
good morning
MG

Session 2
The Middle Ages, Weapons and Injuries

Plan for the Course

- Session 1: Ancient history, Rome, Greece.
- Session 2: Middle Ages, weapons & injuries.
- Session 3: US Revolutionary & Civil Wars.
- Session 4: World War I.
- Session 5: World War II.
- Session 6: Korea, Vietnam.
- Session 7: 20th & 21st Century Regional wars.
- Session 8: Peek into future, Nuclear War?

Plan for Session 2

- Metals in history
- Chronology of Medical & Surgical Knowledge
- Medieval Wound treatment
- Bows and Arrows
- Battle of Crécy
- Arrow extractions
  - Bodkin: Prince of Wales (Henry V)
  - Broadhead: Jan Ipman technique

Metals in History

Primitive man discovered meteorites made of nickel and iron and learned to smelt these elements into steel.

In the Iron Age, blacksmiths discovered that iron became stronger, harder and more durable with the addition of carbon in the coal furnaces.

Prior to the Iron Age, bronze was the primary metal used to make tools and weapons, but steel soon became the metal of choice.

By the 6th century BC, *Wootz* steel was being used by craftsmen in southern India: this is created by smelting wrought iron with charcoal.

It has tough, sharp qualities, because of the swirling pattern produced by bands of clustered Fe_3C particles during the smelting process.

Metals in History

- Steel from China can be traced all the way back to the 2nd century BC, with evidence of mass production of high quality steel products made around the 3rd century AD.

- Damascus steel originated during the 11th century, was used for swords made from Wootz steel, which resisted shattering and held a razor-sharp edge.

CHRONOLOGY of MEDICAL and SURGICAL KNOWLEDGE

The Early Middle Ages

(800 – 1200 A.D.)

- After the Roman Empire collapsed in the 5th century, the practice of medicine declined, and healers cared for the sick and wounded.
- Few advances in medicine happened in the Middle Ages.
- Medical practice did not really start evolving until the 9th Century.

The Early Middle Ages
(800 – 1200 A.D.)

- During Charlemagne's reign, the Benedictines founded the cathedral medical schools with:
  - a medicinal herb garden
  - rooms for 6 sick people
  - a pharmacy
  - special lodging for a physician

- The 1st hospital in Western Europe was at the monastery of St. Gall in 820 A.D.

Medicine and the Church

- The very conception of medicine, as well as its practice, was deeply touched by the doctrine and discipline of the Church.
- This theological and ecclesiastical influence manifestly shaped the ethics of medicine, and indirectly affected its science.
- As missionaries evangelized Europe, the Church constantly battled against superstition and magic in the work of healing.
- The Church championed rational medicine, along with prayer, to counter superstition.

Medicine and the Church

- To care for those who were ill, St. Basil of Caesarea founded the first hospital in Cappadocia (c. 369).
- Christian hospitals grew, spreading throughout both the East and the West.
- By the mid-1500's there were 37,000 Benedictine monasteries that cared for the sick.
- Four centuries after St. Basil's hospital, Arab Muslims began to build hospitals.

The Knights Hospitaller
(1113-1309)

- The Order of Knights of the Hospital of Saint John of Jerusalem (Latin: *Ordo Fratrum Hospitalis Sancti Ioannis Hierosolymitani*), was a medieval Catholic military order.

- It was initially headquartered in the Kingdom of Jerusalem, later in Cyprus and Malta.

- It was charged by papal bull with the care of ill Christian pilgrims to the Holy Land.

The Knights Hospitaller

- They later extended their work to provide pilgrims with armed escort in the Holy Land.
- Eventually they became a significant military force, like the Knights Templar.
- The Order of St. John became militaristic without losing its charitable character.

The Knights Hospitaller

13th Century

- They founded hospitals and infirmaries and cared for the injured during the Crusades.

- The organization became a military religious order under its own papal charter, charged with the care and defense of the Holy Land.

Medicine and the Church

- The rebirth of medicine and the start of modern medical history begins at the end of the 4th century.
- This coincides with the founding of the first Christian hospital at Cappadocia.
- By the end of the 14th century, medicine was in place in the universities and in the public life of the emerging nations of Europe.

The High Middle Ages
(1200 – 1400 A.D)

- In the 13th and 14th centuries, universities like Bologna and Montpellier started issuing degrees in medicine and graduated the first true "physicians".

- William of Saliceto (1210 – 1280) set up the 1st school of surgery.

- He recommended the use of knives instead of cautery during surgery and taught that pus was a bad thing, not a good thing.

Late Middle Ages and Renaissance
(1400 – on)

- During the 14th century, guns became more widespread in battle, therefore the art of surgery also advanced.
- Amputations were closed with a skin flap instead of being cauterized, and arteries that were tied did better than ones that were cauterized.
- Ambroise Paré found that a mixture of eggs, oil of roses and turpentine healed wounds better than scalding oil.

17th Century

- After three hundred years the dominance of the longbow in weaponry was coming to an end and giving way to the age of muskets and guns.

- The last battle involving the longbow took place in 1644 at Tippermuir in Perthshire, Scotland during the English Civil War.

MIDDLE AGE WARFARE

Middle Age Warfare

- All war is hell, but medieval war was especially hellish.
- Medieval warfare was terrible, it was brutal and it was largely inhumane.
- The preferred method to kill large numbers of people in medieval times was the use of sharp objects.
- Swords, knives, javelins, arrows, spears, and pikes were all popular, brutal, and lethal.

Middle Age Warfare

- If the injury was a crushing hit to the skull, warriors had a hole drilled in the skull to relieve pressure on the brain (trephining).
- Salves of various effectiveness would be applied to fight infections.
- Pain killers in the form of teas, alcohol and even opium would be given to the wounded.
- Next step: WAIT, and PRAY to the gods!!!

Medieval Warfare

- Social standing dictated how aggressively wounds would be treated , but ironically, the most aggressively treated wounds might not have had the best ending.
- Once an infection set in, the patient would be bled to rebalance the humors.
- The more important injured would be placed closer to the church altar because the closer to God you were the better your chances were.

Medieval Warfare

- Wound prognosis was poor:
  - a puncture wound to an extremity may lose that limb
  - a penetrating wound to the torso was usually fatal

- In medieval times, armor was light or non-existent, especially for the poor.

- Swords were capable of limb amputations, slashing damage, and even decapitations, as well as blunt and piercing damage.

- A common tactic was to bring your sword in under the shield of an opponent, striking the legs; once the opponent was down you could then deliver a killing blow.

Medieval Warfare

- Ancient Celt & Greek units fought almost naked because bits of cloth embedded in a wound were more dangerous than enemy weapons.
- In late medieval times, swords fell out of favor in the battlefield because they could not pierce the heavy armor of the day and were ineffective as slashing weapons.
- Predominant were spears, poleaxes, maces, flails, lances and especially the bow and arrow, the most lethal weapon on the battlefield.

Face-to-Face Combat

Medieval Melee Weapons

Medieval Armor

- Mongols learned from the Chinese to use multiple layers of silk cloth on top of each other, like a gambeson.
- Silk is surprisingly resistant to cutting or piercing.
- It would be more than capable of resisting an errant shot from long range
- Armor does not have to stop an arrow to be useful, it's enough if it can slow down an arrow to change a deadly wound into merely a painful one.

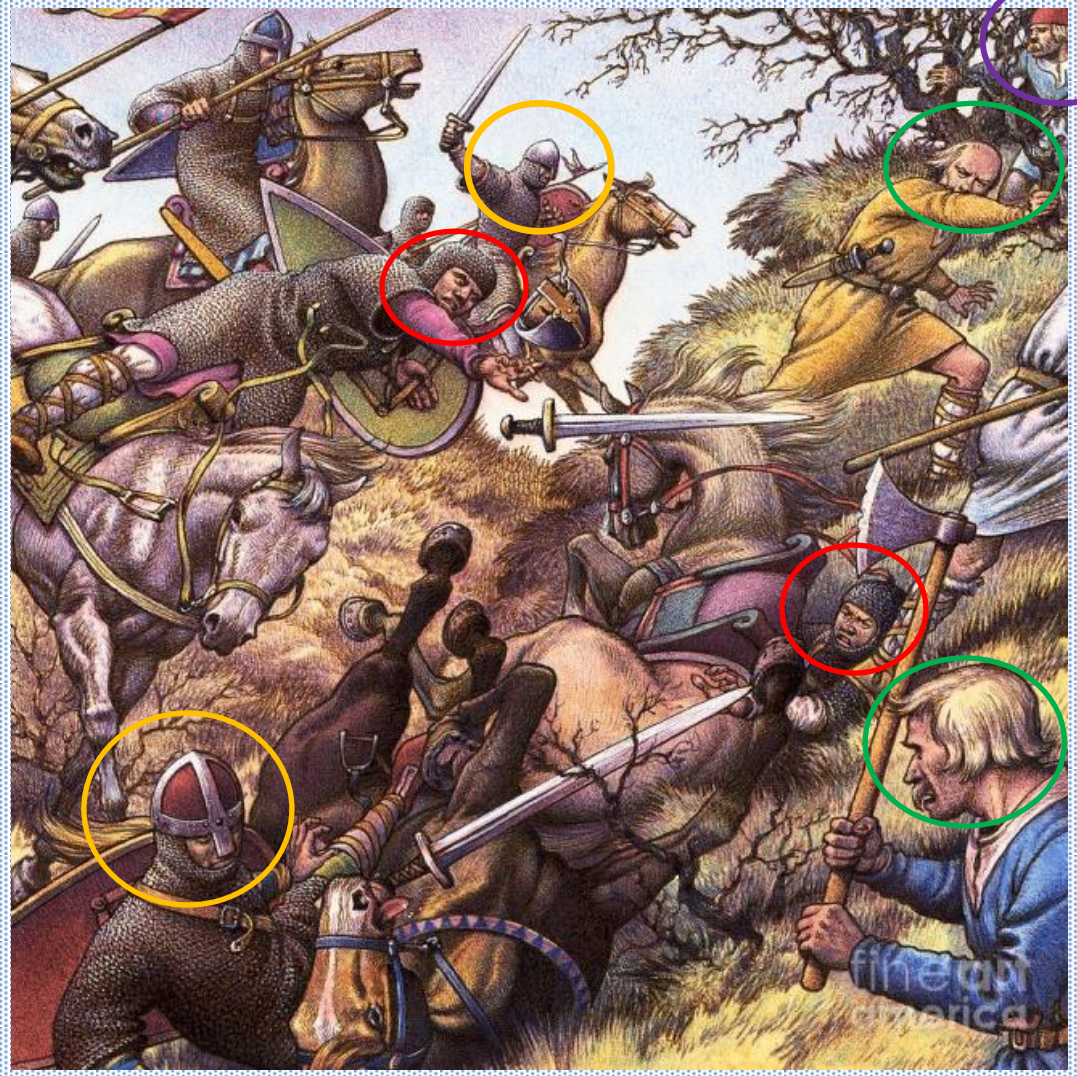
Medieval Armor

- Mongol cavalrymen would wear a heavy protective silk undershirt under their lamellar or mail armor.
- Even if the arrow penetrated armor, it might not penetrate the silk.
- Wearing a silk undershirt made it easier to extract the arrow without additional damage.

Arrow Wounds

- Unless the warrior was rich, or an officer, he would have no metal helmet.
- He may have padded cloth headgear with scant protection against arrows.
- If he were lucky, a chain metal head cover would be available to him, if not…..

Medieval Headcoverings



Green: bare head
Purple: cloth cap
Red: Chainmail
Orange: Helmet

Archers and Warfare
Battle of Crécy
Medieval Arrowheads
Extraction of Arrowheads
Henry, Prince of Wales

BOWS and ARROWS

English Longbows

- The best English longbows were made from yew and were around 6 feet tall.
- Drawing the weapon required anywhere from 150 to 180 pounds of force.
- Depending on the weight of the arrow, archers could shoot the projectiles about 1,000 ft. (333 yards)

English Longbows

- Medieval longbows played a pivotal role in many 14th and 15th century clashes.
- During a brief archery duel a large force of French mercenary crossbowmen was defeated by Welsh and English Cheshire longbowmen.
- At the Battle of Crécy in 1346, historians estimate that English archers fired about 35,000 arrows **per minute**, achieving victory despite being outnumbered by a ratio of 2 to 1.

Battle of Crécy

English Army

Modern historians estimate its size at about 15K:

- 2,500 men-at-arms,
- 7,000 longbowmen,
- 3,250 light cavalry and mounted archers
- 2,250 spearmen.

Battle of Crécy
French Army

It was at least 2X and perhaps as much as 3X as large as the English:

- 10,000 mounted men-at-arms
- 10,000 mercenary crossbowmen from Genoa,
- 12,000 infantry

Battle of Crécy

France

England

Battle of Crécy

English Army

- Archers carried 1 quiver of 24 arrows; the morning of the battle, they were each issued 2 more, for a total of 72 arrows per man.
- This was enough for 15 minutes' shooting at the maximum rate, although as the battle wore on, the rate would slow.
- Resupply of arrows would be from the rear wagons, but archers also ventured forward during pauses to retrieve arrows.
- Modern historians suggest that over half a million arrows could have been shot during the battle.

Battle of Crécy

French Army

- The French first sent out the mercenary Genoese crossbowmen, about 10K men.
- Their firing rate of 3 to 5 volleys per minute was no match for the English and Welsh longbow men who could fire 10 to 12 arrows per minute.
- The longbowmen outranged their opponents and had a rate of fire more than 3 times greater.

Battle of Crécy

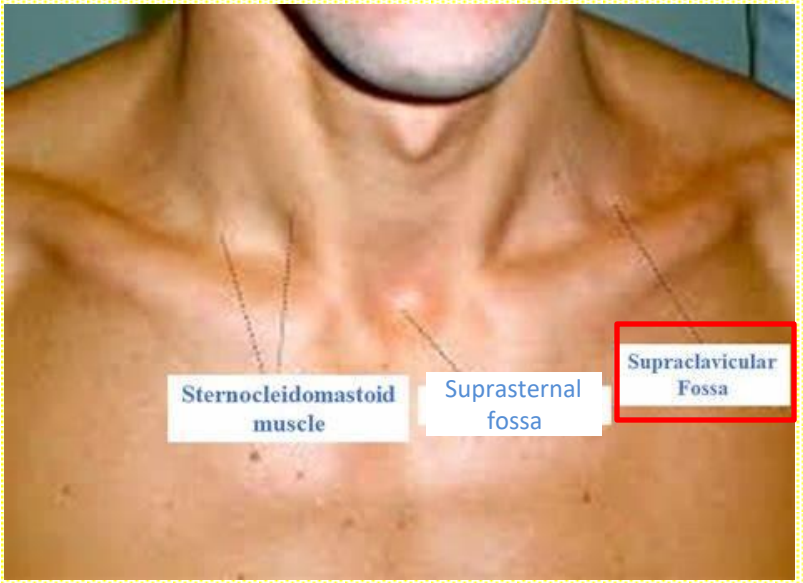
Volley of Arrows

The English and Welsh archers, some ten ranks deep, rained tens of thousands of arrows down onto the mud-trapped French and what followed was a bloodbath.

The battle itself lasted just a few hours and between 10K and 15K French were killed while the English only suffered losses of about 300.

Volley of Arrows

- Volleys would be like a rainstorm of arrows coming down from the sky.
- Injuries were mostly in the head, face, upper body, and occasionally arms and legs.



Arrows that penetrated the chest through the supraclavicular fossa could injure the heart, lungs, or aorta and could cause death in a few minutes.

Soldiers Attacked by Arrows

Volley of Arrows

Medieval Arrowheads

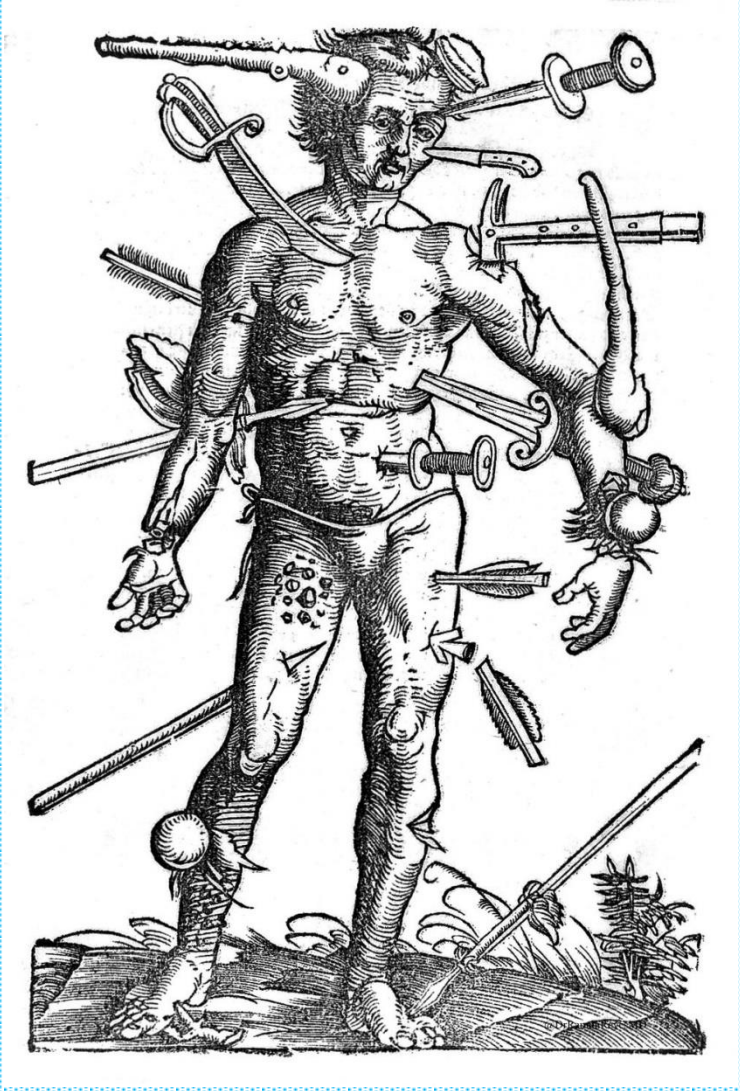
- The longbow used by the English and Welsh archers took up to 10 years to master and could discharge up to 10 arrows per minute well over 300 meters (~1,000 ft).
- Bodkins had the force to pierce armor while the wide cutting surface of the broadhead caused more serious wounds and tissue damage.
- Bodkin point arrows could penetrate typical plate armor at 250 meters (~750 ft).

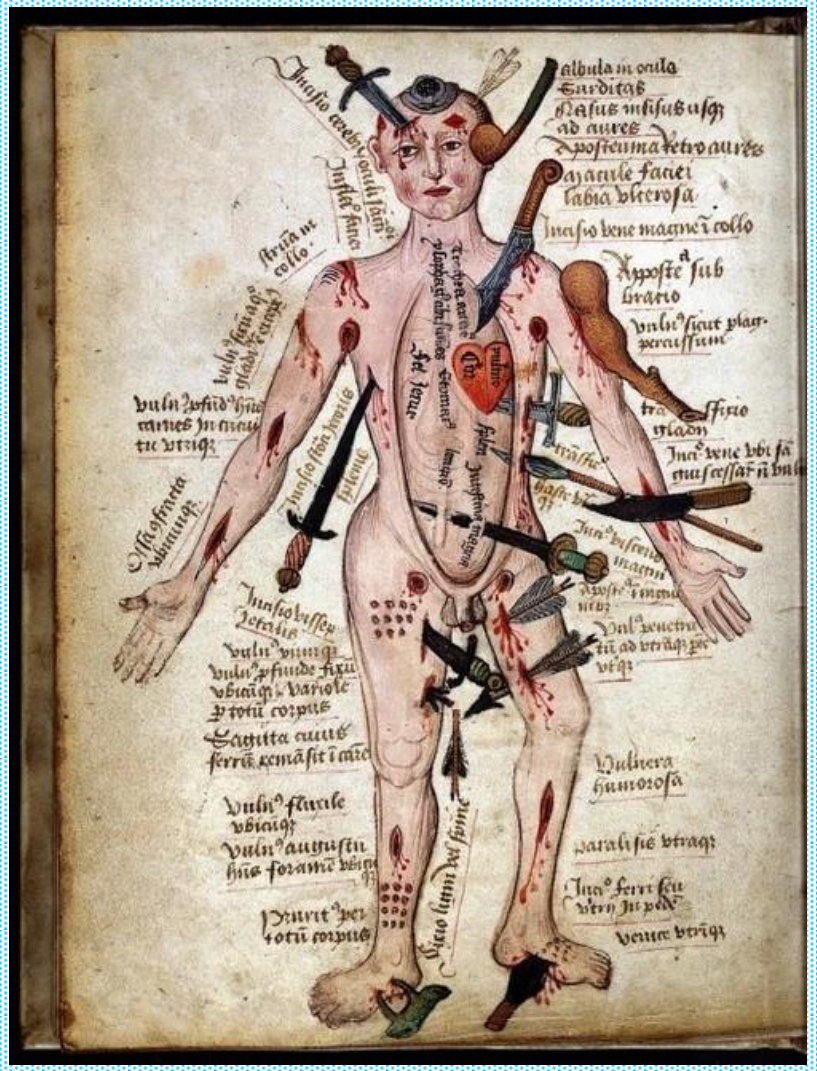
Medieval Arrowheads

Questions? (1)

WOUND TREATMENT

The “Wound Man”





Medieval Wound Treatment

If an organ was pierced it was invariably fatal, in a slow and agonizing death.

If too much blood was lost it was fatal.

Infections were often fatal.

Bleeding could be fatal to a man who might otherwise have survived.

Stitches were uncommon, and they could be fatal by causing an infection.

Most wounded were going to die anyway, and any chance was better than none, so experimenting was frequent.

Wound Treatment

- Theodoric, Bishop of Cervia (1205–1298), recommended the use of wine to clean wounds, because the concept of cleanliness was evolving.
- He wrote that sponges should be soaked in drugs like opium and held over a patient's nose to induce a "deep sleep".
- This is the first recorded use of pre-operative anesthesia!

Wound Treatment

- Knowledge of Anatomy was rudimentary, and knowledge of Microbiology was non-existent, so surgery was primitive and drastic.
- Amputations of arms or legs were the most frequent interventions.
- No abdominal or thoracic surgeries were even attempted.

Wound Treatment

- Guy de Chauliac (1300 – 1368), the most influential surgeon of the 14th & 15th centuries, outlined 4 conditions for wound treatment:
  - 1. Remove foreign bodies from the divided parts
  - 2. Bring together the divided parts
  - 3. Unite the parts drawn together
  - 4. Conserve and maximally preserve the tissue

- Today, ~650 years later, the same principles are used for the treatment of wounds.

Wound Treatment

- Sharp objects leave nasty injuries that can linger for days before ultimately leading to death.
- Before antiseptics and antibiotics, a stab wound in the thigh could quickly become infected.
- Infected wounds if contaminated with blood, guts, dirt, and sweat would not always resolve by themselves, and could end in death.

Wound Treatment

- One method of treating severe cuts that were still bleeding was cauterization of blood vessels.
- After cauterization, honey and egg whites could be applied directly as an ointment to help reduce inflammation and prevent infection.
- Prior to bandaging, wounds would be cleaned with some type of alcohol such as wine.

Wound Treatment

- On the battlefield, many wounds got little treatment beyond staunching or cauterizing for bleeding.
- Foreign material was removed and poultices made of ingredients like herbs or dung might be applied, and animal urine was often used to reduce infection.
- Pain medications like alcohol or opium might also be given.

Surgery in Middle Ages

- Broken bones and grievous wounds required surgery.
- This was done without the benefit of anesthesia, as most means of “putting someone under” were as likely to kill them as was the surgery.
- Associating infection with lack of cleanliness was entirely unknown at the time, so surgery was not done in anything remotely resembling a sterile field.

Surgery in Middle Ages

- Without surgery, many of the people who were stabbed in the gut would never survive.
- This led to tents and camps full of groaning people slowly dying of wounds which the doctors of the day had no means of treating
- Some people recovered, but many more would languish and slowly die.

ARROW WOUNDS TREATMENT

Arrow Wounds Treatment

- If an arrow did not clearly exit the body, it would require removal, causing further injury.

- Arrowheads were attached to the shaft by adhesive, cording, or wax, so that upon penetration, the head would stay imbedded making extraction challenging and increasing risk of infection.

- Wound infection was common because use of soap and water was infrequent and bathing was considered unhealthy.

Arrow Wounds Treatment

- If bodkin arrows were used, and the injury was in an extremity, the usual treatment was to push it through to the other side.
- When the arrowhead exited the extremity, the shaft would be cut and pulled back through the wound.
- This was an extremely painful procedure and predisposed to serious infection.

Arrow Wounds Treatment

Aulus Cornelius Celsus (c. 25 BC – c. 50 AD)

- First to systematically differentiate removal of arrows:
  - *per extractionem: extracted from the side where it entered the body*
  - *per expulsionem*: pushed or pulled through after incision of the soft tissues at the opposite side

- He understood the importance of pushing an arrow through emergence as opposed to pulling with traction.

- He developed a surgical instrument, which he called the spoon of Diocles, to aid in this process.

Arrow Wounds Treatment

Aulus Cornelius Celsus (c. 25 BC – c. 50 AD)

- If the arrowhead was still attached to the shaft, Celsus preferred removal *per expulsionem;* wounds from arrows removed this way did better than wounds with a single opening.

- If there was bone or essential organs located in front of the arrow, it had to be removed *per extractionem*: the entry wound had to be enlarged and hooks had to be broken off with a forceps or covered with split tubes.

- Instead of split tubes Celsus recommended the spoon of Diocles.

Arrow Wounds Treatment

Options for dealing with an arrow in the body:

- Leave it in there, hope it heals over.
- Propulsion: force the embedded arrow through the flesh thus creating an exit wound, then sealing with lard.
- Saw off the shaft, leave for 8-14 days until the wound becomes full of pus; then lift out the arrowhead, and scald the site with boiling oil and a branding iron.

Arrow Wounds Treatment

Options for dealing with an arrow in the body:

- Stretch the wound by plugging it with probes of elder pith soaked in honey, then, using a special tool, reach for the arrowhead, slowly pull it free, wash with white wine, then apply a gauze soaked in barley, honey and turpentine.

- Later, the wound is washed and sealed with hot plaster to prevent "spasms" (probably tetanus).

Arrow Wounds Treatment

- Pliny the Elder (AD 23–79) used the perennial *dittany* for extracting arrowheads, because it causes the point to fall out when placed on the wound.
- He adds that this was first discovered by hunters, who observed that arrows became dislodged from wounded stags who grazed on this plant.
- Rhazes (c. 925) mentions extractive drugs made with a honey-based compound with ammoniac salt, reed root or narcissus bulb that draw out thorns and arrowheads from flesh.

Arrow Wounds Treatment

Avicenna (980-1037)

- Gives a complex list of extractive drug recipes for removing arrows in the *Canon of Medicine,* as a supplement to surgical instructions.

- Tells of several extractive drug recipes prepared from plant and animal materials, like reed root and narcissus bulb, but does not mix these with honey.

- The reed root should be crushed on the wound and the narcissus, added to a plaster of gillyflower and birthroot.

- Advises the use of frog skins, which uproot teeth, so, when placed on arrow wounds, this will draw out even the most adherent points.

Arrow Wounds Treatment

- Arrows cause both a puncture and an incision wound.
- If the arrow pierces a person, it leaves entry and exit wounds:
  - the entry wound looks like a darkened, bruised, and depressed slit
  - the exit wound looks like a simple slit
- If they hit the target tangentially, it results in a linear slit that resembles a laceration.

Arrow Wounds

- Vikings used to have a simple test to determine if a given arrow wound was survivable.
- After the arrow was removed they'd feed the wounded a strong-smelling onion soup.
- If the wound smelled like onions, odds are they were going to die because the wound had penetrated a vital organ.

Arrow Wounds Treatment

(Chest)

- If the arrow penetrates the lung, the warrior would die 72% of the time.
- These wounds rarely resulted in collapse of the lung, because the arrow usually remained lodged within the thorax, and would act as a seal.
- Arrow wounds allow the outward flow of fluids, but if they remain in their target, they serve as a seal for blood vessels and organ structures.

Arrow Wounds Treatment
(Chest)

- If the warrior survives the hemorrhage period, the prognosis was favorable unless the arrowhead was lodged in lung tissue, then the prognosis was less favorable, often resulting in his demise.

- All instances when the arrow either pierced both lungs or the heart resulted in death.

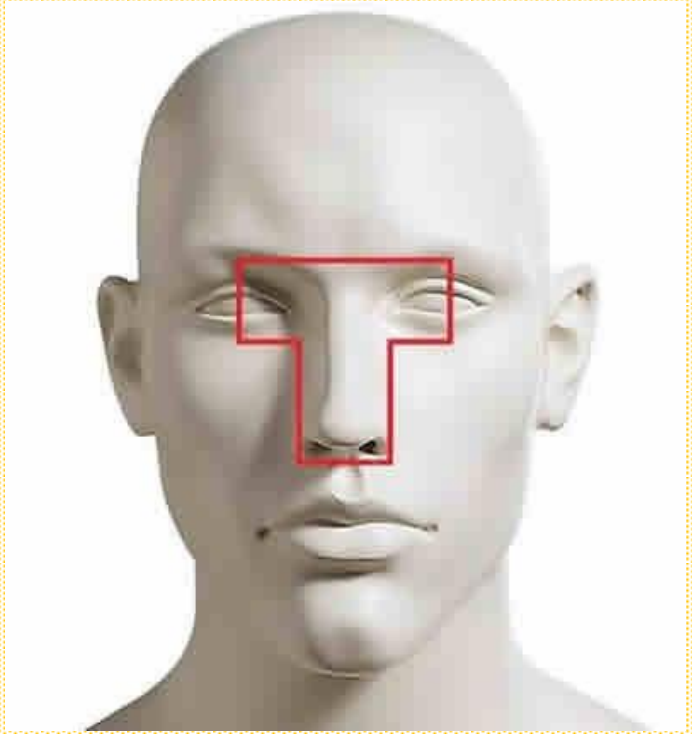
Arrow Wounds Treatment

(Abdomen)

- Arrow wounds of the abdomen and pelvis were generally fatal.
- Fecal spillage and peritonitis led to often fatal infections; the other main cause of death for abdominal wounds was hemorrhage.
- Treatment of an arrow wound of the abdomen depends on type of arrow, hemorrhage, and injury to major vessels or intestines.

Arrow Wounds Treatment

- If you hit this “T” shaped area with an arrow, the person will be dead almost immediately as a shot here will end brain function.
- A shot to the heart or a major artery with a broadhead will kill the person in about 10 to 20 seconds.



Arrow Wounds
(Head)

- These images show a mannequin made of a plastic gel with the density of a human body.
- A bodkin arrow is fired against the head shape at a distance of about 75 feet.
- The shape is protected by chain mail, but the arrow clearly enters and traverse the head.

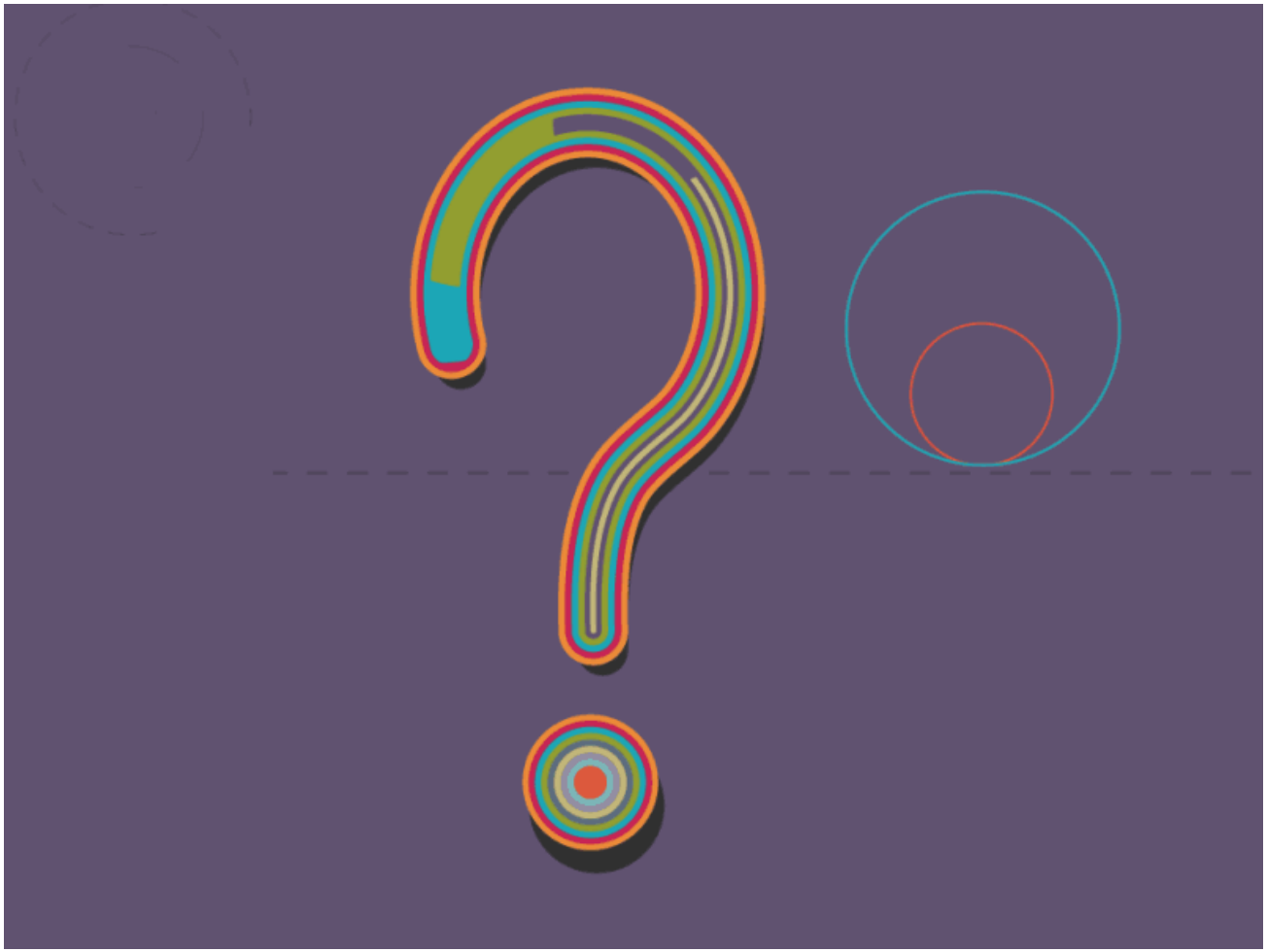
Arrow through Head Chainmail

Arrow through Head Chainmail

Arrow through Head Chainmail

Arrow through Head Chainmail

Questions? (2)



ARROW EXTRACTION

Arrow Extraction
(Spoon of Diocles)

The spoon enclosed the arrowhead and the barbed hooks, and allowed extraction of arrows without additional trauma to the warrior.

Arrow Extraction

- Archaic peoples developed considerable skill for extraction of arrows, including thoracotomy and trephination.
- Homer's Iliad introduces the term *iatros*, which means "he who extracts arrows."
- The high incidence of arrow wounds provided a major stimulus for the development of surgery, but during the Dark Ages in Europe, that standard declined drastically.

Arrow Extraction

- Under the dominant influence of the humoral concept, the procedure was to await pus before extraction and to burn the wound with boiling oil and a branding iron.
- Hippocrates and Galen, of the humoral doctrine, shunned surgical intervention and considered purulence a drainage of *materia peccans* (spoiled yellow bile, black bile, phlegm and blood), a good thing!
- Paulus of Aegina favored rapid extraction, aggressive therapy, and ligature on both sides of a vessel before extraction efforts.

Arrow Extraction

- In medieval Europe, the Catholic Church was the main cause for a decline in the standard of surgery.
- The humoral concept became dominant in the removal of arrows.
- This was usually done by leaving the arrow in the wound for several days until the accumulation of pus ensured that the arrow could be extracted more easily.
- Then the wound would be burned with boiling oil, a branding iron, or both.

Arrow Extraction

- In India they had many extraction methods, including excision of arrowheads, the use of magnets, bending of barbed hooks, and extraction from the opposite side after counter-incision of soft tissues (*per expulsionem*).

- Arrowheads firmly embedded in thick bone were a serious problem, which was solved by attaching one end of a string to the arrowhead and the other to a horse or to a strongly bent branch (*per extractionem*):
  - In the case of the horse, it was made to startle so that the string tore the arrow out of the bone
  - In the case of the branch it was released, and upon shooting up pulled the arrow with it

Tooth-pulling *per extractionem*

Extraction of Arrows

(Bodkin)

Extraction of Arrows
(Broadhead)

- Jan (Jehan) Yperman, Flemish surgeon, in 1304 wrote that 2 goose quills should be inserted alongside the shaft of the arrow into the wound.

- They would be placed over the barbs, blocking the cutting edges of the arrow, so the arrow can be removed via the channel thus created.

- The quills and arrow were removed as one.

Extraction of Arrows
(Broadhead)

Extraction of Broadhead

Extraction of Broadhead

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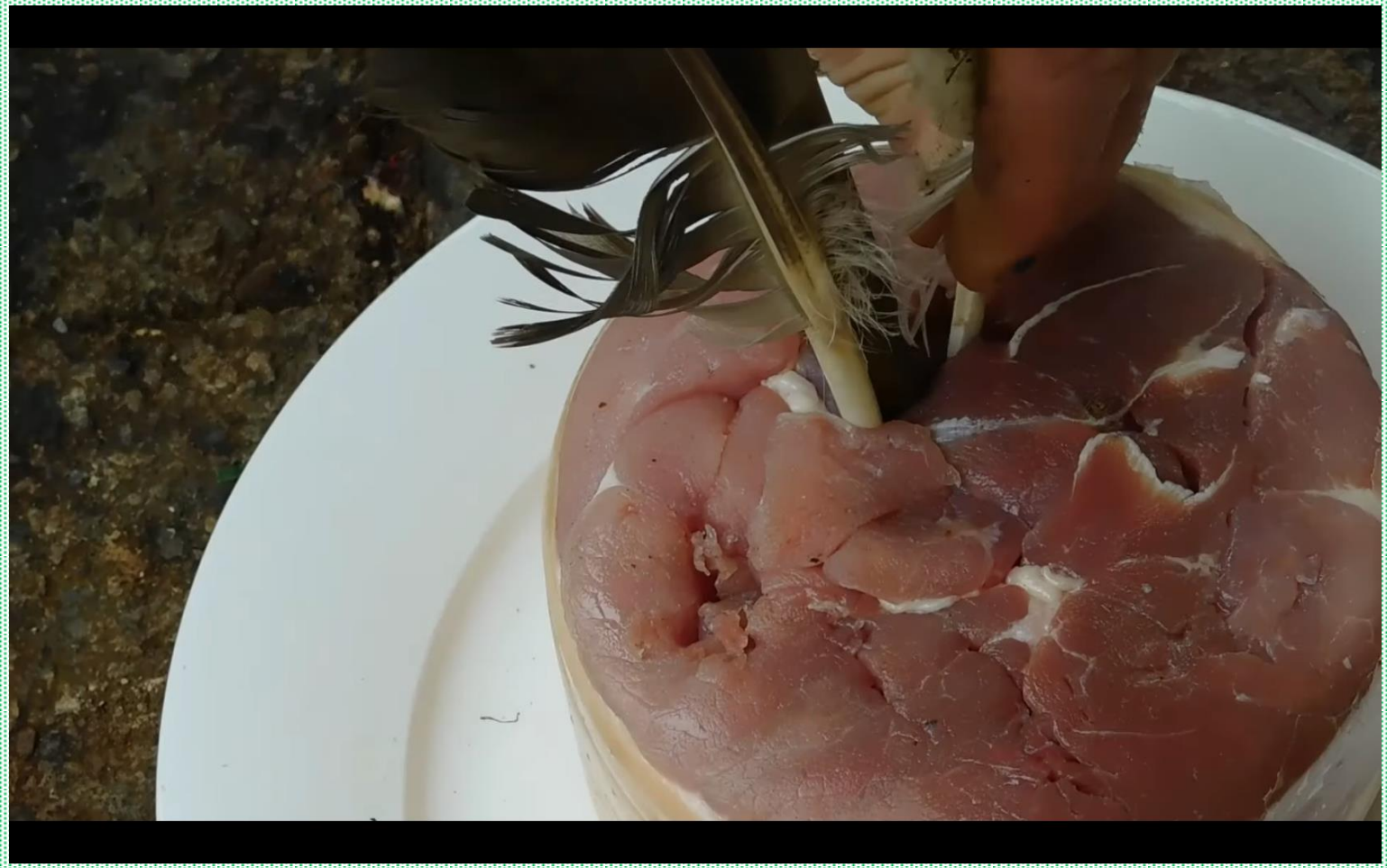
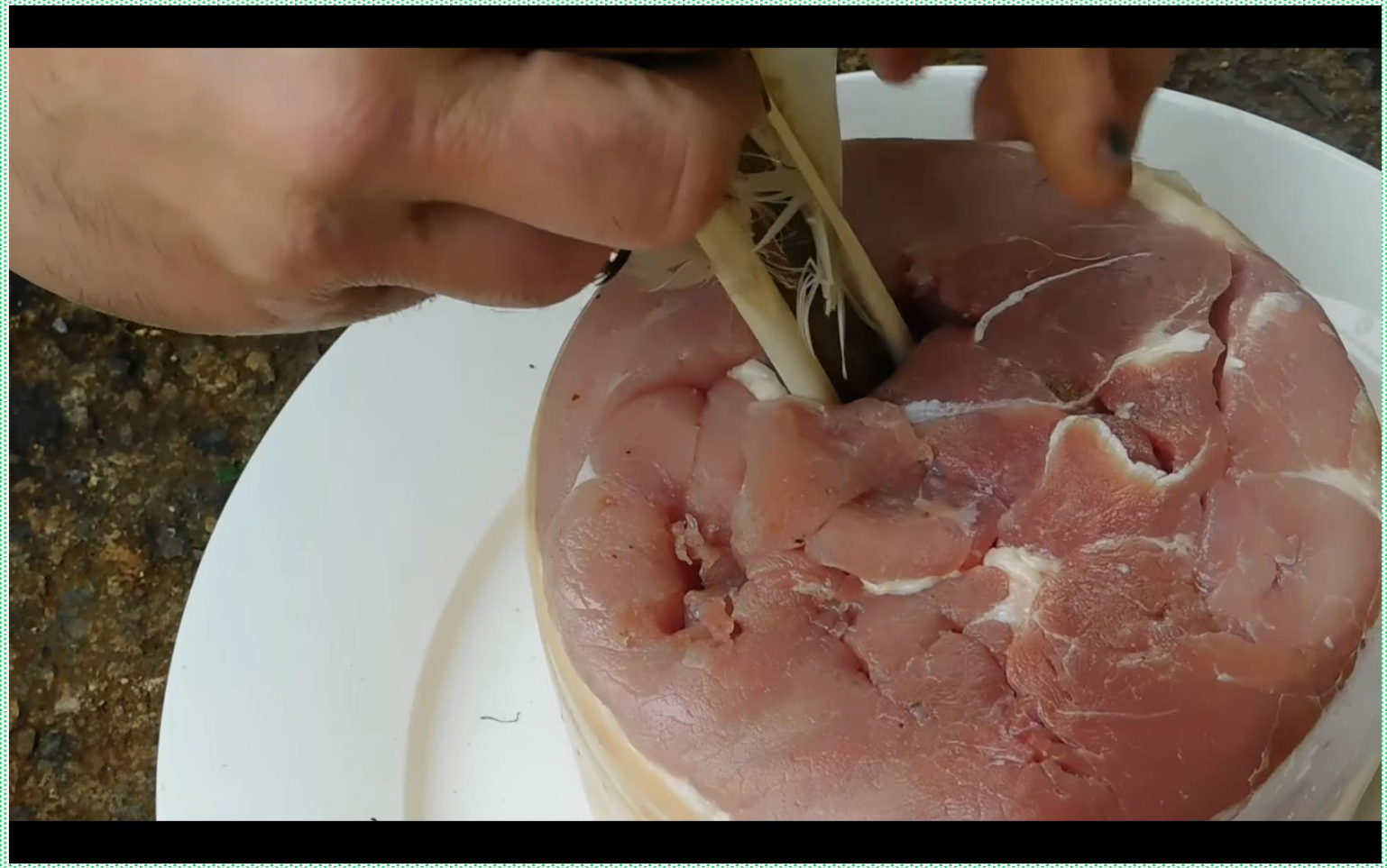
Extraction of Broadhead



Extraction of Broadhead



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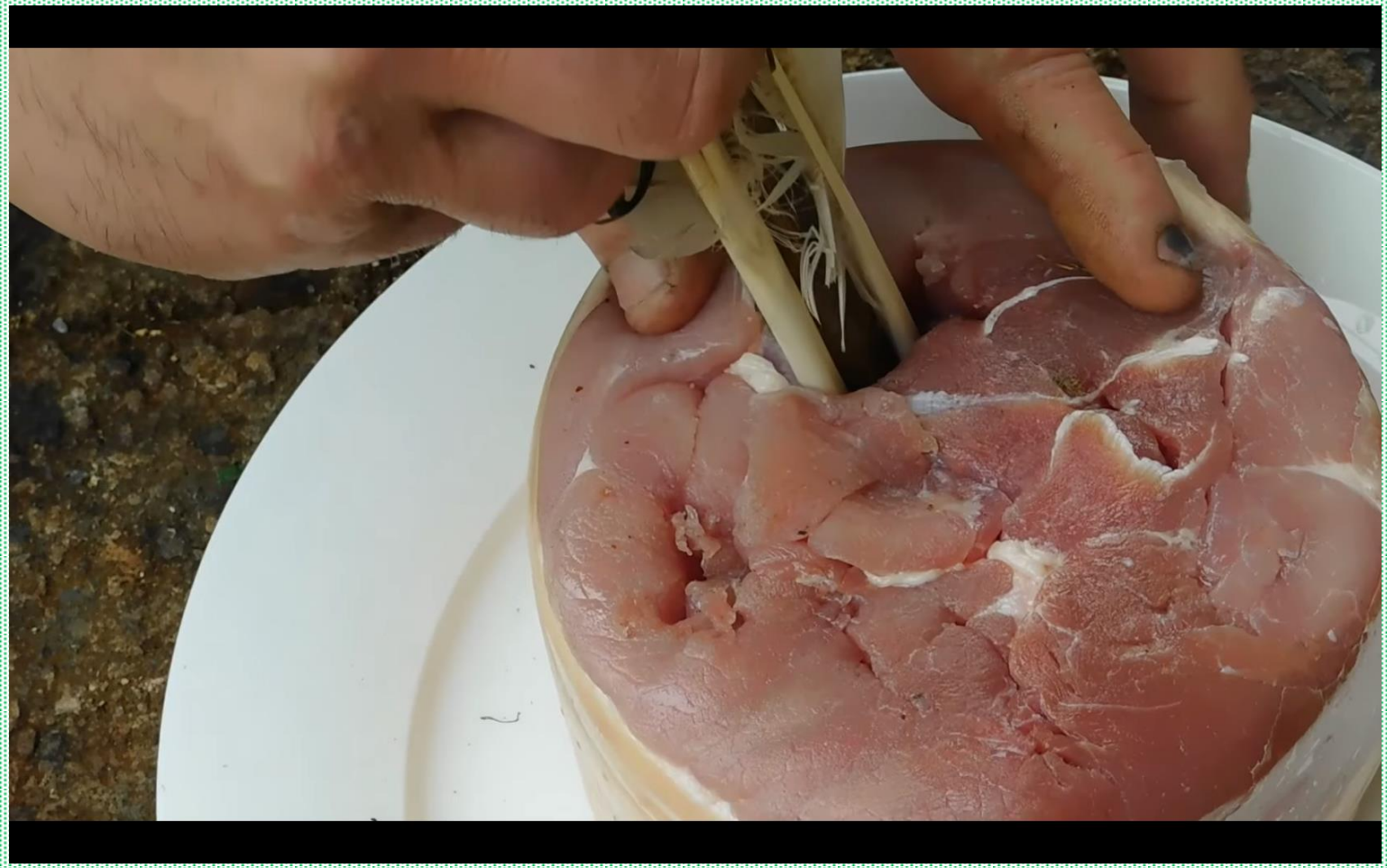

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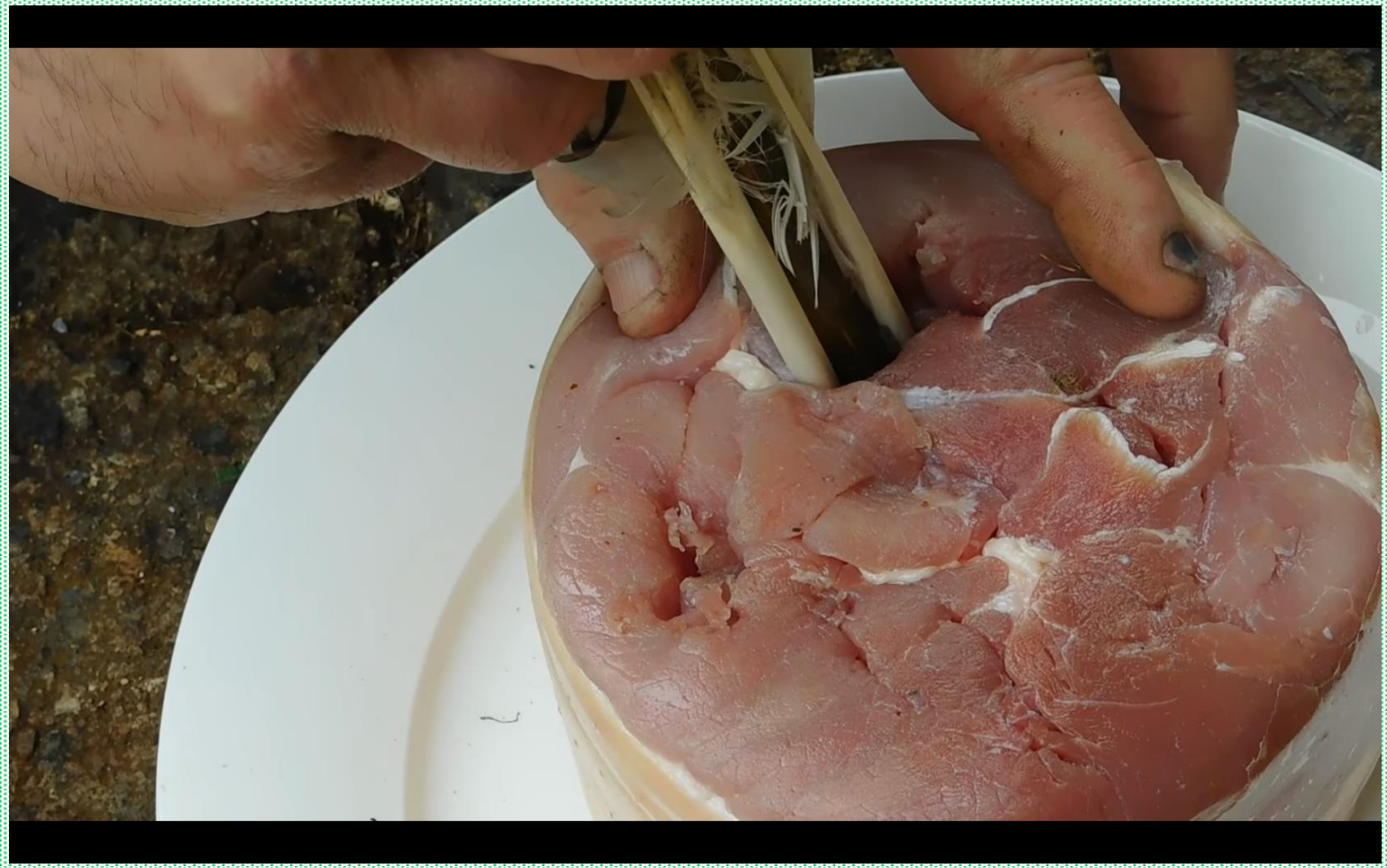

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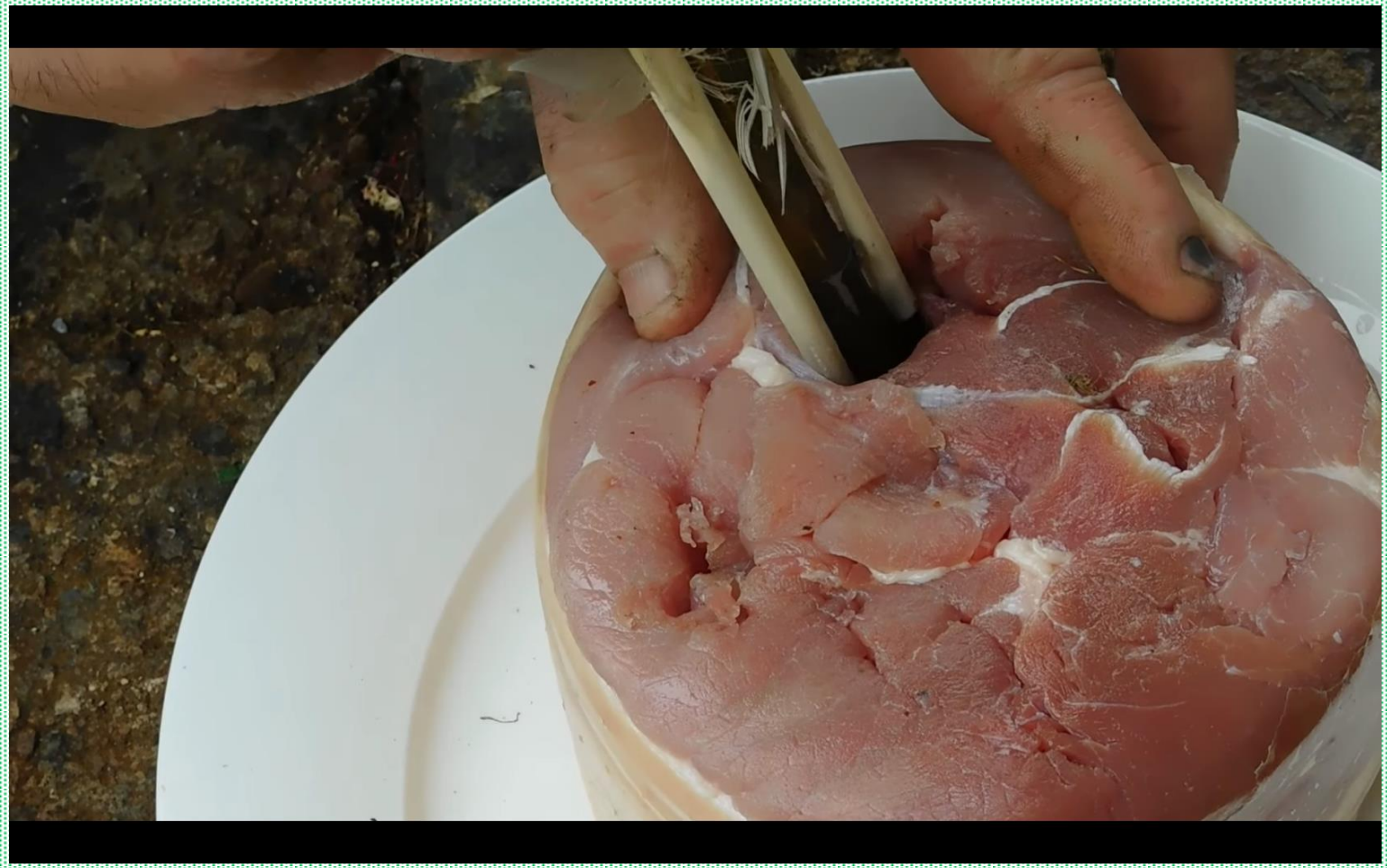

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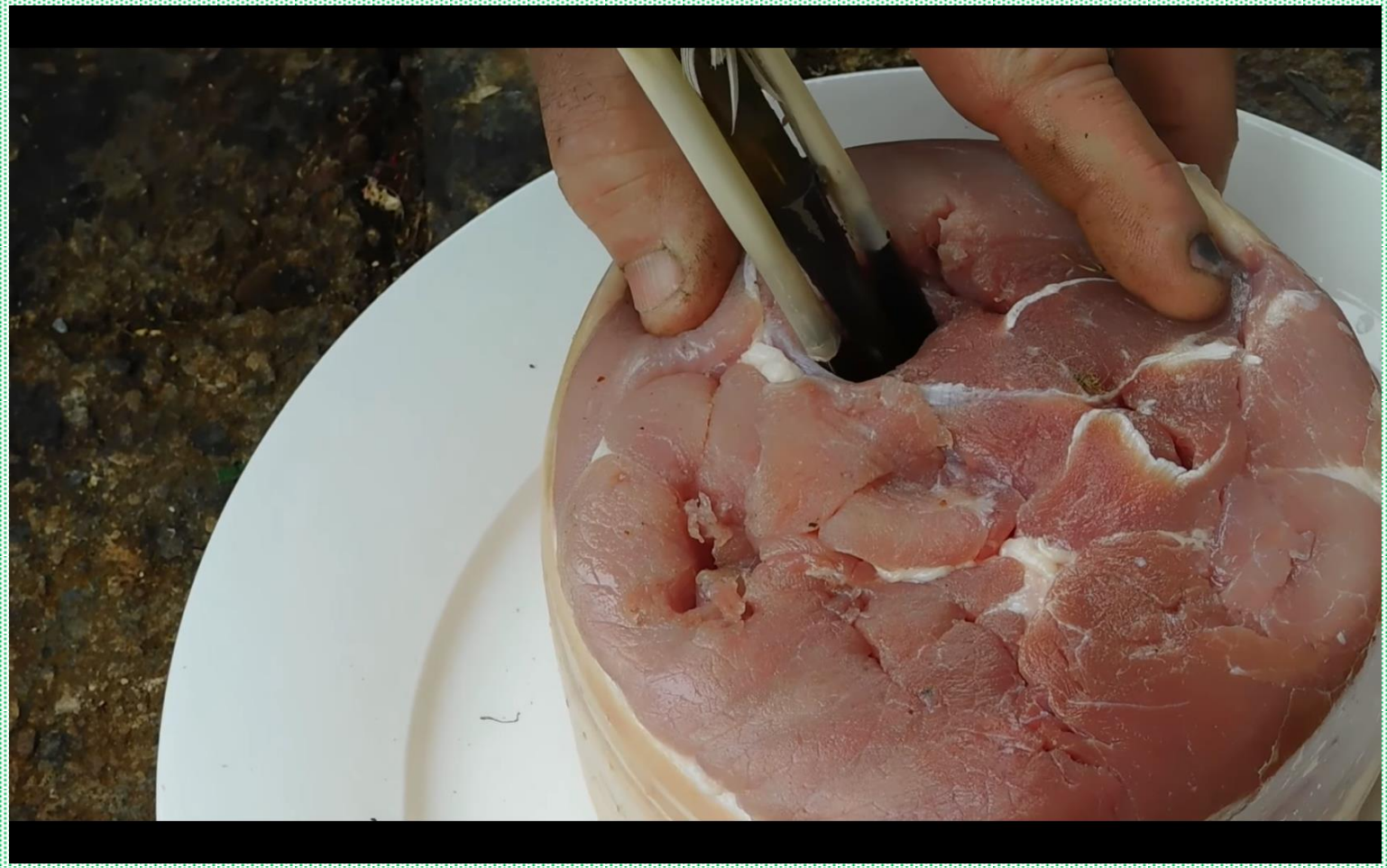

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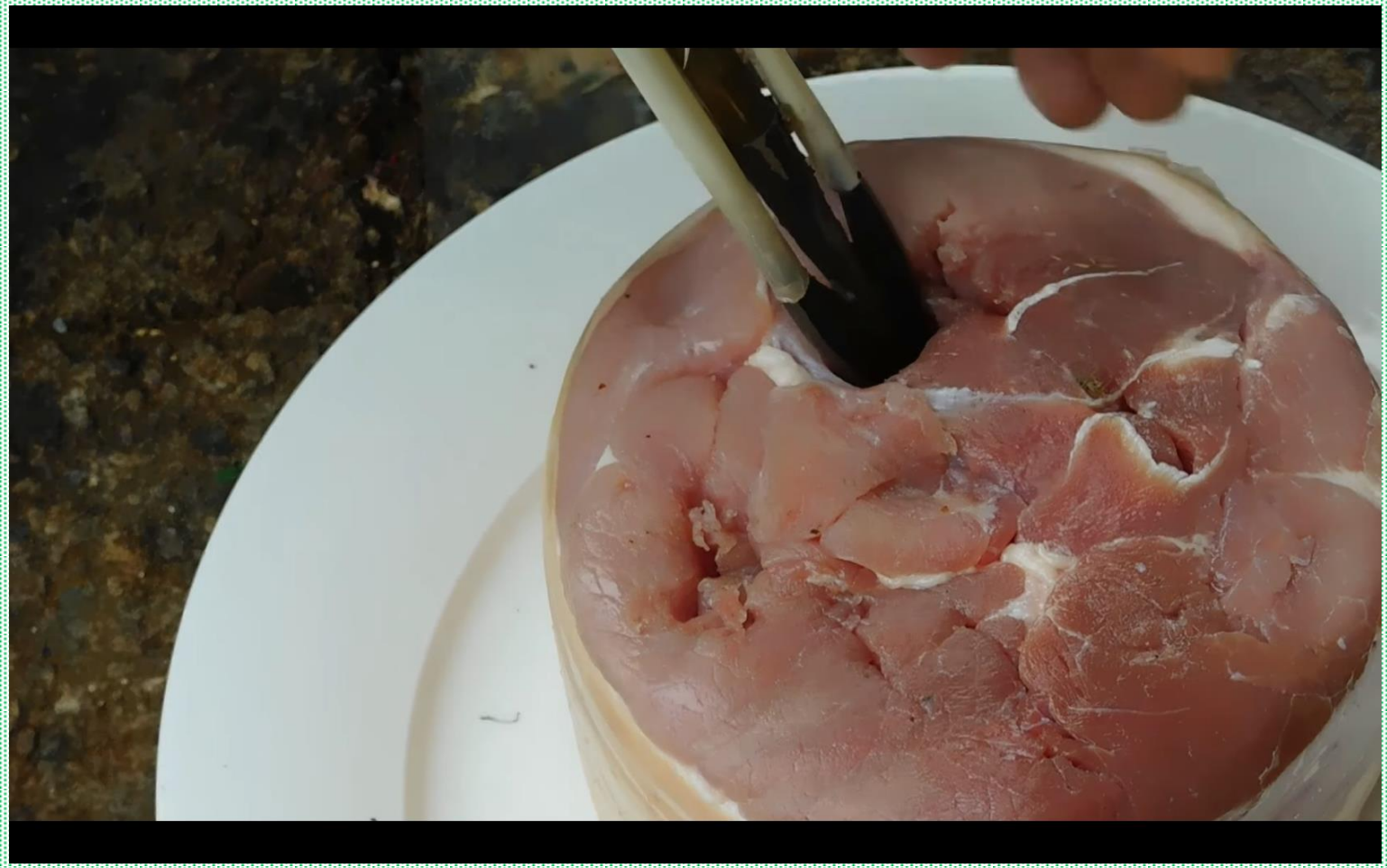


Extraction of Broadhead

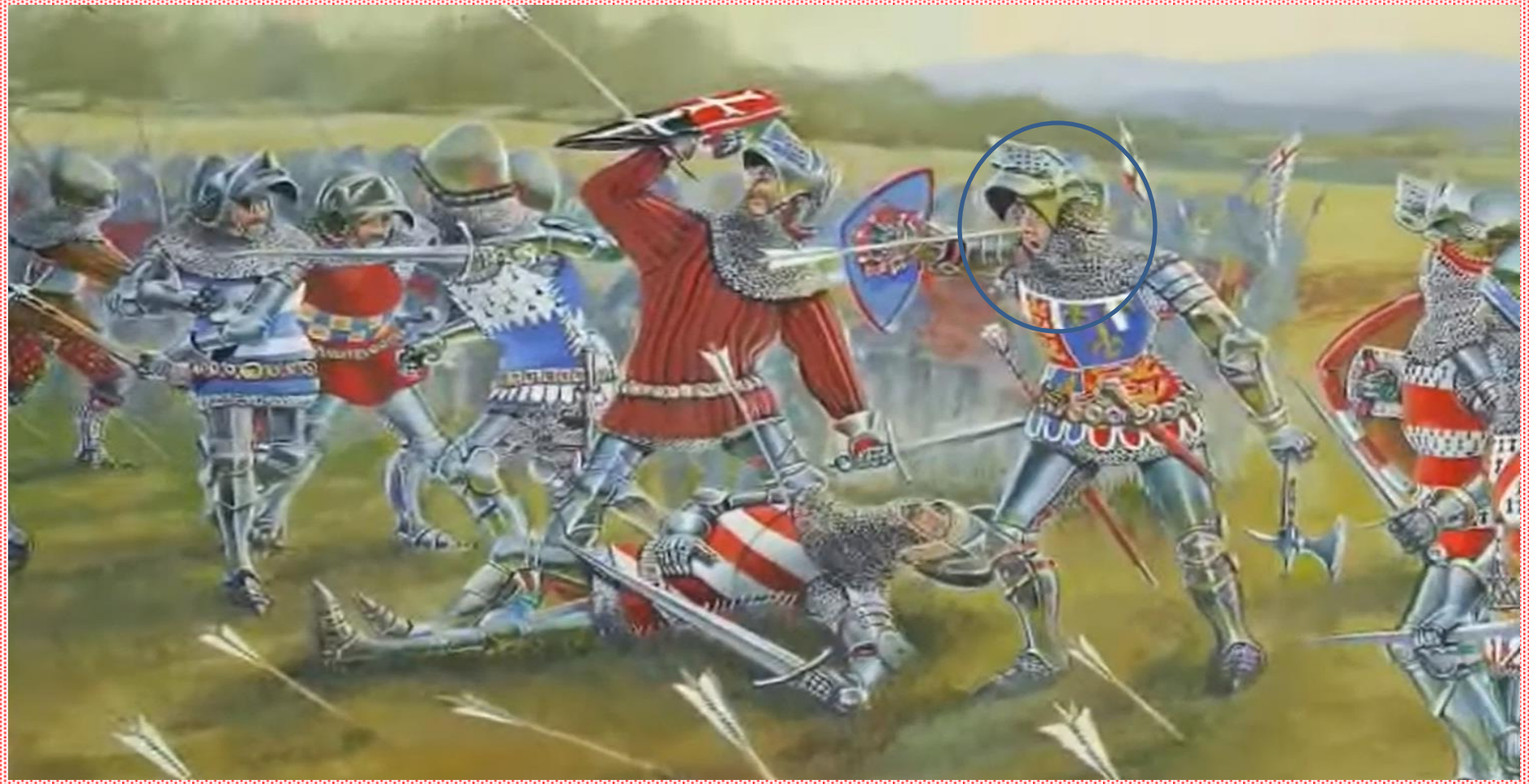
ARROW EXTRACTION
PRINCE HENRY of WALES

Arrow Extraction

Prince Henry of Wales

- In 1403, in the battle of Shrewsbury, Prince Henry, 16 y.o., son of Henry IV was injured.
- An arrow entered his face and the arrowhead became stuck in the face bones.
- The royal surgeons couldn't extract it with potions and chants, so John Bradmore was summoned. (From prison!)
- He was a noted surgeon and a skilled metalworker in jail for counterfeit coins.

Prince Henry's Wound at Shrewsbury



Arrow Extraction

Prince Henry of Wales

- The arrow penetrated on the left side below the eye and beside the nose of the prince.
- The bodkin point was embedded in his skull some five to six inches deep.
- It narrowly missed the vital structures inside the skull.

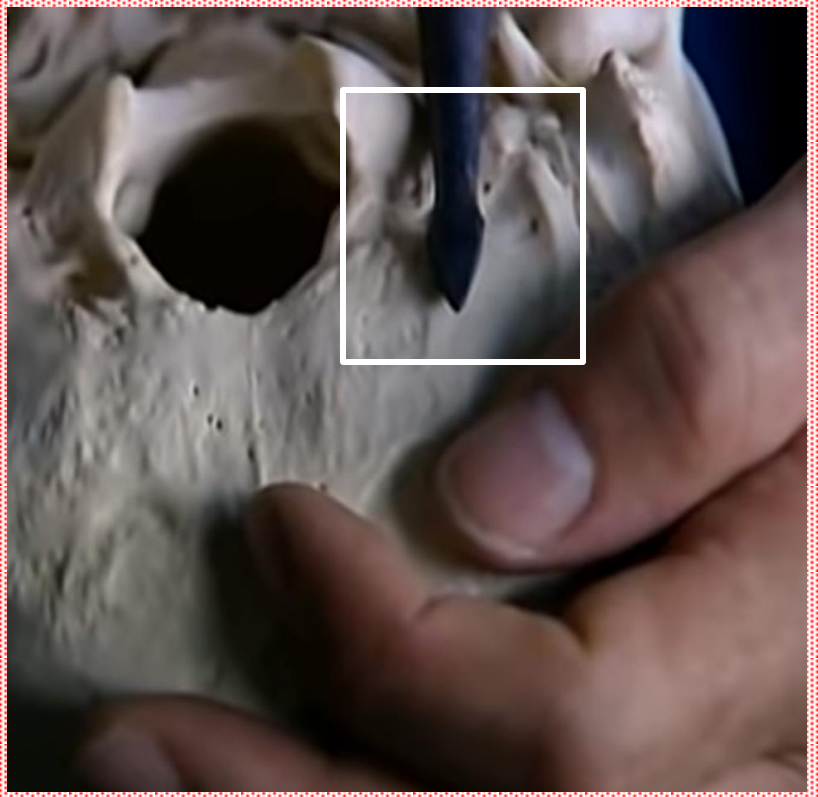
Arrow Extraction

Prince Henry of Wales

If X-rays had been available in 1403.

Arrow Extraction

Prince Henry of Wales



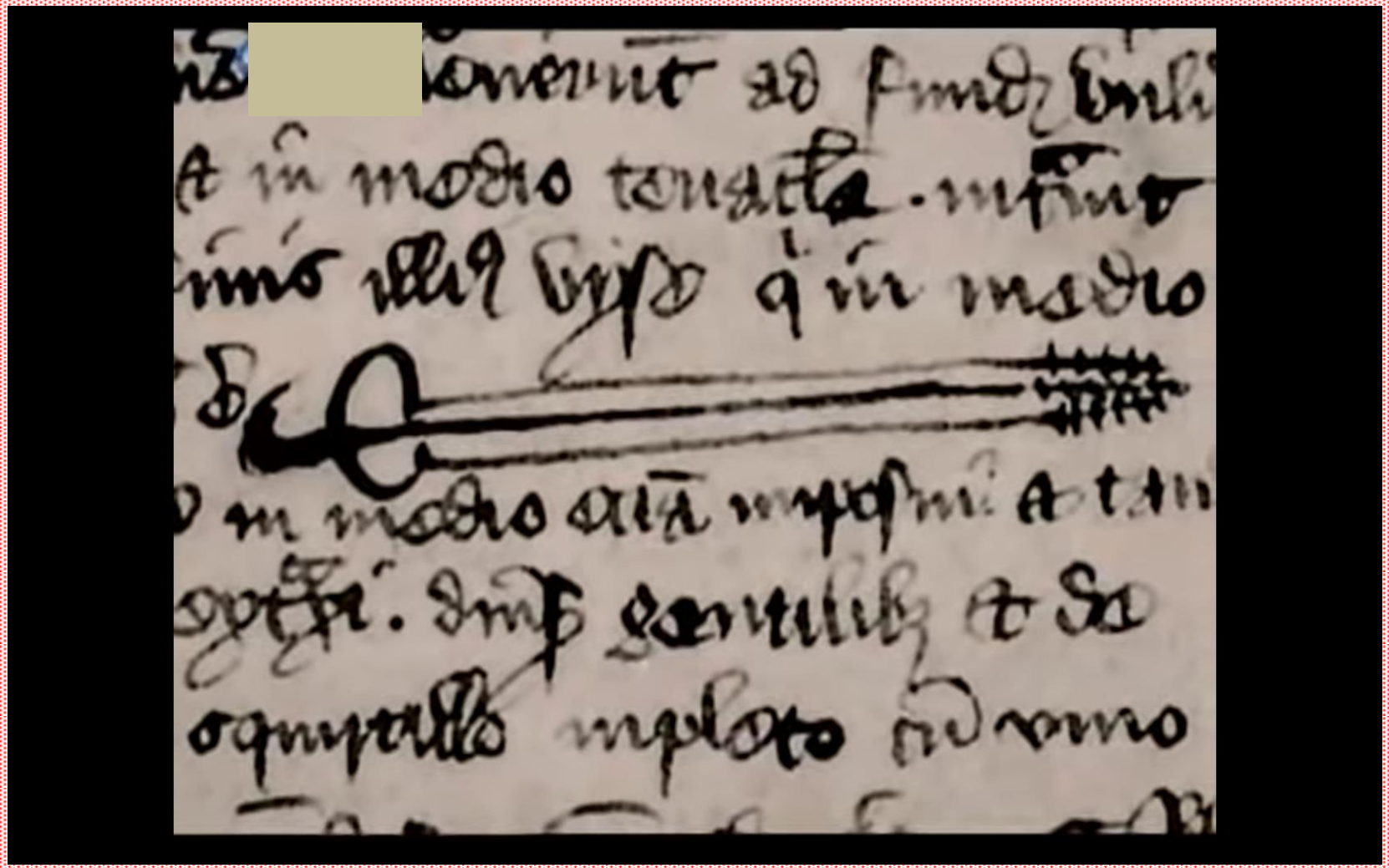
Position of bodkin arrowhead in base of skull.

Arrow Extraction

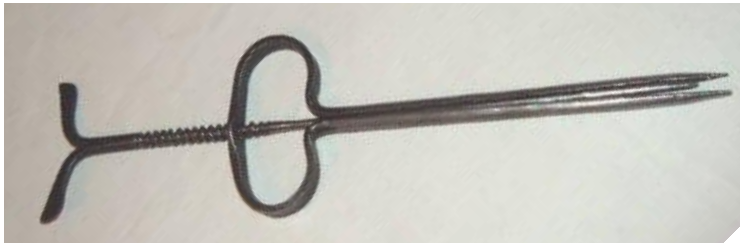
Prince Henry of Wales

- John Bradmore inserted elder pith probes soaked in rose honey and milk and wrapped with linen into the wound and dripped wine into the cavity.
- This would prevent infection and allow some healing without complete wound closure.
- Over the next 4 days, Bradmore devised and built a tool to extract the bodkin.

Bradmore Manuscript



Bradmore Instrument



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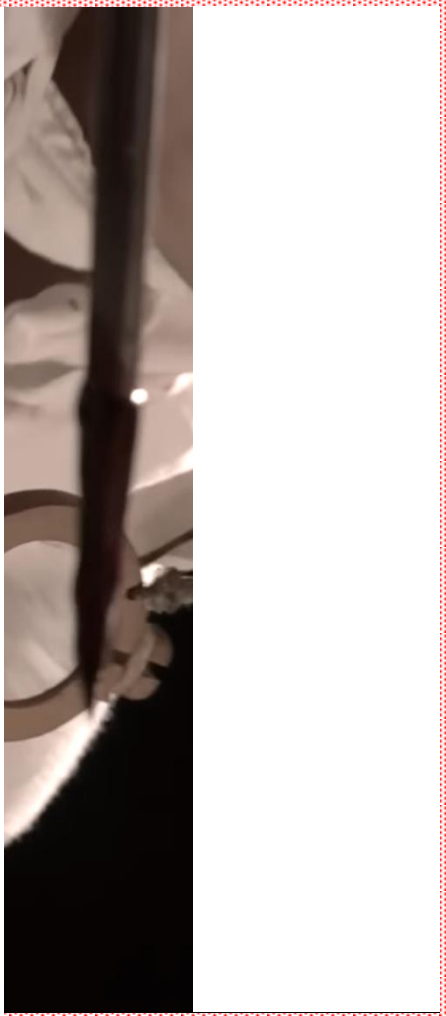

Arrow Extraction

Prince Henry of Wales

Questions? (Final)


THANK YOU

Next Week

- Session 1: Ancient history, Rome, Greece.
- Session 2: Middle Ages, weapons & injuries.
- Session 3: US Revolutionary & Civil Wars.
- Session 4: World War I.
- Session 5: World War II.
- Session 6: Korea, Vietnam.
- Session 7: 20th & 21st Century Regional wars.
- Session 8: Peek into future, Nuclear War?