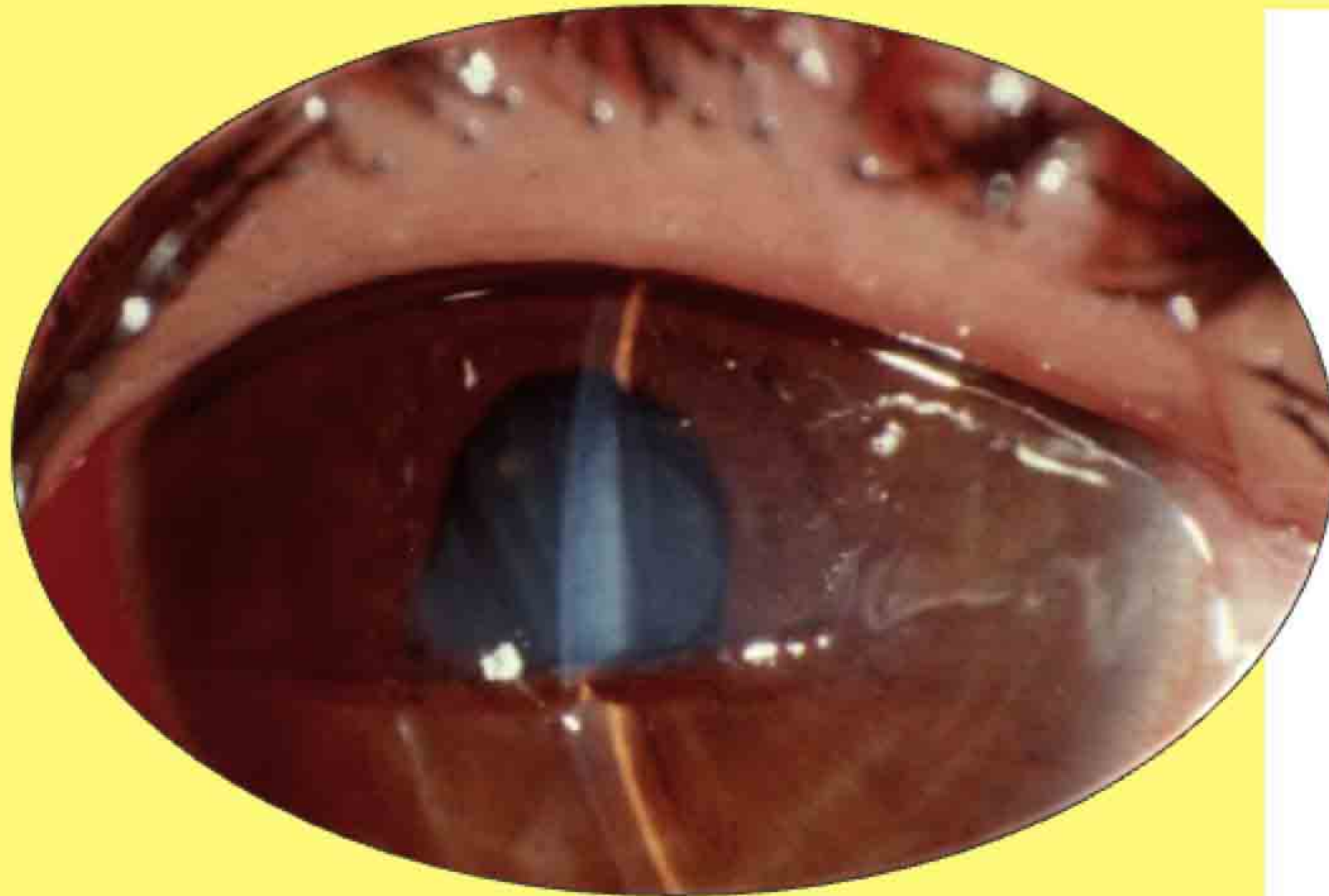
blast stripped off helmet, headset and goggles, could see nothing out of his left eye and only streaks of blood in his right.

Surgery restored vision to right eye, glass # still embedded.

Blind in his left.



Birmingham Eye Trauma Terminology



Urgent care of military eye injury

Role 1 "buddy care" or at Role 2 (Forward Resuscitative Surgical System) facilities

The eye should be protected with a rigid Fox eye shield by field medical teams,

Irrigation and debridement of the eye in the field discouraged

Role 3: and early primary closure of wounds (within 6-8 hours) with careful wound debridement and placement of perioperative prophylactic subconjunctival antibiotics by an ophthalmologist

the need to urgently evacuate patients to Role 4 (e.g., fixed hospital out of combat theater of operations) and Role 5 has superseded the urgency of IOFB removal with the known surgical complexities of vitreoretinal intervention in an austere environment.

Aggressive debridement of lid wounds with re-approximation of margins and placement of nasolacrimal stents standard of care.



Prevention of Infections Associated With Combat-Related Eye, Maxillofacial, and Neck Injuries

Kyle Petersen, J Trauma. 2011 ;71

Modelling Eye injuries

Ocular injuries are now the fourth most common military deployment-related injury.

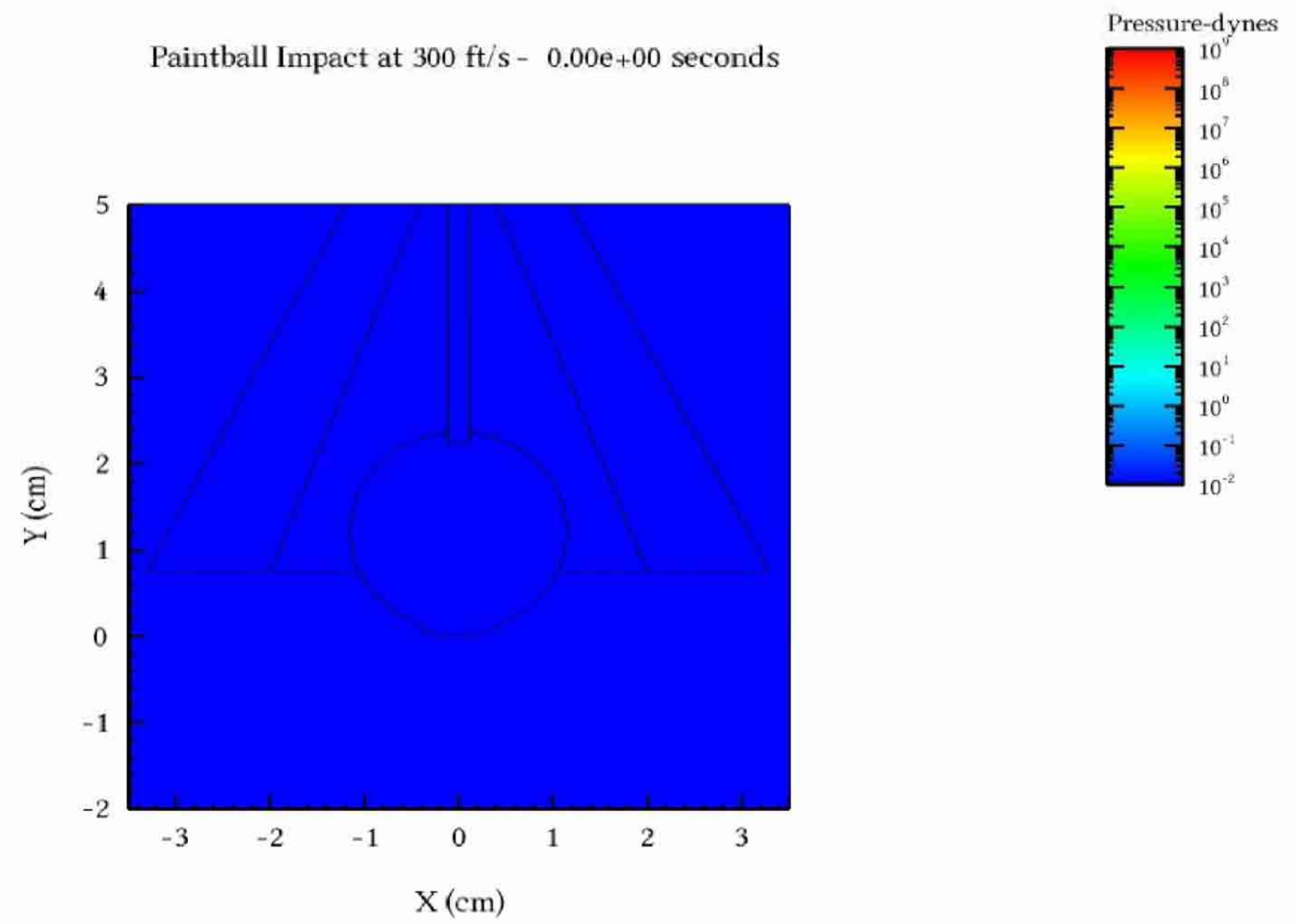
The incidence of ocular injury in combat is 20-50 times greater than one would expect based on exposed surface area alone.

Eye injury rates in active duty military personnel increased from 1996 to 2005,

26 and 21 per 1000 person-years in men and women, respectively



Paintball Impact at 300 ft/s - 0.00e+00 seconds



Modeling of Paintball Impact Ocular Trauma: Identification of Progressive Injury Mechanisms

IR 18-R14165

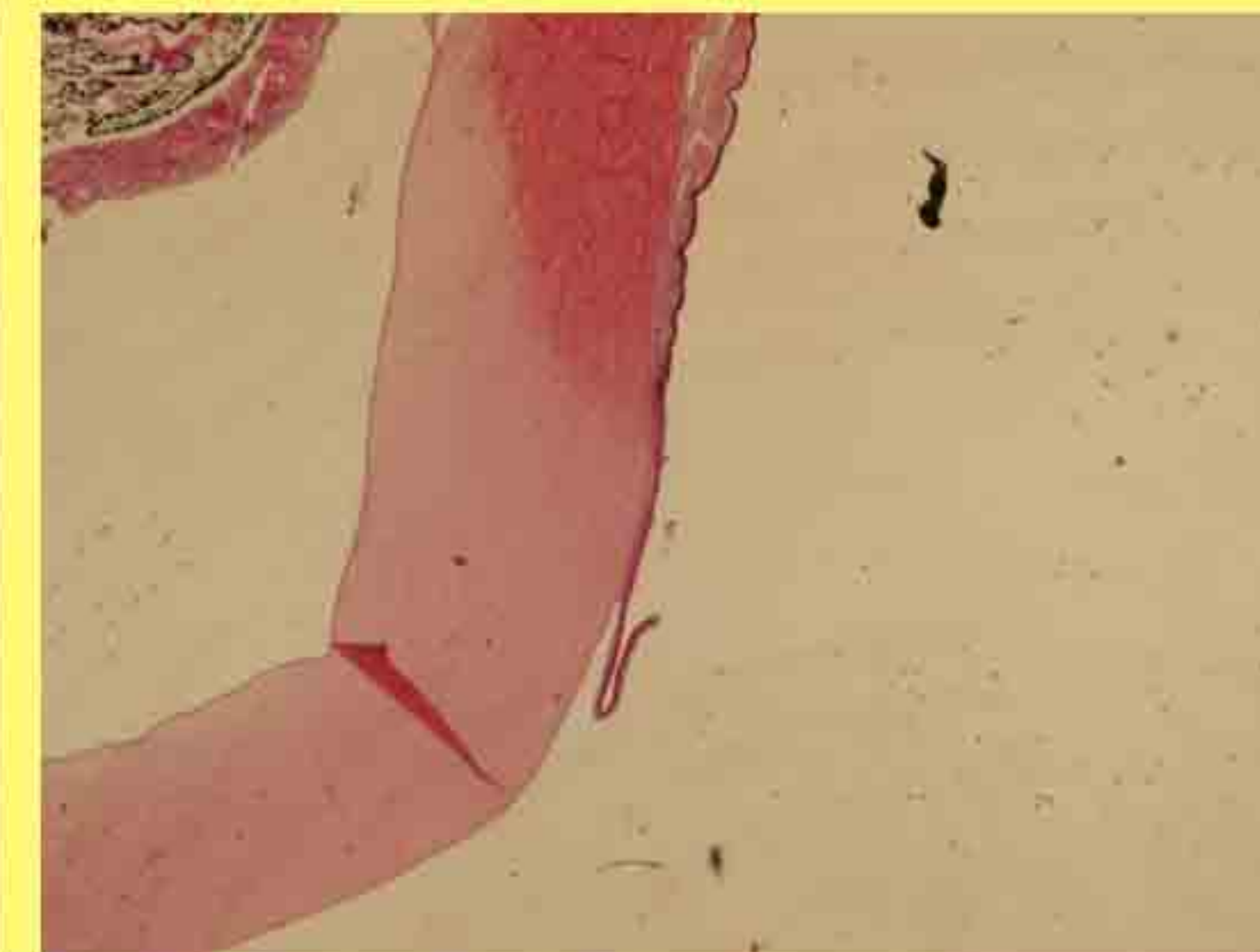
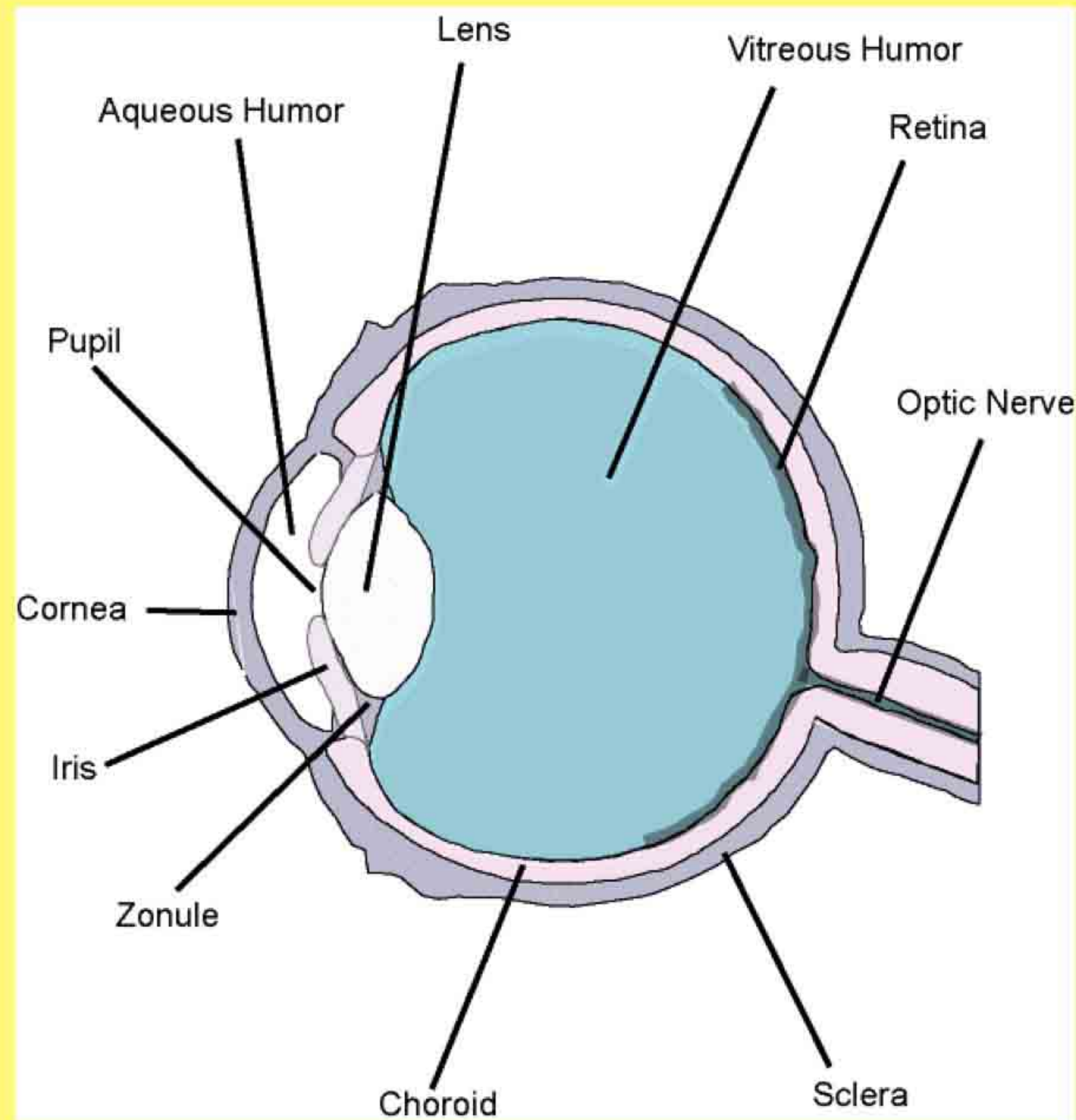
**Walt Gray, Carl E. Weiss, William E. Sponsel, M.D.,
Amber R. Bonivtch
Southwest Research Institute**

**Allison A. Armstrong
University of Texas Health Science Center-San Antonio**

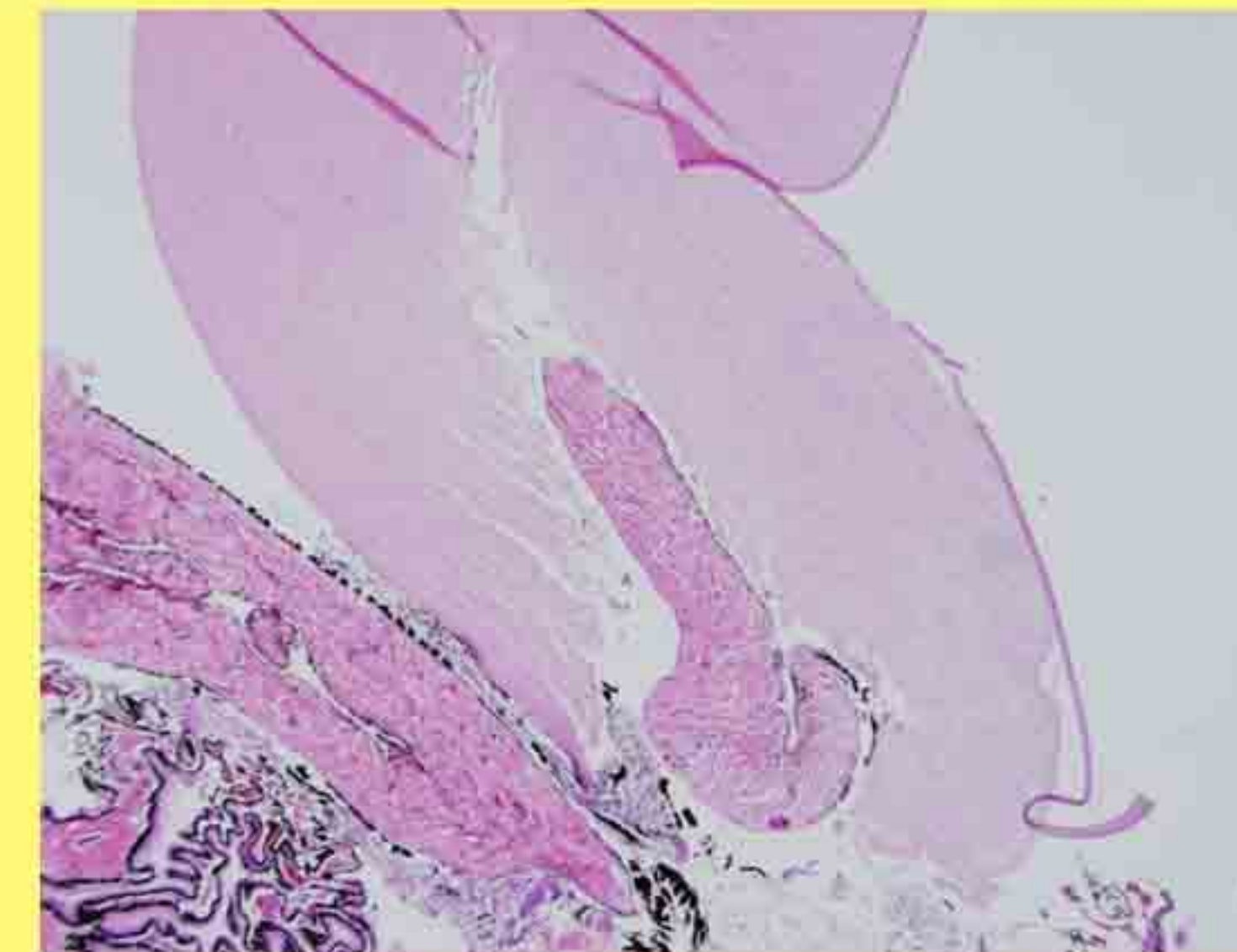
**Peggy Miller, Col. Frank W. Scribbick, M.D.
Lion's Eye Pathology Laboratory
Brooke Army Medical Center**



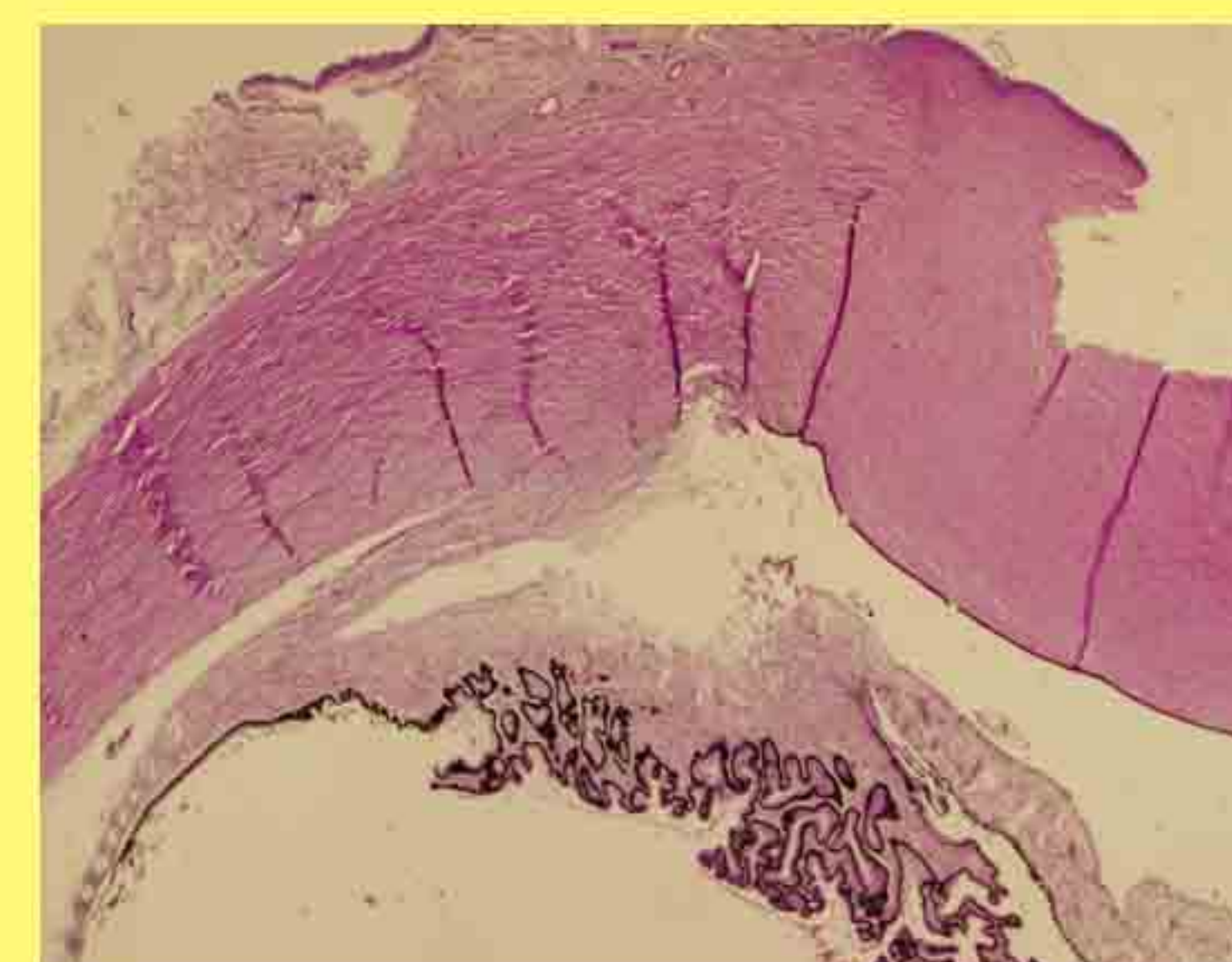
Observed Trauma



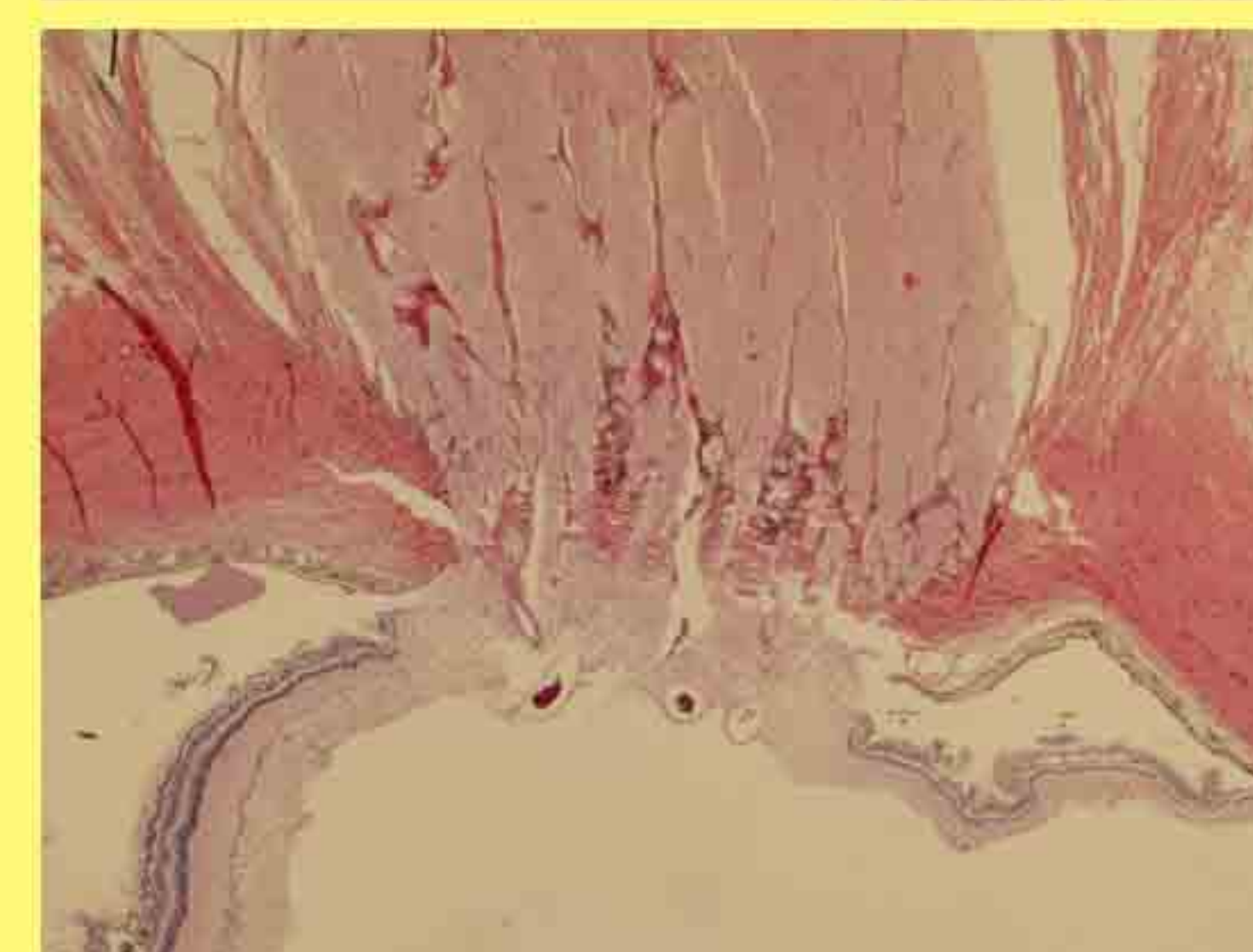
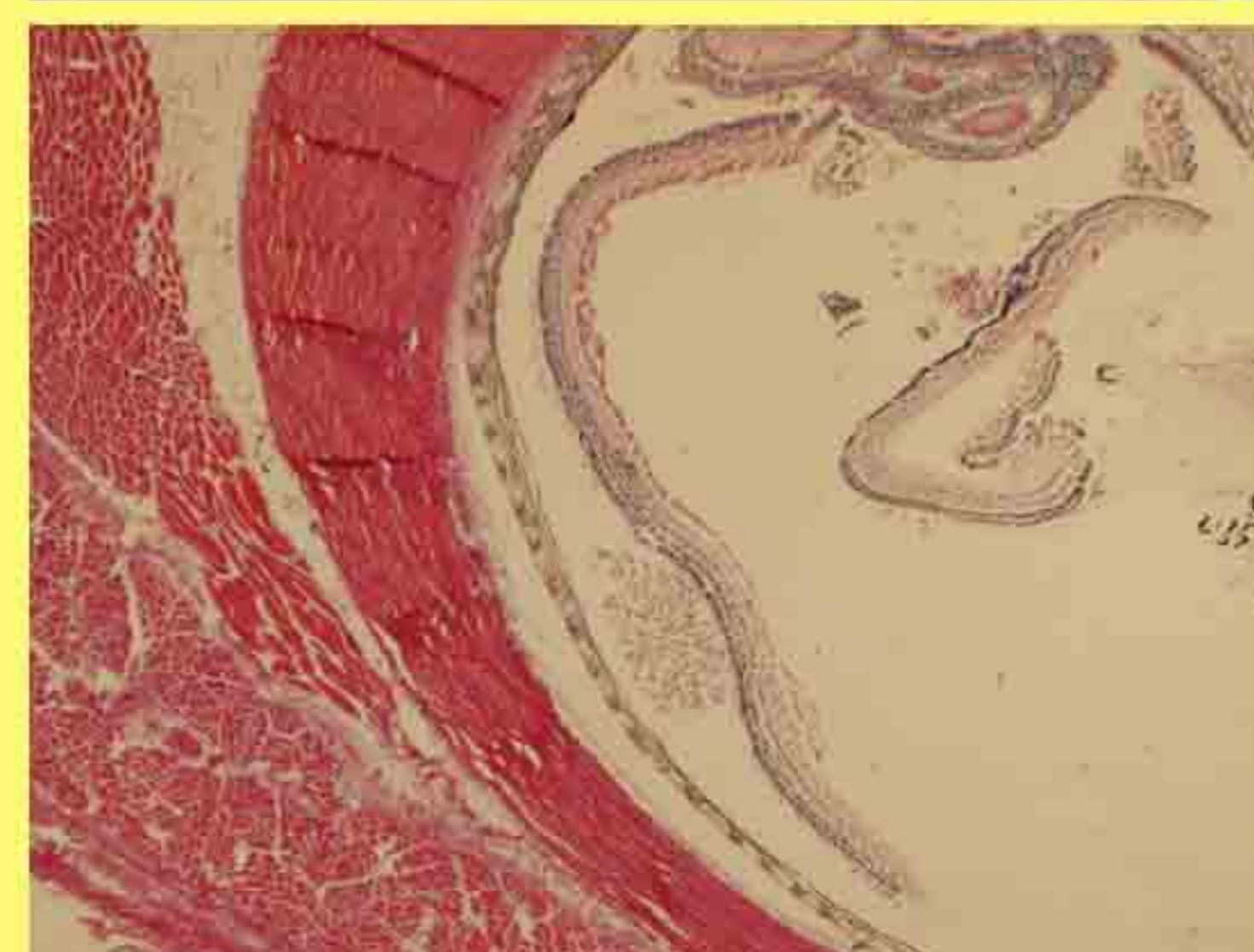
Corneal Abrasion



Angle Recession & damage to Corneal Stoma



Iridodialysis, Cyclodialysis



Detach. & segmentation of Choroid & Retina



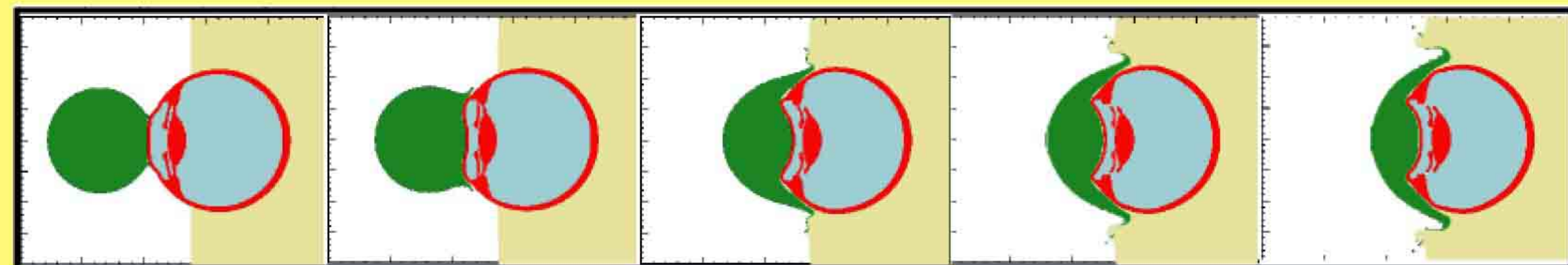
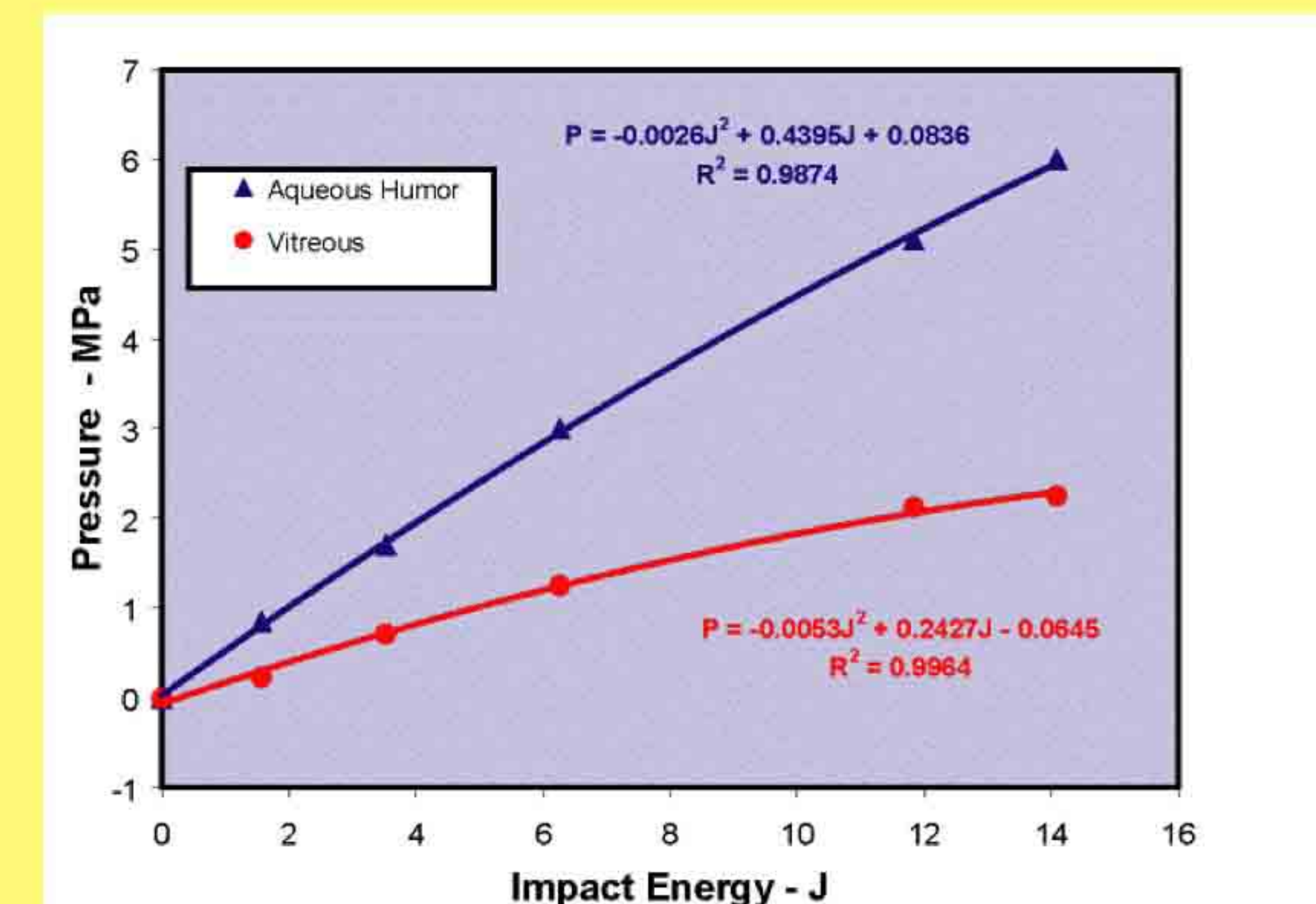
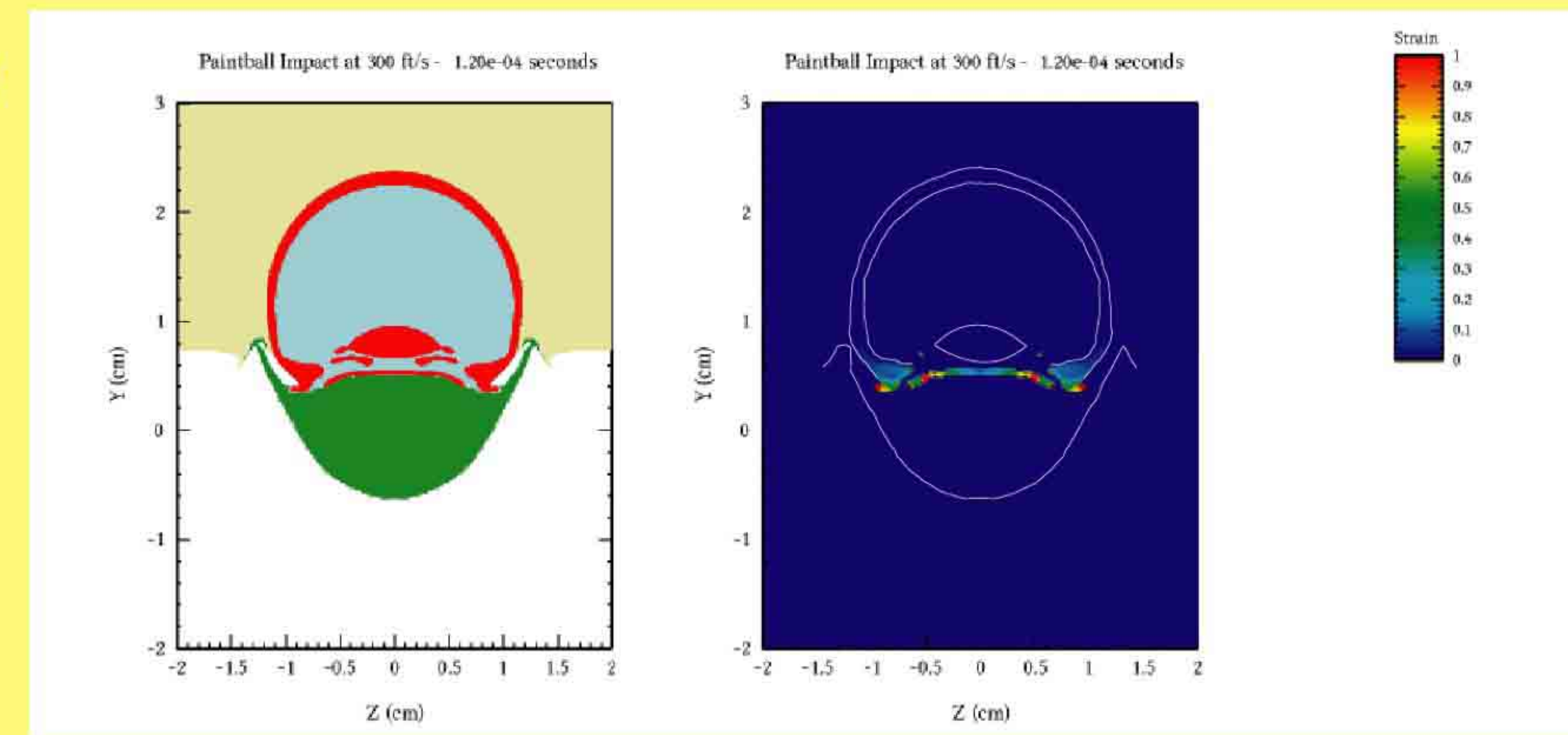
Globe Rupture



Lens Displacement

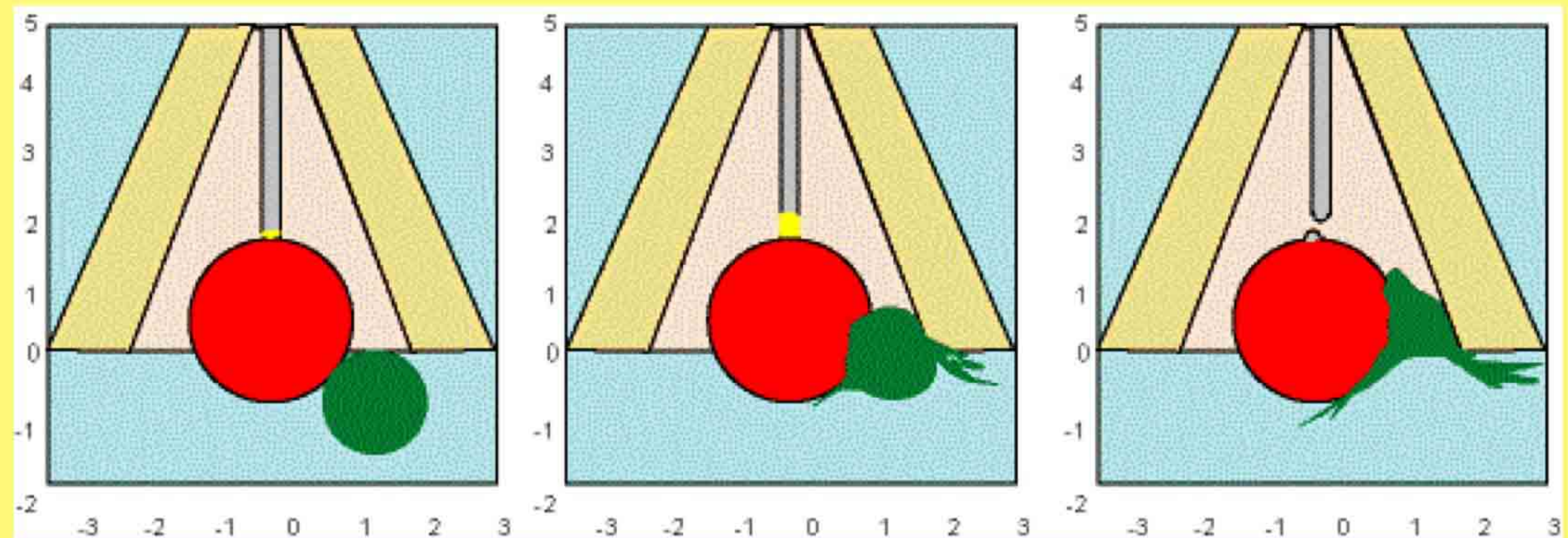
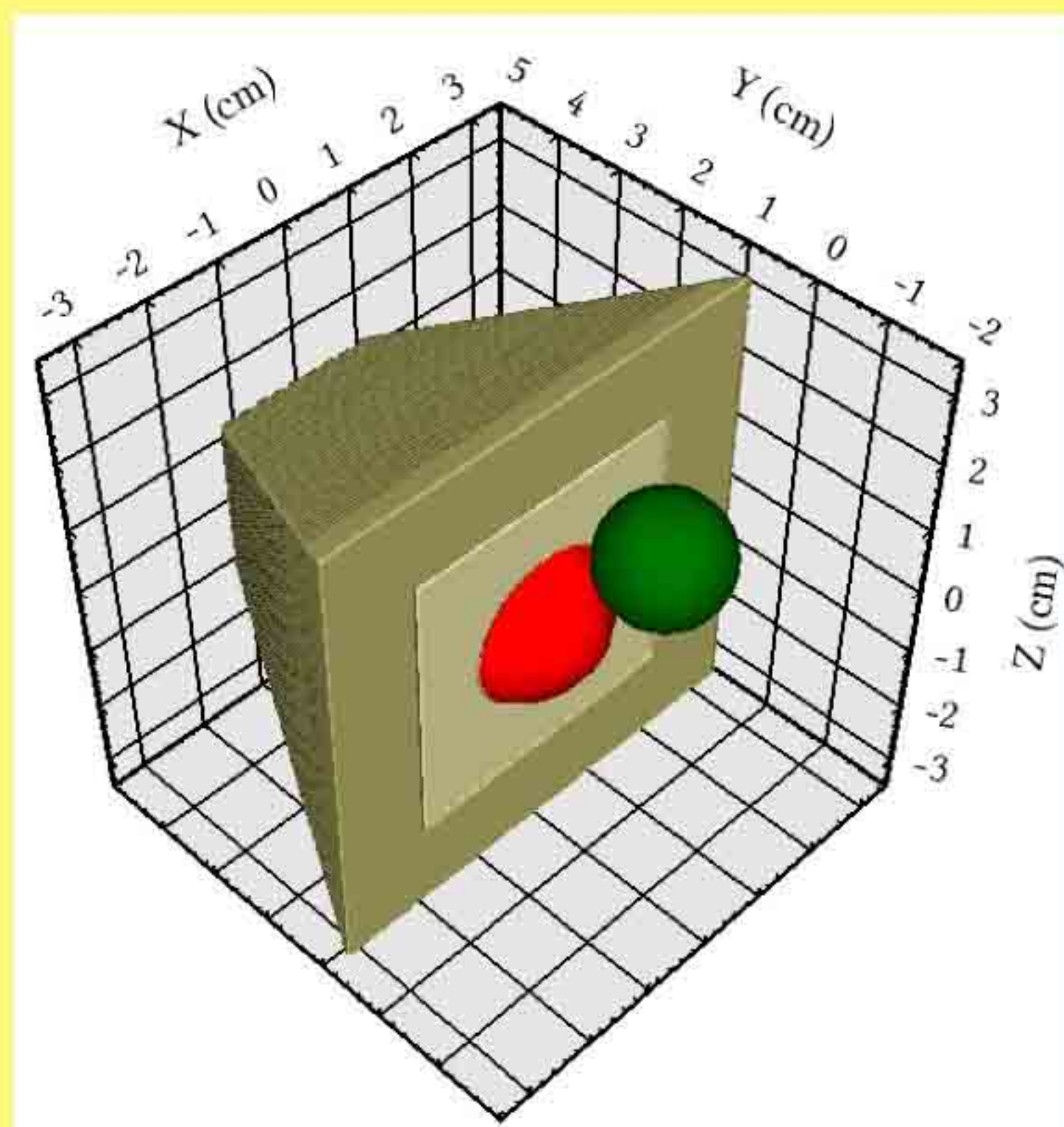
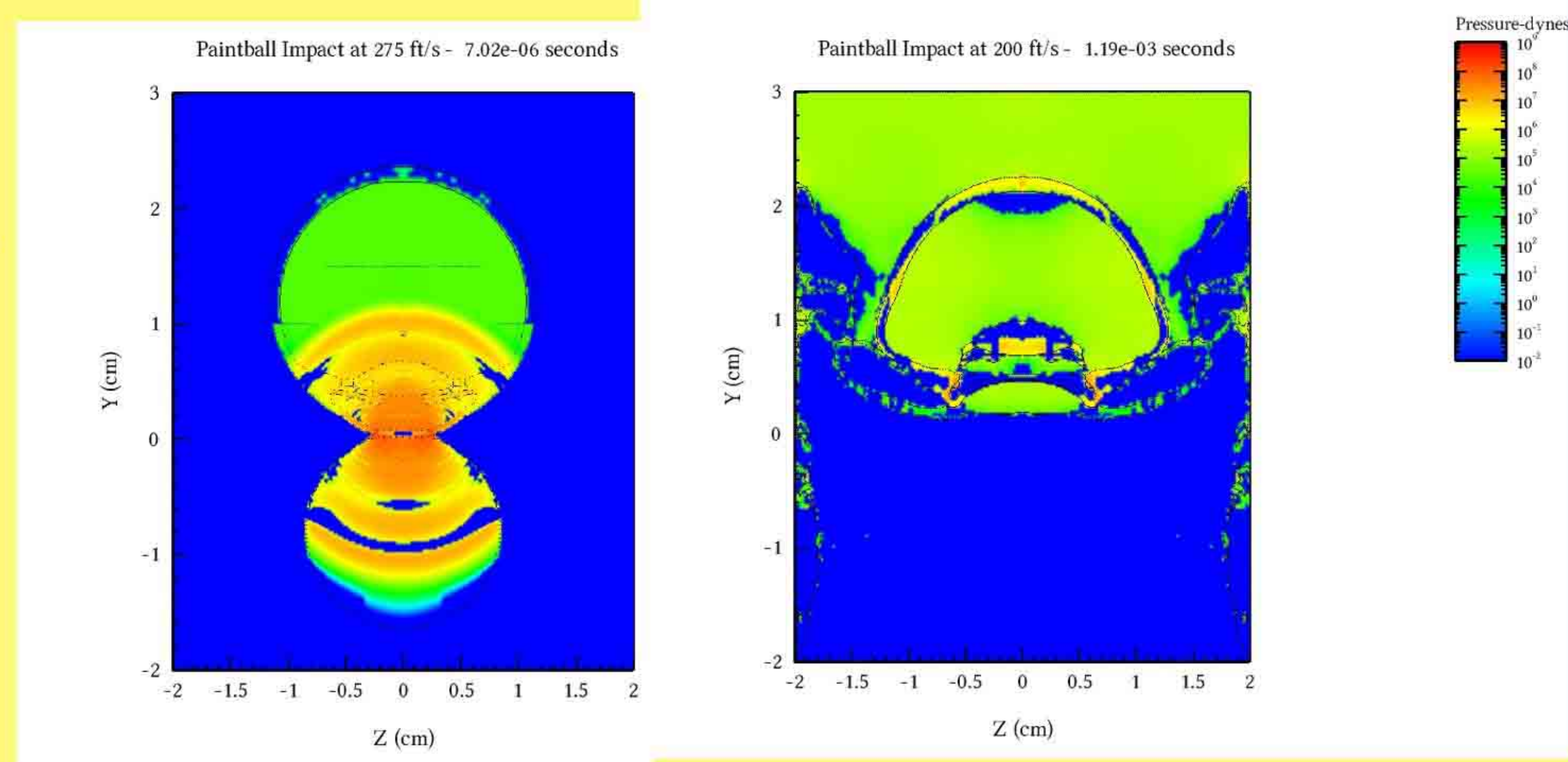
Injury Mechanisms

- High strains (50-100%) in the angle region and ciliary body consistent with the ubiquitous angle recession and cyclodialysis
- Hydrostatic pressurization of the anterior chamber responsible for lens displacement.
 - Pressure loading was sufficient to initiate posterior displacement in advance of cornea.
- Pressure “traps” iris against lens resulting in iridodialysis.



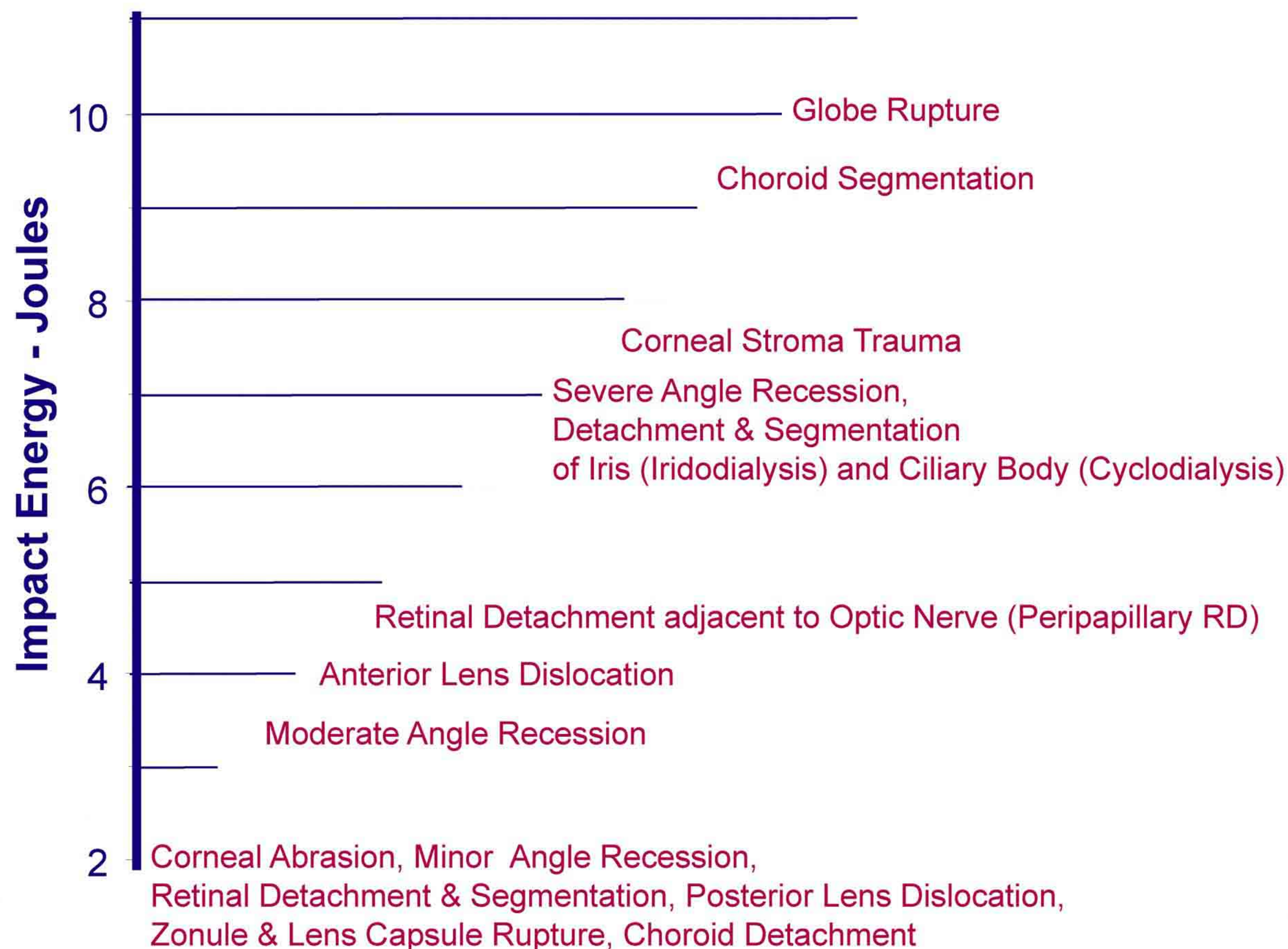
Injury Mechanisms

- Late-time pressure wave reflections off posterior segment may explain contra-coup injuries, especially retinal and choroidal detachment.
- Optic nerve avulsion results from off-axis hit and rapid rotation of globe



Correlation of Trauma with Impact Conditions

Paintball Impact Ocular Trauma Thresholds (Porcine)



Blast injuries

The detonation of an explosive device causes a high-speed chemical decomposition of a solid or a liquid into a gas. creates a **blast wave** of high pressure compressed gas that expands supersonically 10,000 m/sec to 30,000 m/sec.

followed by **blast wind** of -ve pressure, sucks back fragments of the explosive device, and surrounding debris

Blast waves wrap around objects

Buildings may not protect from a blast on opposite side

Eye injuries caused by a combination of two factors:

- 1: the blast wave, causes direct contusion of the eye
- 2: fragment projectiles, cause various penetrating injuries

Account for 70% of warfare ocular trauma

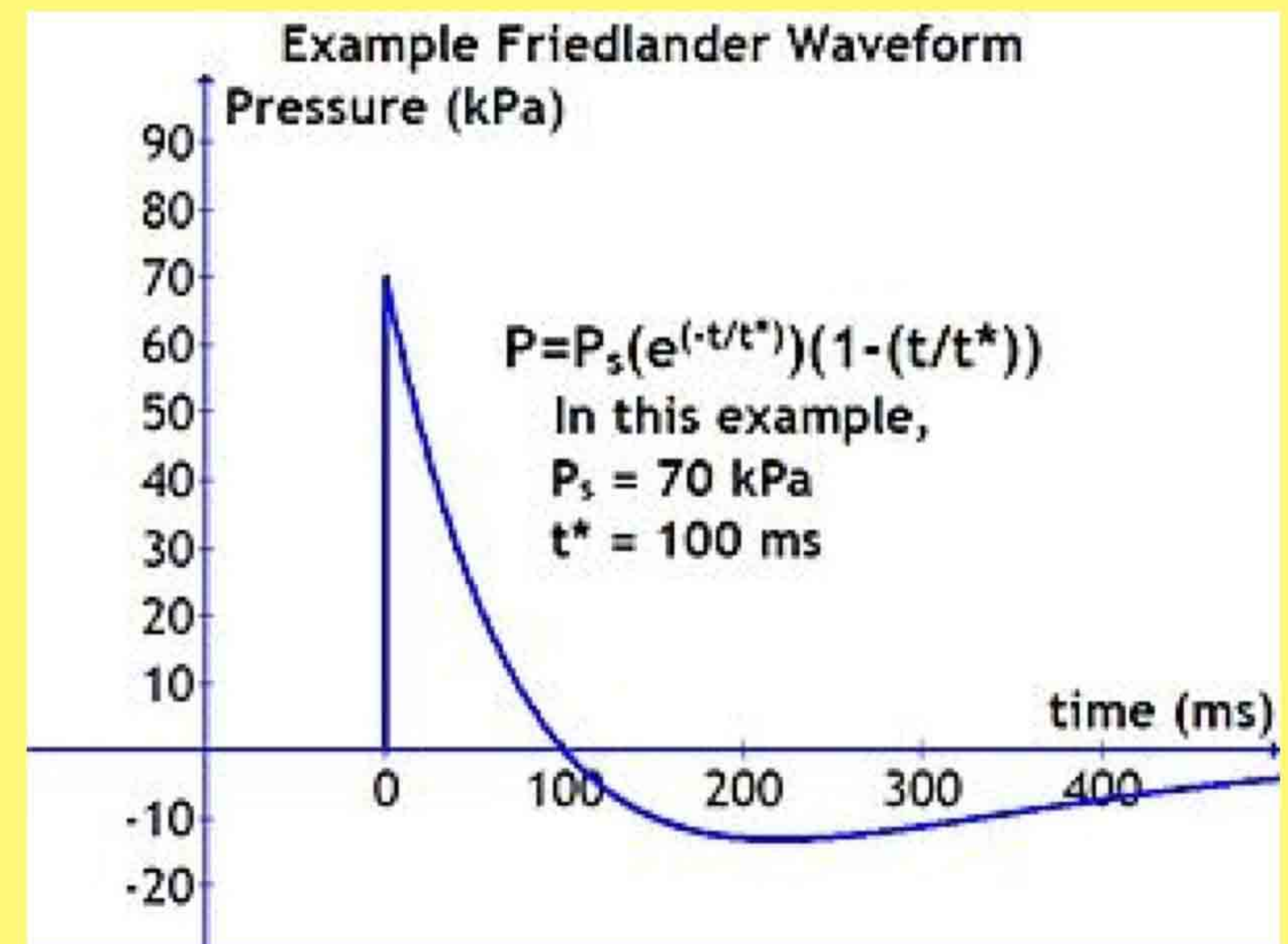
Exposed surface eyeball only 0.1% of the frontal body silhouette, ocular injuries in warfare is about 20 to 50X higher than expected.

Mines: 15% of all munitions-related causes of ocular injuries.

injuries associated with explosive blasts, ocular injuries common, >28% of blast Survivors.

increase with the distance from the site of the explosion (0 m to 20 m = 2%, 50 m to 80 m = 14%).

Any type of closed and open globe lesion may occur bilateral with intraocular foreign bodies and polytrauma.



The future

Lasers

Gas

light is transmitted through the clear ocular media and imaged onto a very small spot on the sensory retina.

In a moment, tissue necrosis and blindness

Lasers targeting and guidance systems, fire-control devices, access-denial systems and communications security.

use of lasers as a weapon is a violation of the Geneva Convention, the potential for nefarious use continues to attract international concern.

a few microjoules of laser through the pupils in a 10 to 30 nanosecond pulse can produce a visible lesion.

At 150 to 300 microjoules, a small retinal hemorrhage can occur, a devastating effect on a pilot's vision.



Wall painting from the Stanzino delle Matematiche in the Galleria degli Uffizi (Florence, Italy). Painted by Giulio Parigi (1571-1635)

THANK YOU

Thanks to patients

Colleagues

Gillies archive

Giorgio Romani, MD, Policlinico

Militare di Roma,

Wikipedia

Ric Sponsel

Staff of Gresham College

Royal College of Surgeons

Rob Scott

