SÃO LEOPOLDO MANDIC

Ferimento por Arma de Fogo

R2:DR. ANDRE FURTADO
R2:DR. LAWRENCE CAIXETA
PRECEPTOR: PROF. DR. LEONARD DUARTE
COORDENADOR HOSPITALAR: PROF. DR. CLAUDIO JODAS
COORDENADOR GERAL: PROF. DR. RUBENS TEIXEIRA

O que fazer ??????

Majeed Ranna, 2012

Panorâmica

Considerações e Danos

- *Tipo do projétil / Diâmetro*
- *Local*
- *Trajetória do projétil*
- *Distância do disparo*

PETERSON, 2004

TIPOS DE PROJÉTEIS DE RIFLES

PETERSON, 2004

Classificação dos Projéteis

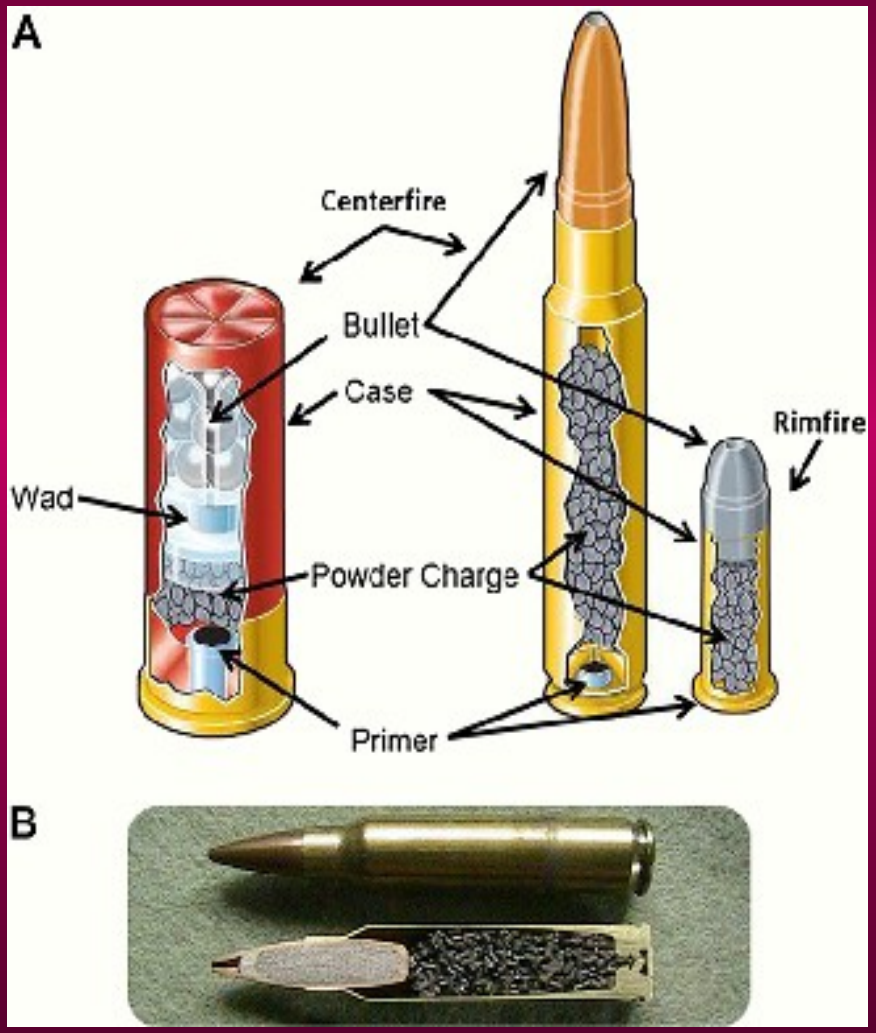
- *Baixa Velocidade*
- *Média Velocidade*
- *Alta Velocidade*

PETERSON, 2004

LESÃO PÉRFUROCONTUSA (por arma de fogo)

- *O projétil é o mais típico agente pérfurocontundente*
- *É composto de chumbo e revestido ou não por outros metais*
- *Possuem formas variáveis: cilíndricas ou ogivais*
- *As munições podem ter carga simples ou única (revólver) ou múltiplas (cartucheiras)*

- *Peterson, 2008*



David et al , 2013

CRITÉRIO DE ESTUDO DA LESÃO

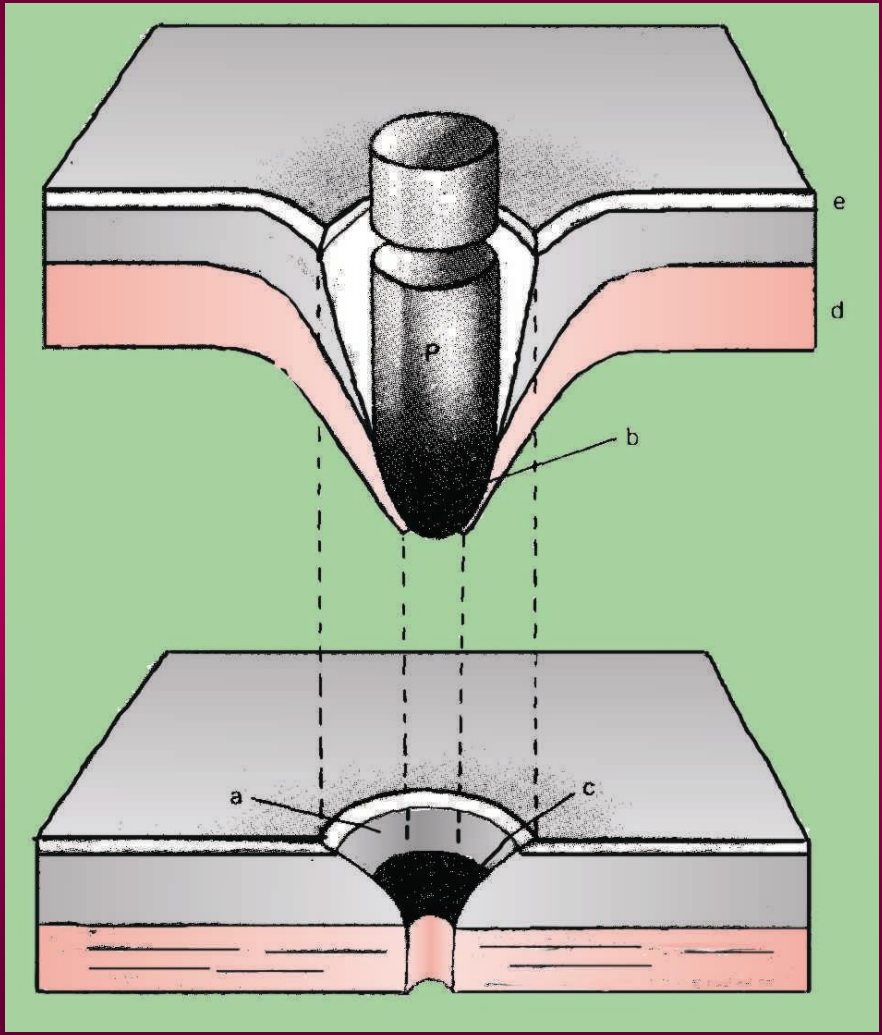
- *São consideradas:*

1. *pela distância de disparo do alvo*
2. *pelas características de seus orifícios:*
    1. *de entrada*
    2. *de saída*
3. *pela sua trajetória (ou trajetos)*

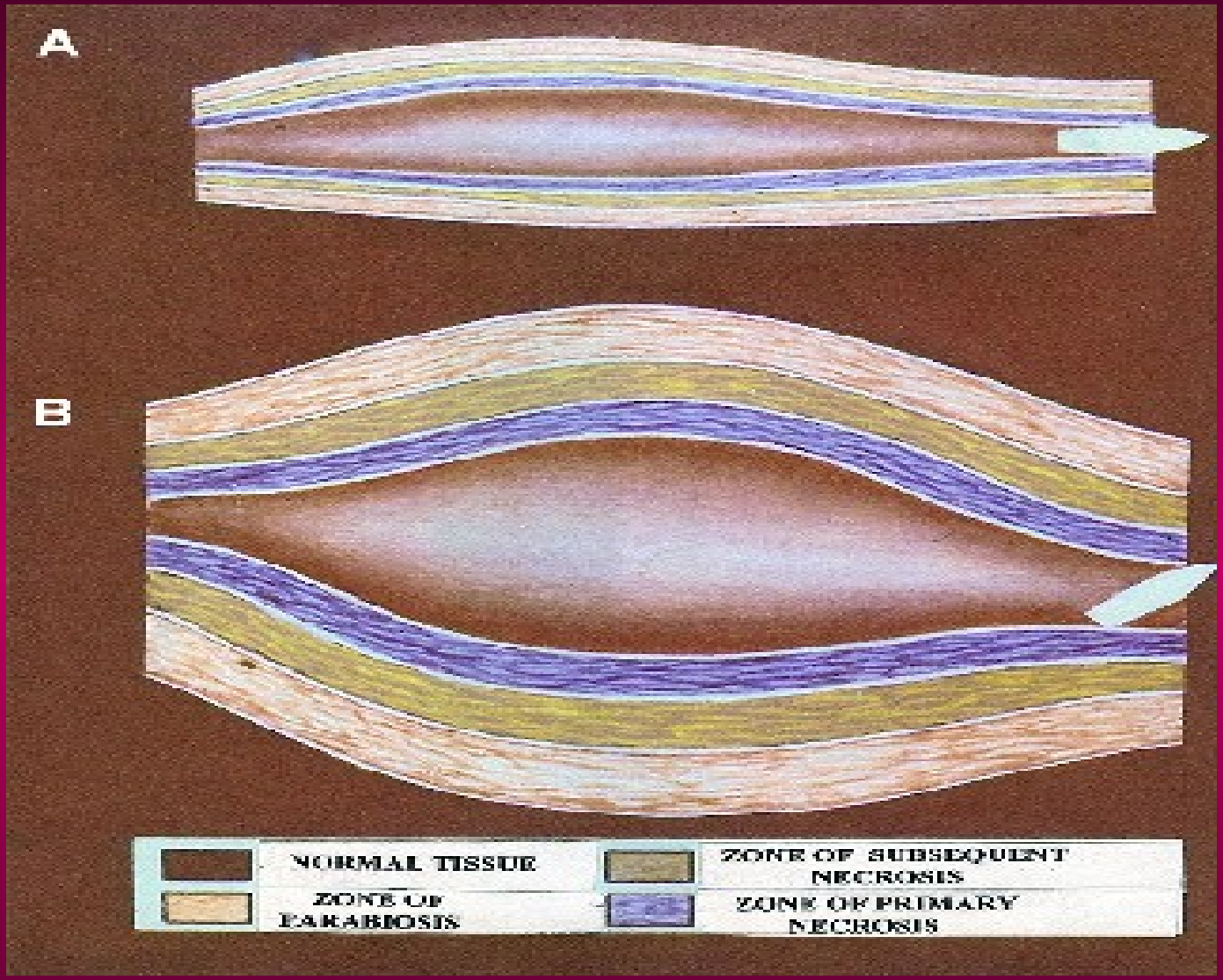
Peterson, 2008

LESÕES PÉRFUROCONTUSAS

- *Lesões que causam*
  - *perfuração e*
  - *ruptura dos tecidos*
- *Características do ferimento*
  - *bordas irregulares*
  - *predomínio da profundidade*
  - *caráter penetrante ou transfixante*



Peterson, 2008



Peterson, 2008

LESÕES PÉRFUROCONTUSAS

- *Ao atingir o corpo, o projétil provoca*
  - *rompimento na pele, formando um orifício em forma tubular no qual se enxuga de seus detritos (orla de enxugo)*
  - *arrancamento da epiderme (orla de contusão)*
- *Ao se formar o túnel de entrada*
  - *pequenos vasos se rompem formando equimoses em torno do ferimento (orla equimótica)*

Peterson, 2008

ORIFÍCIO DE ENTRADA – ORLAS (SEMPRE PRESENTES)

- *ORLA DE CONTUSÃO: a pele se invagina e se rompe devido à diferença de elasticidade de derme e epiderme*
- *ORLA EQUIMÓTICA: zona da hemorragia oriunda da ruptura de pequenos vasos*
- *ORLA DE ENXUGO: zona de cor escura que se adaptou às faces do projétil, limpando-os dos resíduos da pólvora*

Peterson, 2008

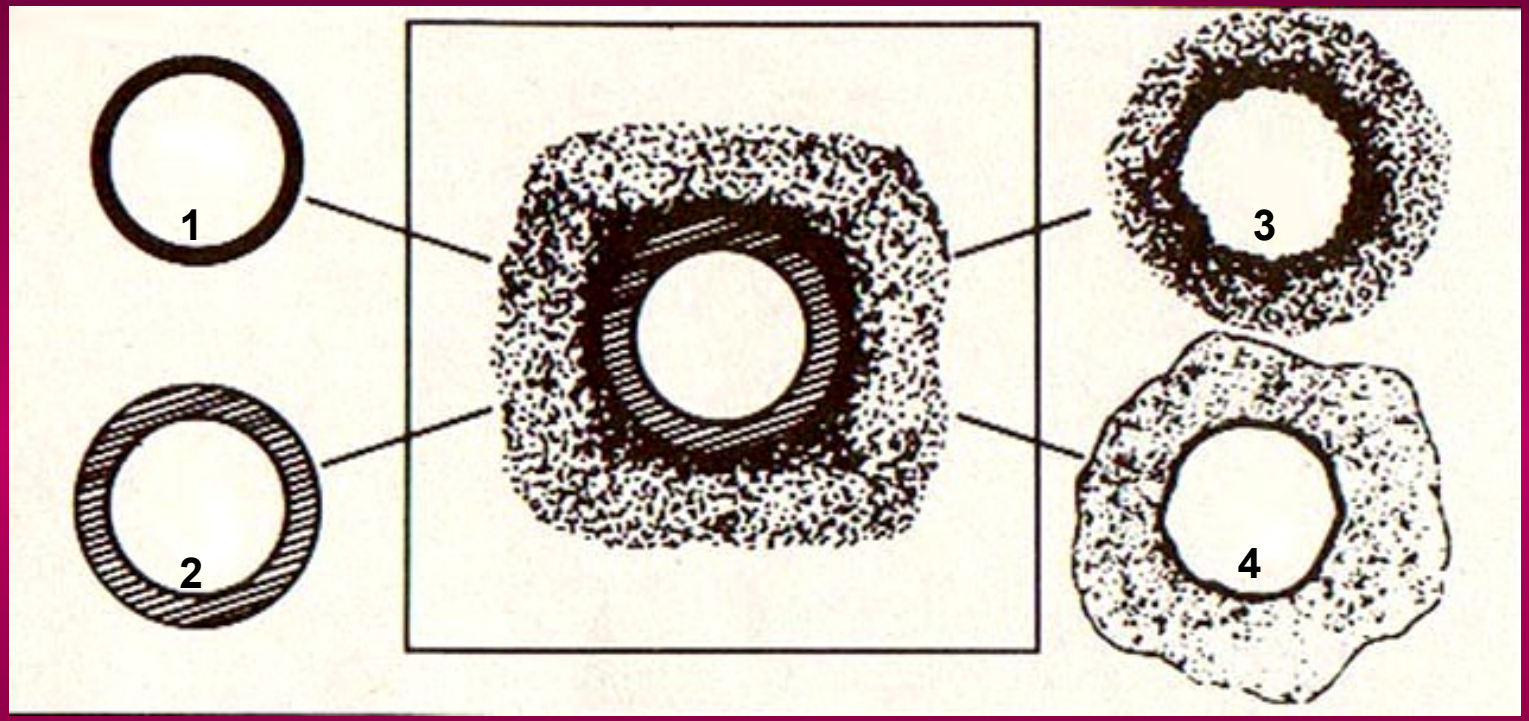
ORIFÍCIO DE ENTRADA - ZONAS

- *ZONA DE TATUAGEM: é resultante da impregnação de partículas de pólvora incombusta que alcançam o corpo*
- *ZONA DE ESFUMAÇAMENTO: é produzida pelo depósito de fuligem da pólvora ao redor do orifício de entrada*
- *ZONA DE CHAMUSCAMENTO: tem como responsável a ação superaquecida dos gases que atingem e queimam o alvo*

Peterson, 2008

Peterson, 2008

ORLAS E ZONAS DE CONTORNO



1. Orla de enxugo

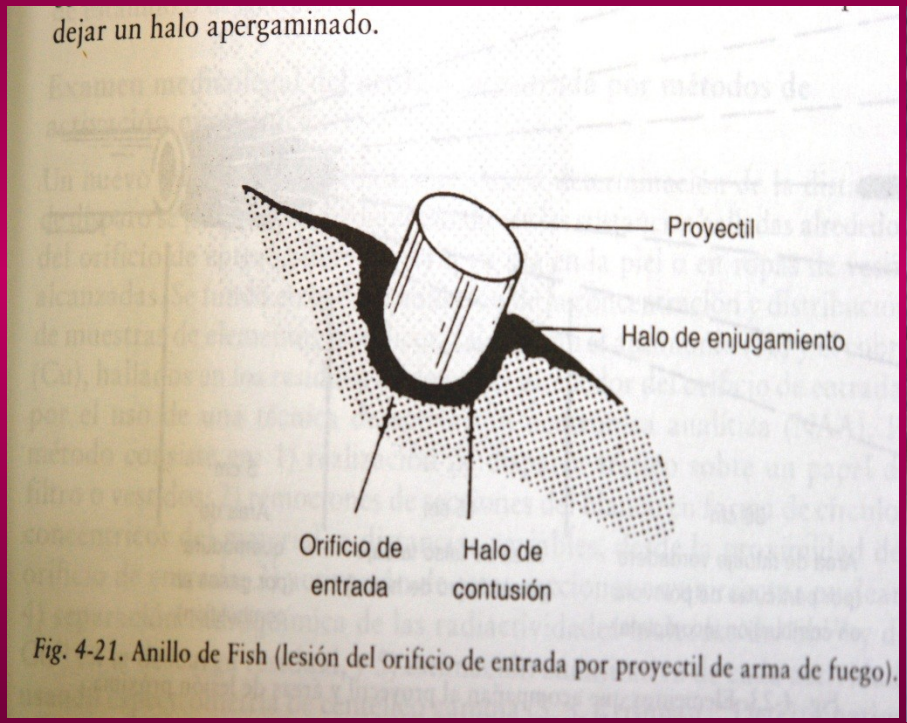
2. Orla equimótica

3. Zona de esfumaçamento

4. Zona de tatuagem

Peterson, 2008

ORLA DE CONTUSÃO E ENXUGO
ANEL DE FISH



Peterson, 2008

ORIFÍCIOS DE ENTRADA

- *Podem ser*
  - *circulares (90°)*
  - *ovais ou arredondados (ângulo diverso de 90°) ou*
  - *tangencial, de acordo com o ângulo de incidência*

Peterson, 2008

TIRO ENCOSTADO

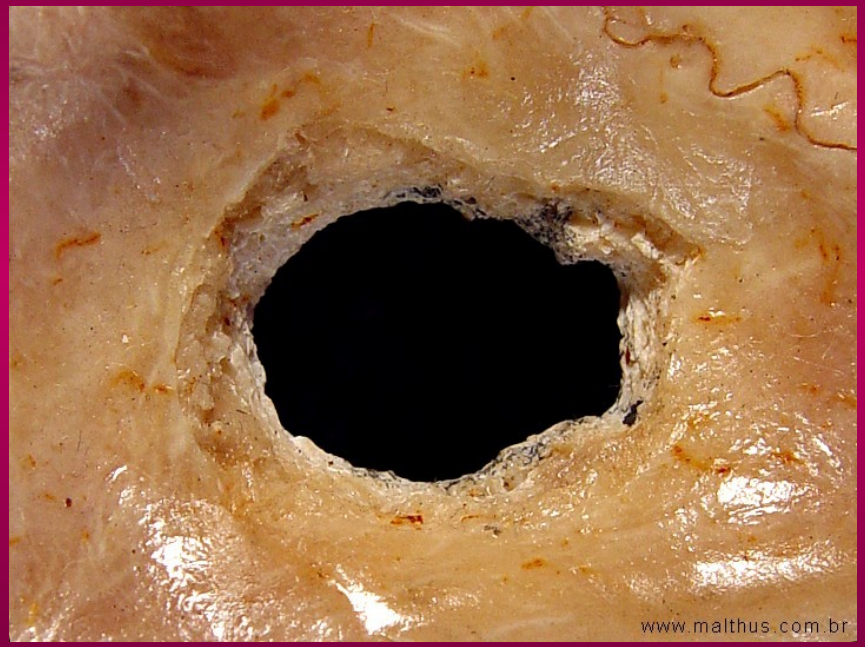
Peterson, 2008

ORIFÍCIOS DE ENTRADA – TIRO ENCOSTADO

a) *forma irregular (estrelado) pela dilaceração dos tecidos pelos gases explosivos (mina de Hoffmann)*
b) *sem zona de tatuagem ou de esfumaçamento*
c) *diâmetro do ferimento maior que o projétil (explosão dos gases)*
d) *halo fuliginoso nos ossos: (sinal de Benassi)*
e) *impressão (pressão) do cano da arma (sinal de Werkgaertner)*
f) *quando transfixante: trajeto com orifício de entrada e saída*

Peterson, 2008

Sinal do Funil de Bonnet
(define entrada e saída de projéteis em crânio)



sinal de Benassi

halo fuliginoso

câmara de mina de Hofmann

Câmara de Mina de Hofmann

Sinal de Pupe Werkgaetner

Marca da alça de mira

ORIFÍCIO DE ENTRADA – TIRO A CURTA DISTÂNCIA

a) *cone de dispersão do tiro*
b) *forma arredondada ou circular*
c) *orla de escoriação ou contusão*
d) *orla equimótica*
e) *orla de enxugo*
f) *zona de tatuagem*
g) *zona de esfumaçamento (removível)*
h) *zona de queimadura (chamuscamento)*

Zona de Esfumaçamento

Chamuscamento e Esfumaçamento

Zona de Tatuagem

ORIFÍCIO DE ENTRADA
TIRO À DISTÂNCIA

a) *forma arredondada*
b) *diâmetro menor que o do projétil*
c) *com orla de escoriação*
d) *com orla equimótica*

ORIFÍCIO DE ENTRADA
TIRO À DISTÂNCIA

ORIFÍCIO DE SAÍDA

a) de forma irregular ou dilacerado
b) maior que orifício de entrada
c) maior sangramento
d) ausência de orlas, zonas e halos
e) bordos evertidos

Peterson, 2008

Lesões Pérfurocontusas
Orifício de Entrada x Orifício de Saída

Entrada	*Saída*
Regular	*Dilacerado*
Invertido	*Evertido*
Normalmente proporcional ao diâmetro do projétil *(exceção aos projéteis de ponta oca, principalmente os expansivos)*	*Desproporcional ao diâmetro do projétil*
Com orlas e zonas	*Sem orlas e zonas*

Exceções podem ocorrer:

- *tiro encostado*
- *ricochete, o projétil perde sua propulsão (“bala perdida”)*
- *dois ou mais projéteis sucessivos atingem o mesmo ponto na pele*

TRAJETO/TRAJETÓRIA

- *Trajeto: é o caminho percorrido pelo projétil dentro do corpo da vítima*
  - *pode ser*
    - *transfixante*
    - *não transfixante (projétil retido)*
- *Trajetória: é o caminho percorrido pelo projétil fora do corpo (da arma até a superfície atingida)*
  - *por ser*
    - *trajeto simples: resultante de projétil único*
    - *trajeto múltiplo: resultante de projéteis múltiplos*

Peterson, 2008

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www.JBiomech.com

Wound ballistics of the pig mandibular angle: A preliminary finite element analysis and experimental study

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ABSTRACT

To study wound ballistics of the mandibular angle, a combined hexahedral-tetrahedral finite element (FE) model of the pig mandible was developed to simulate ballistic impact. An experimental study was carried out by measuring impact load parameters from 14 fresh pig mandibles that were shot at the mandibular angle by a standard 7.62 mm M43 bullet. FE analysis was executed through the LS-DYNA code under impact loads similar to those obtained from the experimental study. The resulting residual velocity, the transferred energy from the bullet to the mandible, and the surface area of the entrance wound had no statistical differences between the FE simulation and the experimental study. However, the mean surface area of the exit wounds in the experimental study was significantly larger than that in the simulation. According to the FE analysis, the stress concentrated zones were mainly located at the region of impact, condylar neck, coronoid process and mandibular body. The simulation results also indicated that trabecular bone had less stress concentration and a lower speed of stress propagation compared with cortical bone. The FE model is appropriate and conforms to the basic principles of wound ballistics. This modeling system will be helpful for further investigations of the biomechanical mechanisms of wound ballistics.

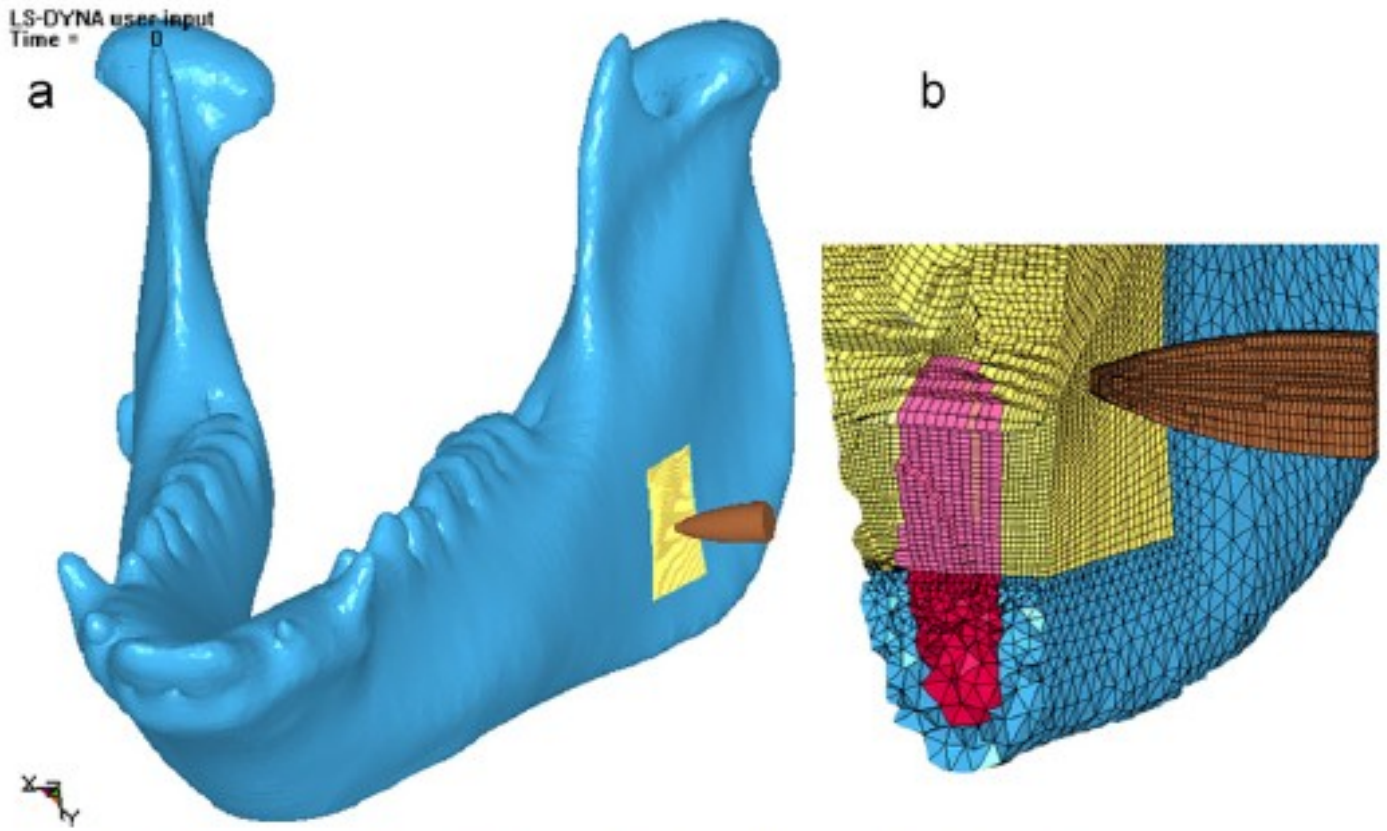


Fig. 1. The integrated FE model (a) and local view (b) of the refined mesh of impact region.

Velocity, transferred energy and surface area of beveled entrance and exit of experimental and simulation results (mean ± SD).

Part of study	Impact velocity (m/s)	Residual velocity (m/s)	Transferred energy (J)	Area of bullet hole (mm^2)	
				Entrance	exit
Experiment	732.6 ± 11.3	707.8 ± 13.1	141.0 ± 58.4	96.7 ± 67.7	404.5 ± 216.3[a,b]
Simulation	732.6 ± 11.3	702.5 ± 11.8	170.8 ± 5.6	68.4 ± 2.3	112.2 ± 6.1[b]

[a] Compared with simulation: $p < 0.05$.
[b] Compared with entrance in the same part of study: $p < 0.05$.

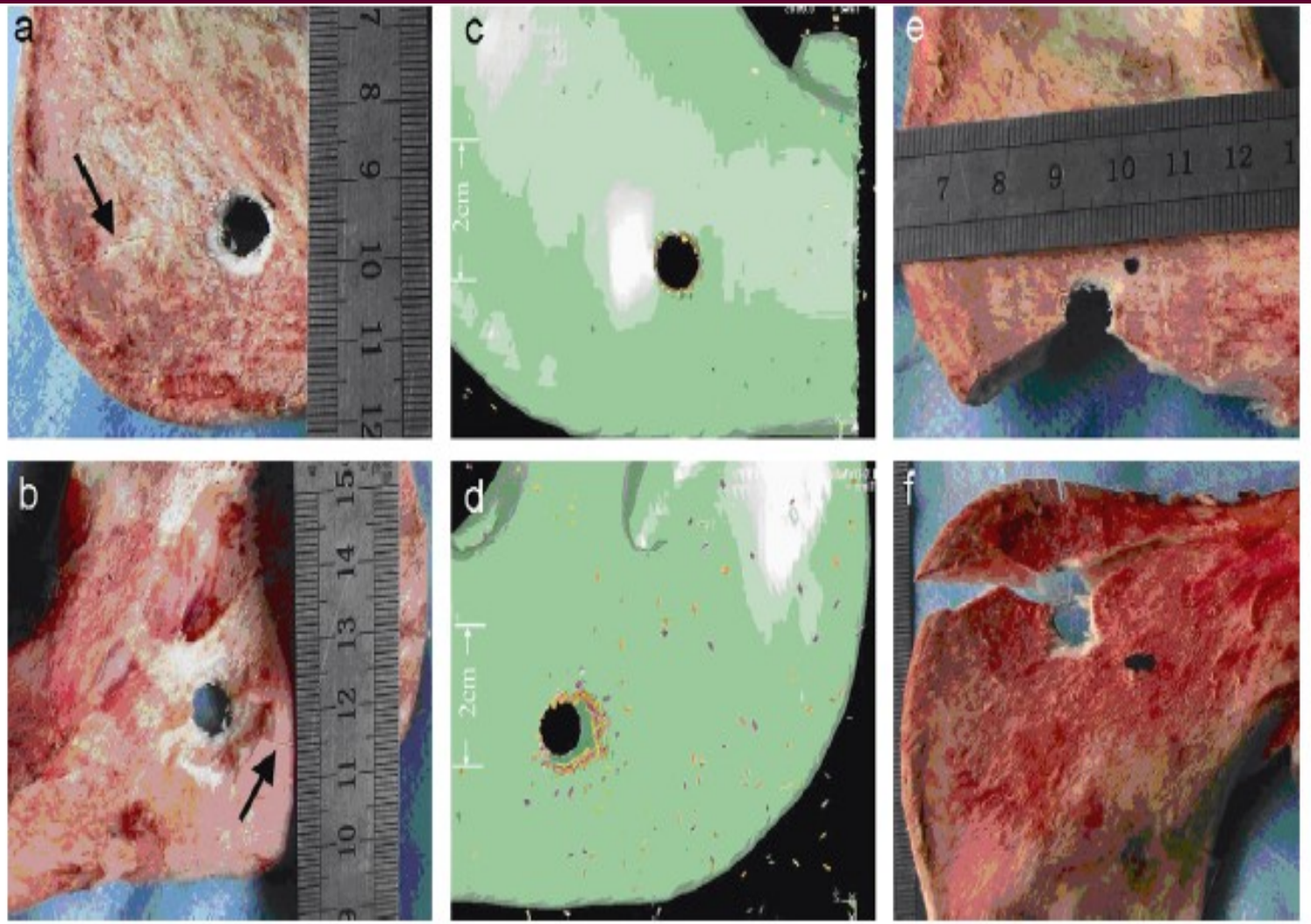
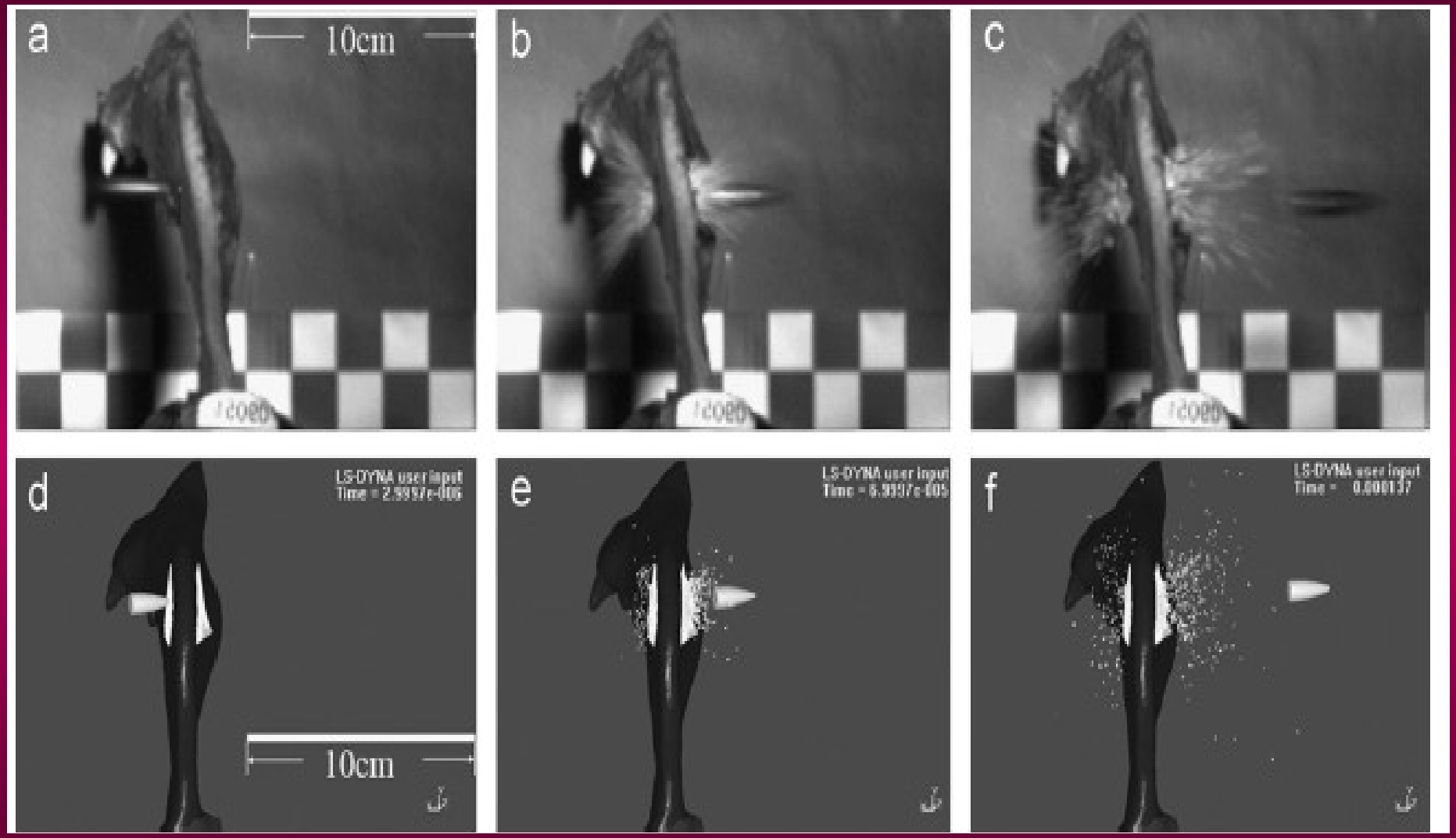


Fig. 2. Experimental and simulation ballistic wound patterns of pig mandibular angle: (a) entrance of experimental study; (b) exit of experimental study; (c) entrance of simulation; (d) exit of simulation; (e) and (f) defective patterns of mandibular angle of experimental study. Black arrows show the crack of mandible.


a
10cm
b
c
d
LS-DYNA user input
10cm
e
LS-DYNA user input
f
LS-DYNA user input

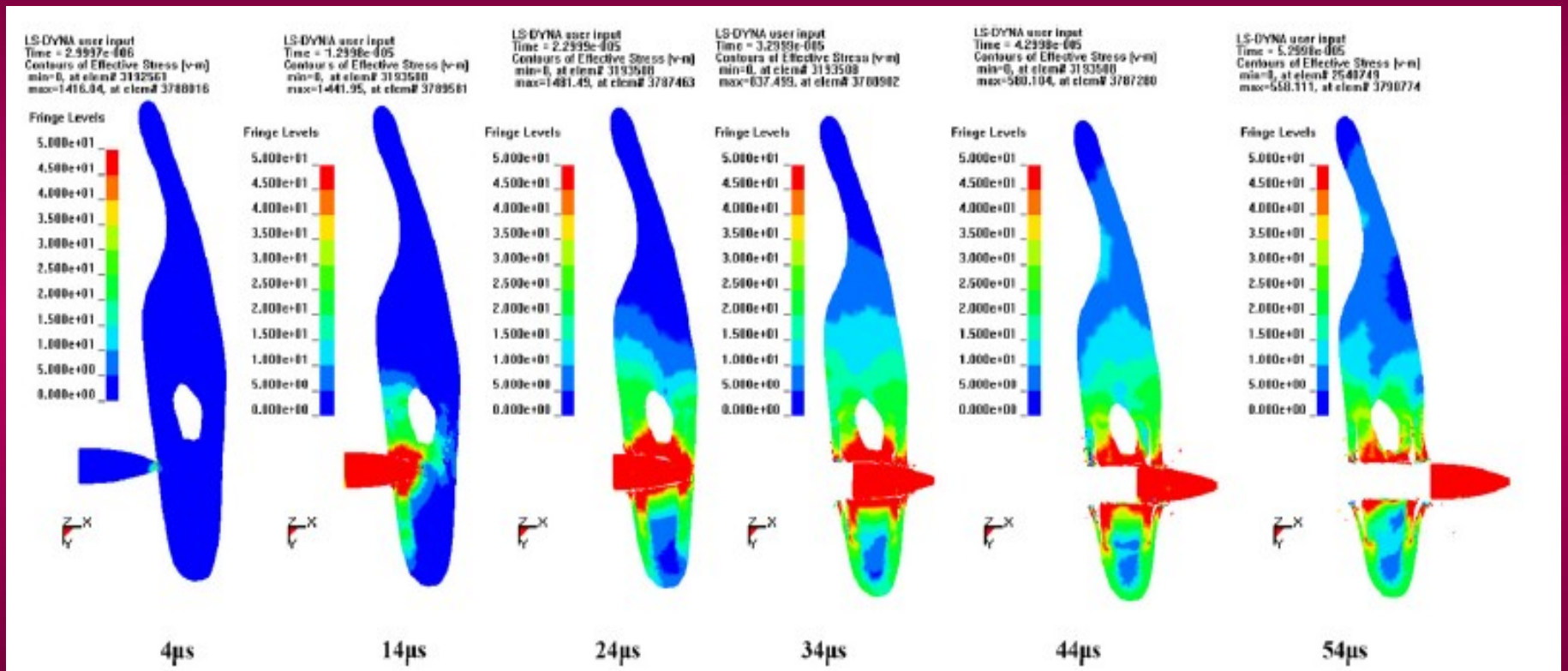


Fig. 5. Von Mises stress distribution pattern of coronal section of pig mandible at different time step.

Characteristics of Ballistic and Blast Injuries

David B. Powers, DMD, MD, FACS, FRCS (Ed) [a,*], Robert I. Delo, DDS, MD [b]

KEYWORDS

• Facial • Maxillofacial • Ballistic • Blast • Soft tissue injury • Bone injury

KEY POINTS

- The permanent cavity is the site of initial permanent tissue destruction.
- Deformation of the projectile after impacting hard tissues causes an increase in the size of the permanent cavity.
- After striking bone, fragmentation of the projectile and/or bone can result in the formation of numerous secondary projectiles each producing additional wounding potential, enlarging the size of the permanent cavity.
- The ultimate fate and compositional makeup of the projectile is more important than its velocity or caliber.
- Soft tissue injuries inherent in ballistic trauma may exhibit avulsive loss, sequential necrosis over days to weeks, and compromised vascularity, negating/delaying potential microvascular or pedicled soft tissue reconstruction.

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Atlas Oral Maxillofacial Surg Clin N Am 21 (2013) 15–24
1061-3315/13/$ - see front matter
http://dx.doi.org/10.1016/j.cxom.2012.12.001

Box 1. Factors affecting energy transfer between a projectile and body tissue

Velocity
Profile
Shape
Stability
Fragmentation
Expansion
Secondary impact

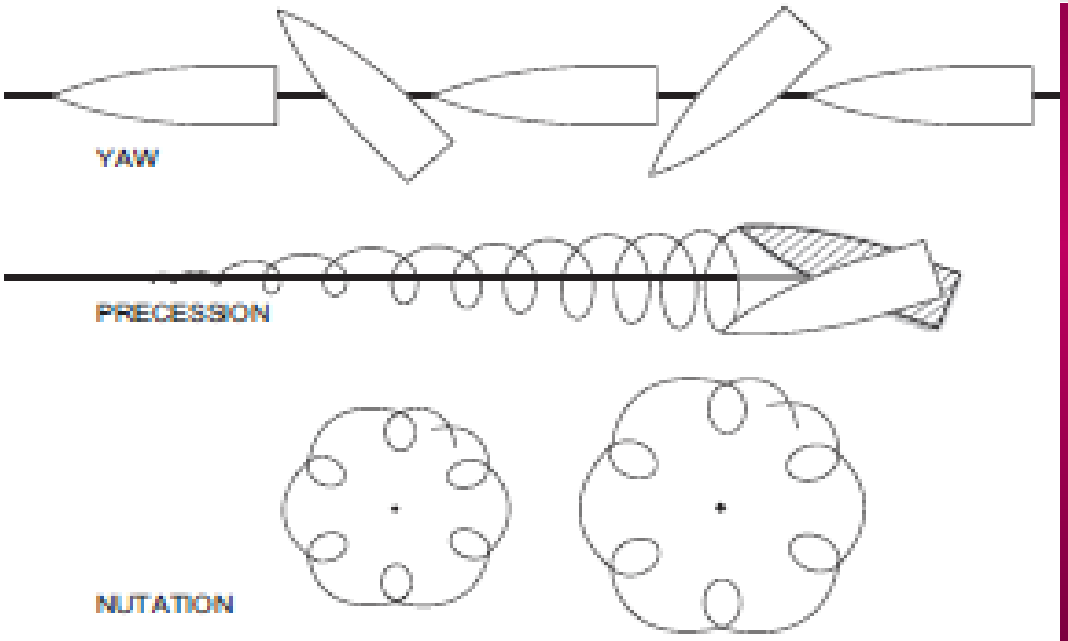
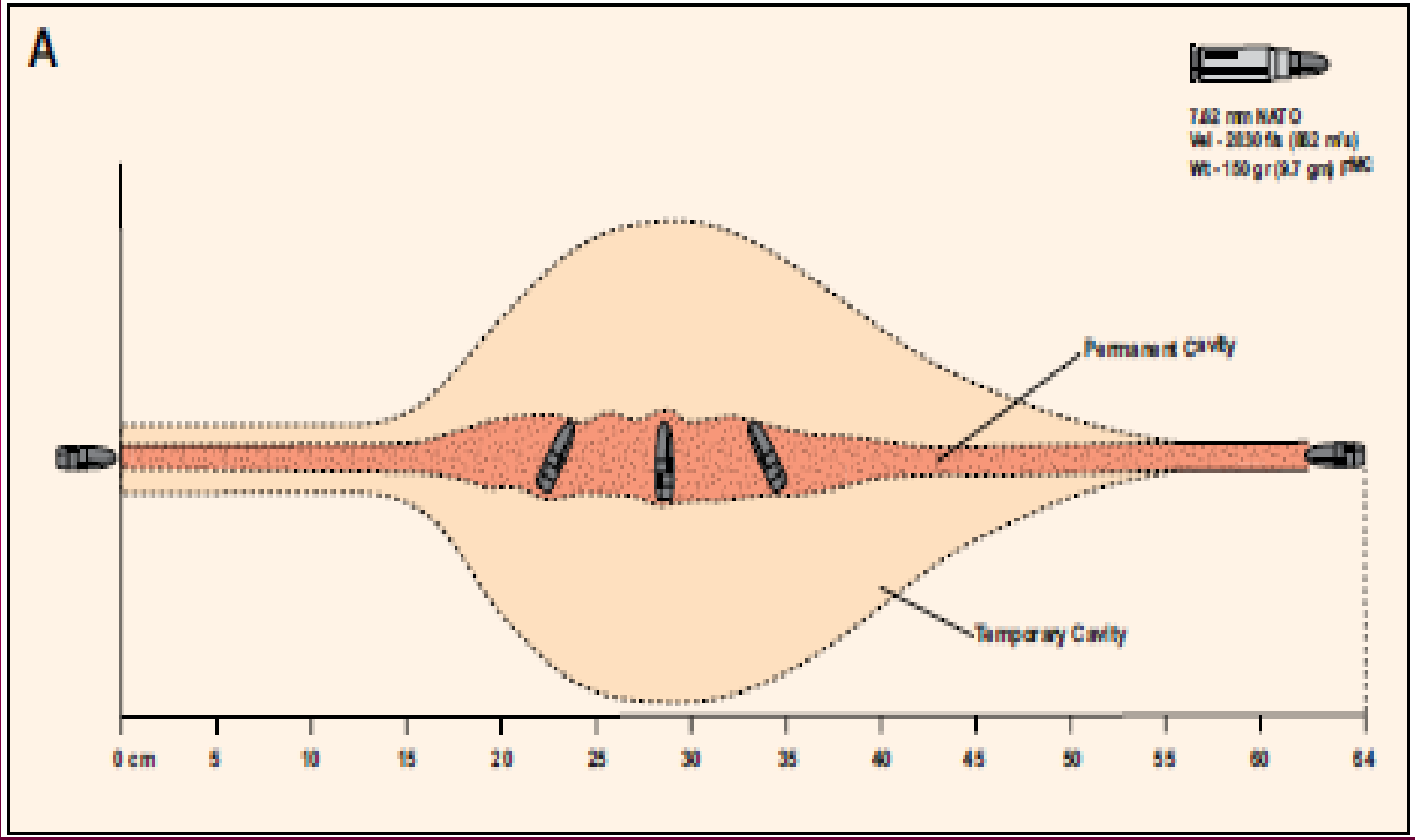
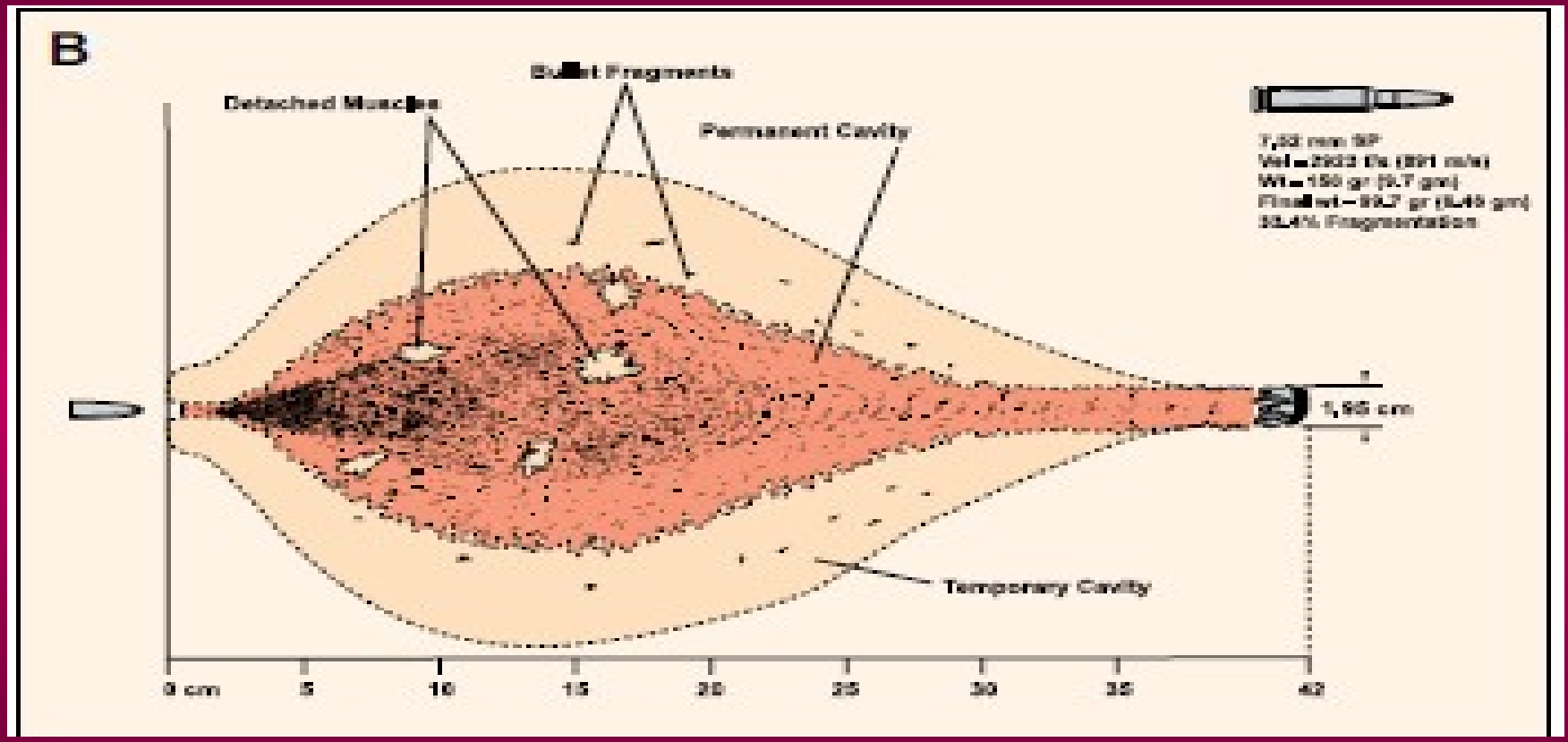


Fig. 1 Yaw: Movement along the longitudinal access of the projectile; precession: rotation of the projectile around the center of mass; nutation: small circular movement along the projectile tip

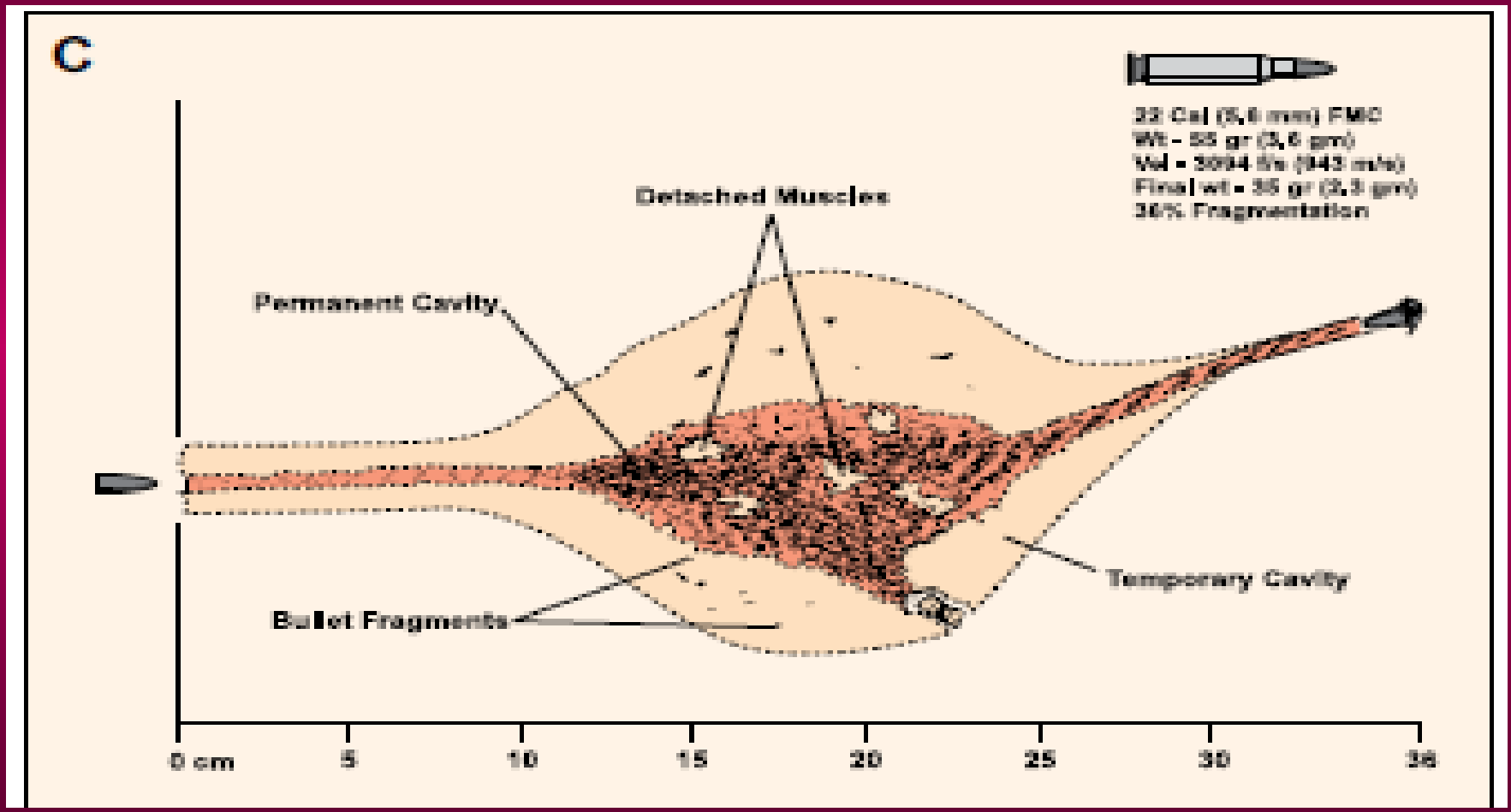
David, 2008


A
7.62 mm NATO
Permanent Cavity
Temporary Cavity
0 cm
5
10
15
20
25
30
35
40
45
50
55
60
64

David, 2008


B
Bullet Fragments
Detached Muscles
Permanent Cavity
Temporary Cavity
9 cm
5
10
15
20
25
30
35
42

David, 2008


C
22 Cal (5,6 mm) FMC
Wt - 55 gr (3,6 gm)
Vel - 3084 fps (943 m/s)
Final wt - 35 gr (2,3 gm)
36% Fragmentation
Detached Muscles
Permanent Cavity
Temporary Cavity
Bullet Fragments
0 cm
5
10
15
20
25
30
35

David, 2008

Table 1. TYPES OF GUNS, PROJECTILES, AND PROPELLANTS USED IN THE FOURTEEN CASES UNDER INVESTIGATION

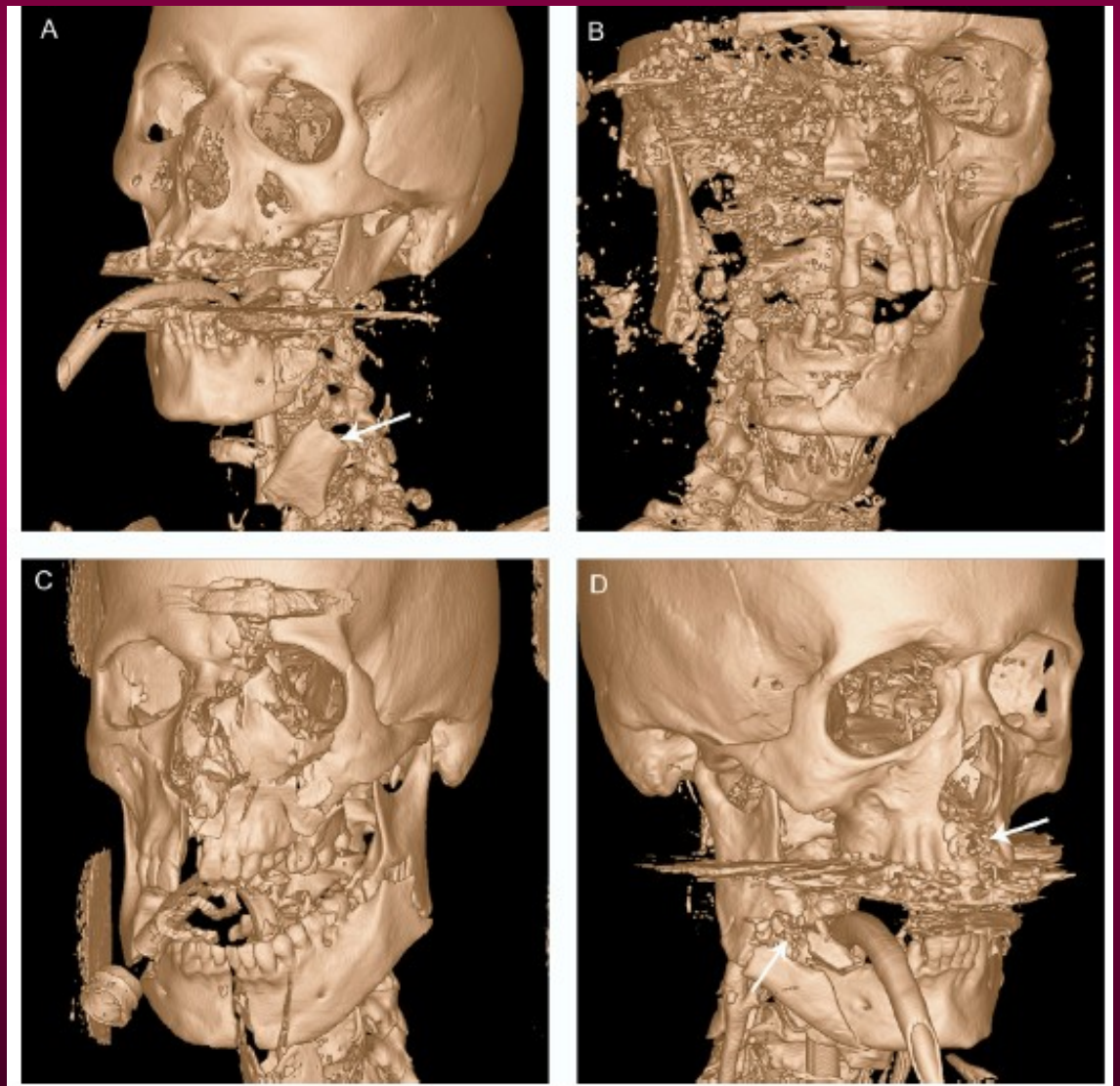
Case No.	Gender/Age (y)	Gun	Projectile/Propellant	Injury	Description of Injury
1	Male/17	Blank-firing pistol	None/nitrocellulose	Tongue	Gaping tongue wound
2	Female/62	Flobert-pistol	(Flobert-type) round lead projectile/gunpowder	Temporal region (three shots)	Non-bleeding entrance wound with gunpowder along the wound track
3	Female/29	Airgun	Airgun pellet/compressed air	Intraoral (palatal) injury	Airgun pellet in close vicinity to the internal carotid artery
4	Male/12	Airgun	Airgun pellet/compressed air	Injury to the forehead	Projectile in the right frontal sinus at the anterior skull base
5	Male/24	Airgun	Airgun pellet/compressed air	Injury to the right cheek	Airgun pellet located in the right zygoma laterally to the infraorbital foramen
6	Male/26	Pistol	Solid hollow-point projectile/nitrocellulose	Submandibular entrance wound	Severe damage to the mandibular, midfacial, and orbital complex and anterior skull
7	Male/47	Pistol	Partial metal-jacketed projectile/nitrocellulose	Submental entrance wound with gaping paranasal exit wound	Destruction of the mandible and the midfacial and orbital complex with soft-tissue loss in the nose and cheek area
8	Male/83	Pistol	Full metal-jacketed projectile/nitrocellulose	Temporal entrance wound	Destruction of the left orbital bone and eyeball
9	Male/78	Rifle	Partial metal-jacketed projectile/nitrocellulose	Submandibular entrance wound with infraorbital exit wound	Multiple bone fragments in the path of the projectile in the presence of trapped air
10	Male/34	Rifle	Full metal-jacketed projectile/nitrocellulose	Entrance wound in the left cheek and exit wound in the right cheek	Perforating injury (from the left to the right maxillary sinus)
11	Male/48	Rifle	Solid partially metal-jacketed projectile/nitrocellulose	Submandibular entrance wound with paramandibular exit wound	Perforating injury with destruction of the mandible and paramandibular soft-tissue destruction
12	Male/70	Shotgun	Lead pellets/nitrocellulose	Left paranasal entrance wound	Destruction of the midfacial and orbital complex with a gaping wound
13	Male/35	Shotgun	Lead pellets/nitrocellulose	Submandibular entrance wound	Destruction of submandibular soft tissue, mandible, and palatal bone
14	Male/40	Shotgun	Lead pellets/nitrocellulose	Submandibular entrance wound and gaping temporal exit wound on the left side	Destruction of midfacial and orbital bone with extensive temporal tissue loss on the left side

Stuebmer et al. Gun-Related Injuries to the Viscerocranium. J Oral Maxillofac Surg 2009.

FIGURE 1. Submental entrance wound (arrow) showing coagulated blood vessels and dark circular soot deposition typical of contact gunshot wounds.

Stuebner et al. Gun-Related Injuries to the Viscerocranium. J Oral Maxillofac Surg 2009.

Imaginologia



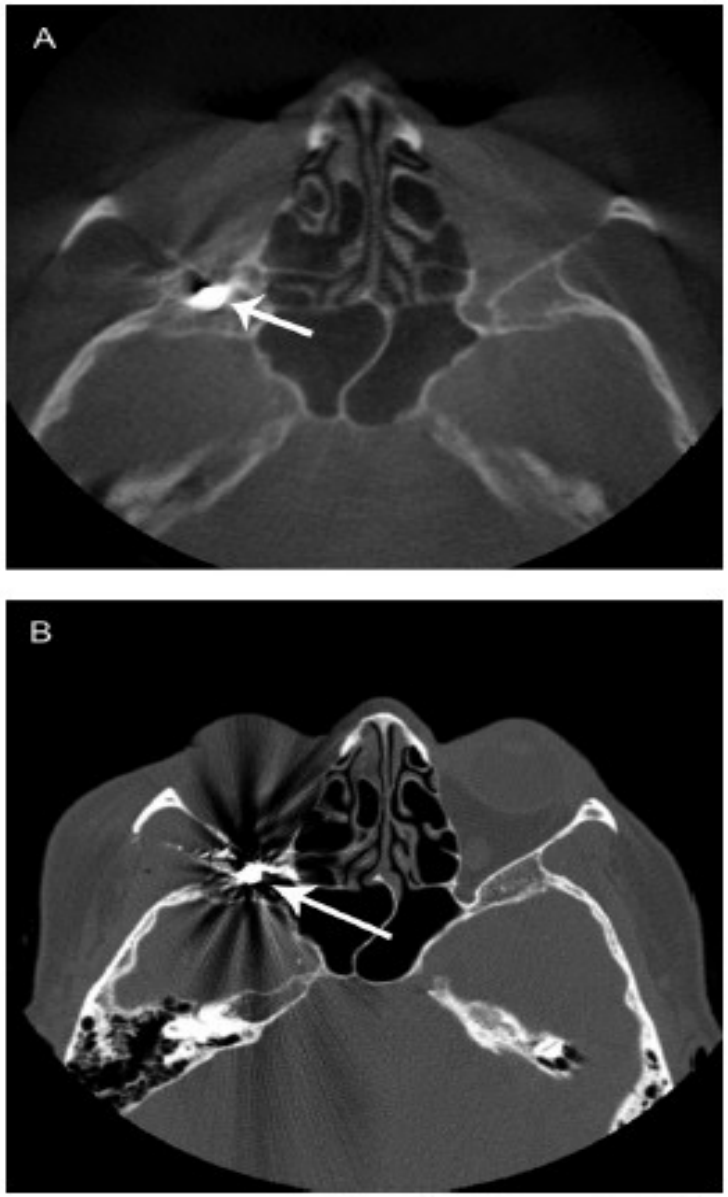


FIGURE 5. Transverse CBCT (*A*) and CT (*B*) scans of a (Flobert-type) lead round nose bullet (*arrow*) lodged lateral to the temporal bone.

Stuehmer et al. Gun-Related Injuries to the Viscerocranium. J Oral Maxillofac Surg 2009.

J Oral Maxillofac Surg
61:932-942, 2003

Firearm Injuries to the Maxillofacial Region: An Overview of Current Thoughts Regarding Demographics, Pathophysiology, and Management

Larry L. Cunningham, DDS, MD, Richard H. Haug, DDS,† and Jason Ford, DDS‡*

Table 4. ADVANTAGES AND DISADVANTAGES OF VARIOUS GRAFT TYPES FOR CRANIOFACIAL RECONSTRUCTION

Type of Graft	Available Bone	Soft Tissue Pedicle	Simultaneous Harvest	Advantages	Disadvantages
Fibula free flap	25 cm	24 cm × 9 cm	Yes	Mandibular reconstruction, any length, versatile, supports implants, blood supply permits contouring osteotomies	May require skin graft for closure, edema, ankle instability, questionably reliable skin paddle
Scapula free flap	14 cm	12 cm × 20 cm	No	Wide latitude in placement relative to skin or muscle; versatile; can be used for orbit, base of skull, maxilla, zygoma, palate, mandibular defect with massive intraoral/extraoral soft tissue defect	Shoulder debilitation, widened scar if oriented transversely and closed primarily, thin bone often inadequate for implants
Iliac crest free flap	15 cm	10 cm × 20 cm	Yes	Reconstruction of mandibular defects, curve parallels mandible, mass permits contouring osteotomies, supports implants	Technically difficult, especially in obese patients, abdominal weakness and hernia, thigh pain ± sensory deficits, gait disturbance, cutaneous portion of flap bulky
Radial forearm free flap	12 cm	Any portion of forearm skin	Yes	Intermediate mandibular defect requiring bone and soft tissue coverage	Radius fracture poor cosmesis, sensory deficit, bone often inadequate for implants unicortical bone intolerant of osteotomies
Iliac crest cancellous or corticocancellous graft	50 mL (anterior) 88 mL (posterior)	None	Yes (anterior) No (posterior)	Mandibular defects, orbital reconstruction, augmentation of small midfacial defects	Hernia, hemorrhage, seroma, thigh pain ± sensory deficits, gait disturbance, intraperitoneal communication (ileus, perforated viscus)
Split calvarium	Extensive	None	No	Orbital reconstruction, nasal dorsum, zygoma, maxilla, mandible	Palpable or cosmetic defect if outer table used, dural tear, sagittal sinus hemorrhage
Rib	12 to 18 cm	None	Yes	Mandibular condyle, ramus, anterior mandible, midface (split), can be contoured	Pneumothorax, possible unsightly scar

G Model
JINJ-5150; No. of Pages 6

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Injury, Int. J. Care Injured xxx (2012) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Management of comminuted but continuous mandible defects after gunshot injuries

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Gunshot injuries
Maxillomandibular fixation
Open reduction
Closed reduction
Internal fixation

ABSTRACT

Introduction: Firearm injuries continue as a major public health problem, contributing significant morbidity, mortality, and expense to our society. There are four main steps in the management of patients with gunshot wounds to the face: securing an airway, controlling haemorrhage, identifying other injuries and definitive repair of the traumatic facial deformities. The objective of this study was to determine late outcome of two treatment options by open reduction and internal fixation versus closed reduction and maxillomandibular fixation (MMF) in the treatment of gunshot injuries of the mandible.
Methods: Sixty patients of gunshot injury were randomly allocated in two groups. In group A, 30 patients were treated by open reduction and internal fixation and in group B, 30 patients were treated by closed reduction and maxillomandibular fixation. Patients were discharged as the treatment completed and recalled for follow up. Up to 3 months after injury, fortnightly complications like infection, malocclusion, malunion of fractured fragments, facial asymmetry, sequestration of bone and exposed plates were evaluated and the differences between two groups were assessed. The follow-up period ranged from 3 months to 10 months.
Results: Patients treated by open reduction tended to have less complications as compared to closed reduction.
Conclusion: Based on this study open reduction and internal fixation is the best available method for the treatment of gunshot mandible fractures without continuity defect.

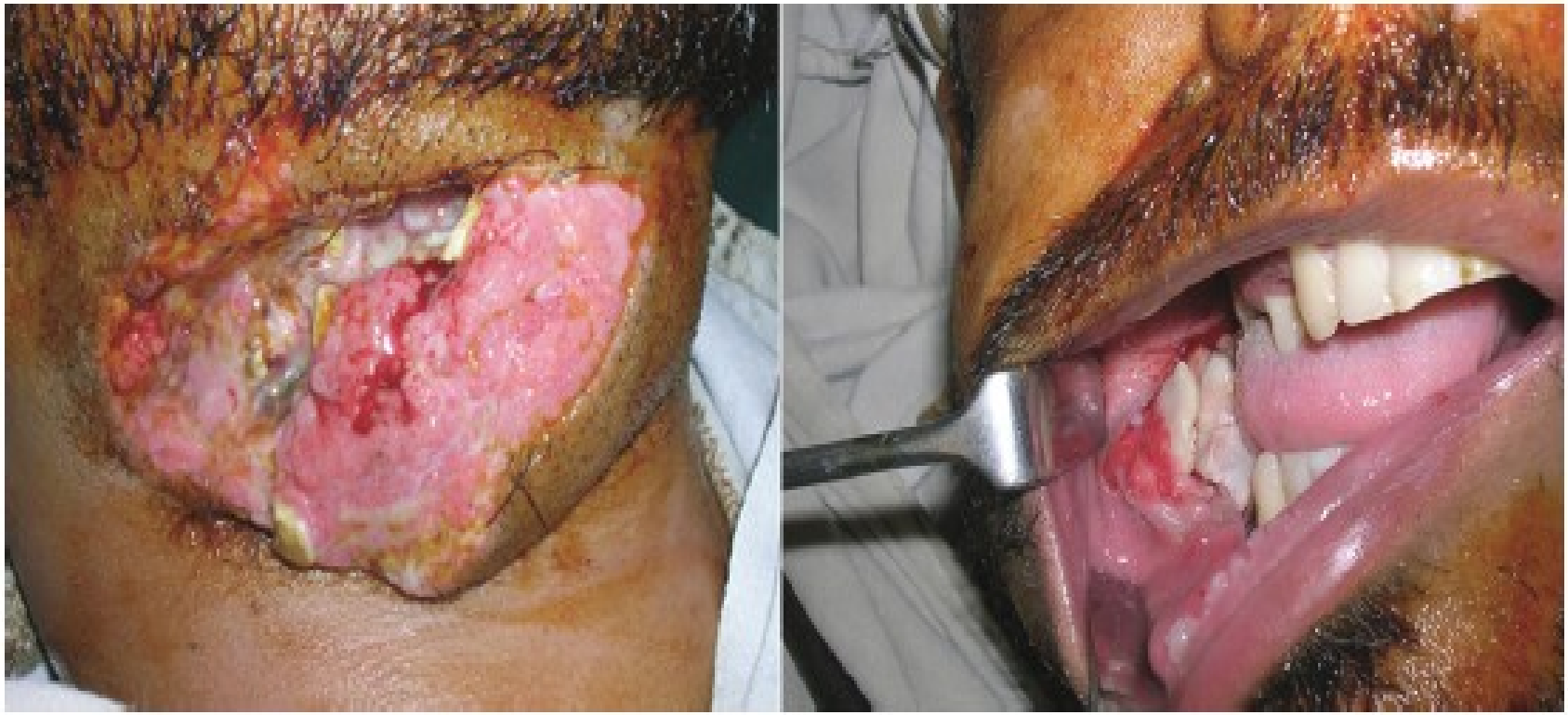

Fig. 1. Extraoral (left) and intraoral (right) view after injury.

***Majeed** et al, 2012*

***Majeed** et al, 2012*

***Majeed** et al, 2012*

Fig. 4. Postoperative early (6th day post-op; left) and late (22nd day post-op; right) outcome.

***Majeed** et al, 2012*

Conclusion

Rigid internal fixation is best available method for the treatment of gunshot mandible fractures without continuity defect being superior to more conventional techniques in spite of minor infection rates. The infection can, however, be reduced by careful selection of patients, meticulous debridement, use of antibiotics, skill and experience of the surgeon. The results show that majority of the patients were young adult males. It was also seen that open reduction and internal fixation was advantageous as it allowed immediate or early mandibular mobility, with good functional and aesthetic results and a tendency towards a lower rate of late complications.

***Majeed** et al, 2012*

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Clinical characteristics and treatment of multiple site comminuted mandible fractures

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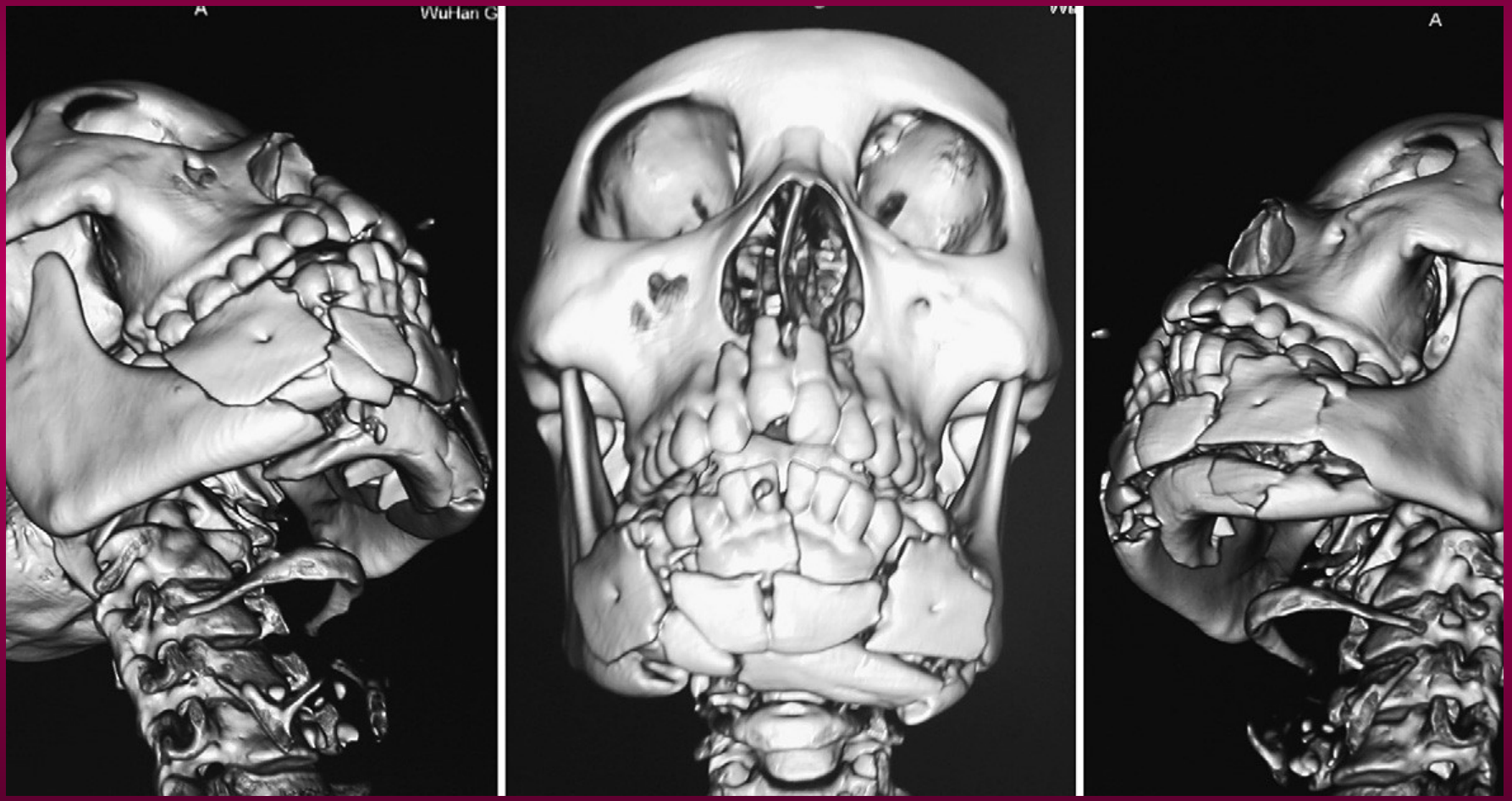
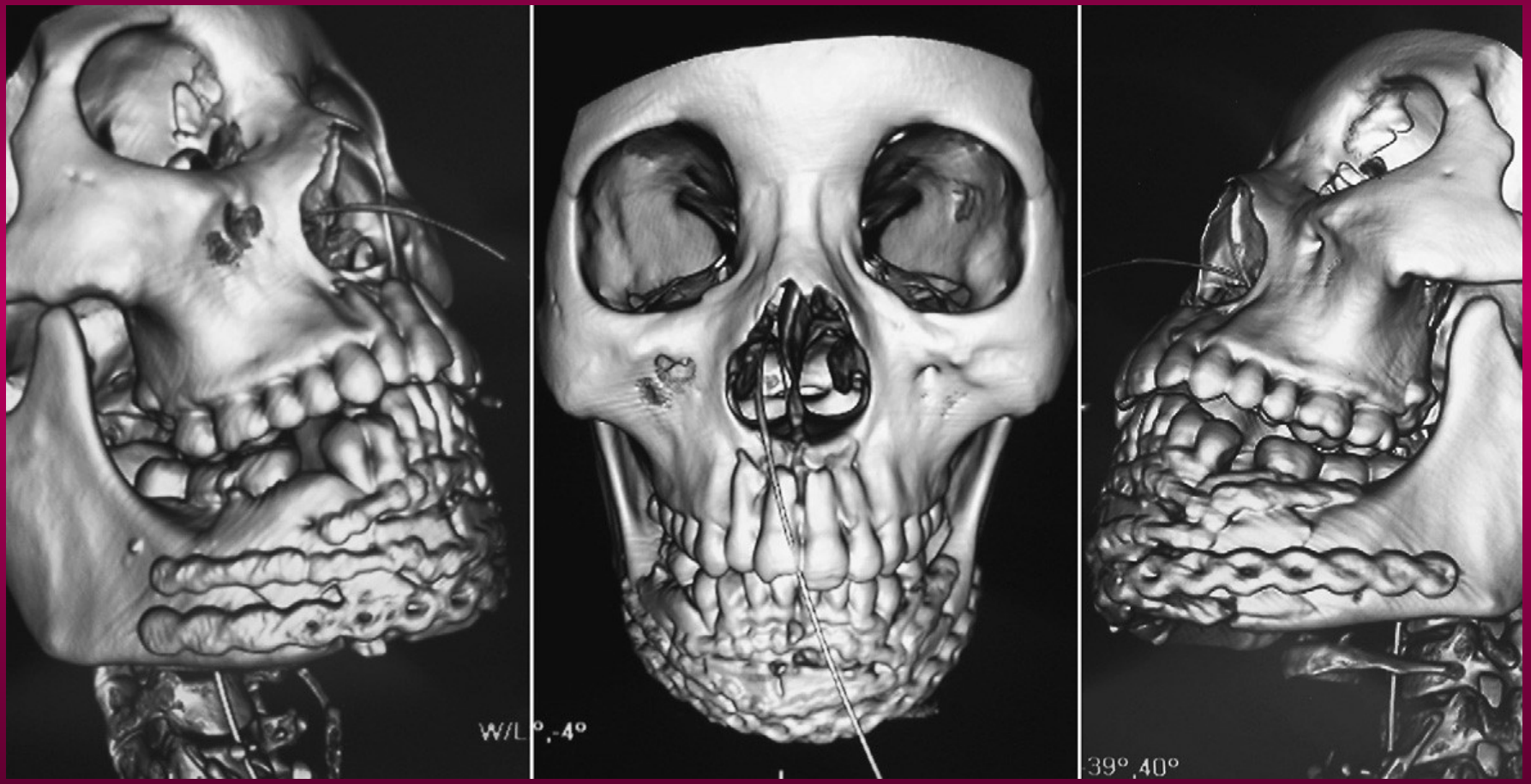
Treatment

ABSTRACT

Multiple site comminuted mandibular fractures are the result a concentrated and prolonged force on a region of the mandible. The purpose of this retrospective study was to investigate the clinical characteristics of these fractures in China, as well as review our experience with these types of fractures. Twenty-one patients treated for multiple site comminuted mandibular fractures were included in the study. The case records were reviewed, with particular attention to the patient's gender, age, aetiology of injury, area and extent of comminution, concomitant injuries and treatment methods. Sixteen of the 21 patients were males. Ages ranged between 18 and 48 years, with a mean of 34.81 years. Traffic accidents were responsible for the majority (42.86%) of the fractures. Concomitant injuries were uncommon. Treatment was with open reduction with rigid internal fixation and maxillo-mandibular fixation. We recommend that fixation and reconstruction of the mandible with reconstruction plates should be the treatment of choice and MMF should be used as an adjunct.

Imaginologia

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Forensic Science International 197 (2010) e13–e17

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Forensic Science International

journal homepage: www.elsevier.com/locate/forsciint

Short communication

Dissecting firearm injury to the head and neck with non-linear bullet trajectory: A case report

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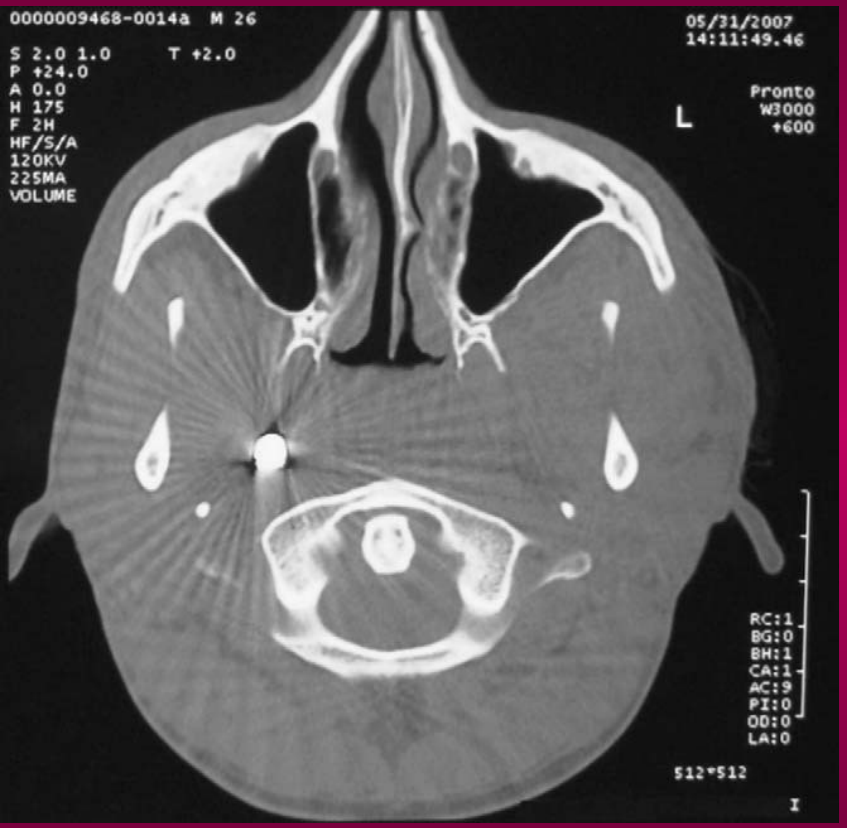
ABSTRACT

Firearm injuries to the head and neck have a potential for fatal complications caused by damage to neurovascular structures in the region. We herewith present a case of a missile injury to the face, caused by a bullet from a rifle with high muzzle energy that slackened while penetrating a vehicle before hitting the victim. The bullet advanced through the retrofacial spaces following a non-linear course and was retained within the opposite parapharyngeal region without injuring any vital structure. The resultant damage was a 'low-velocity injury'. However, it is noteworthy that the missile had still retained enough energy to penetrate the tissue and travel in a 'dissecting' fashion. It is likely that the blunting of the missile during vehicle penetration and the compactness of the anatomical structures bordering the head and neck spaces, such as fascia and tendons, forced the projectile to follow a non-linear inter-structural path. This case yet again demonstrates that the magnitude of firearm-related tissue damage may also depend upon the shape of the projectile and confirms that the head and neck spaces have anatomical integrity rather than just being arbitrarily designated topographical areas. It has also been confirmed that non-surgical approach with regular follow-ups is a viable option for uncomplicated head and neck injuries.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HF/S/A
120KV
225MA
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W3000
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CA:1
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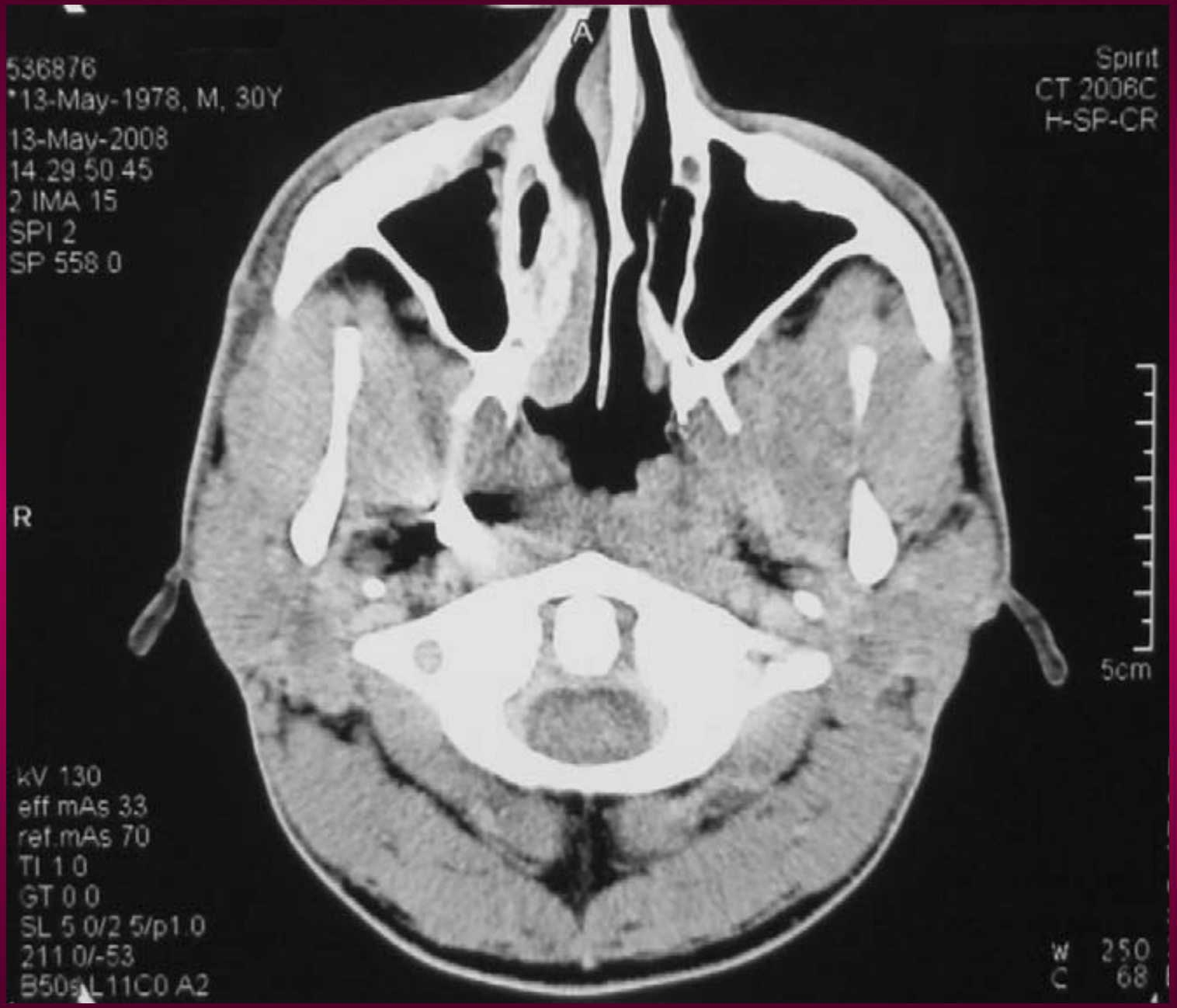
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13-May-2008
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SP 558 0
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Spirit
CT 2006C
H-SP-CR
R
5cm
kV 130
eff mAs 33
ref.mAs 70
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GT 0.0
SL 5.0/2.5/p1.0
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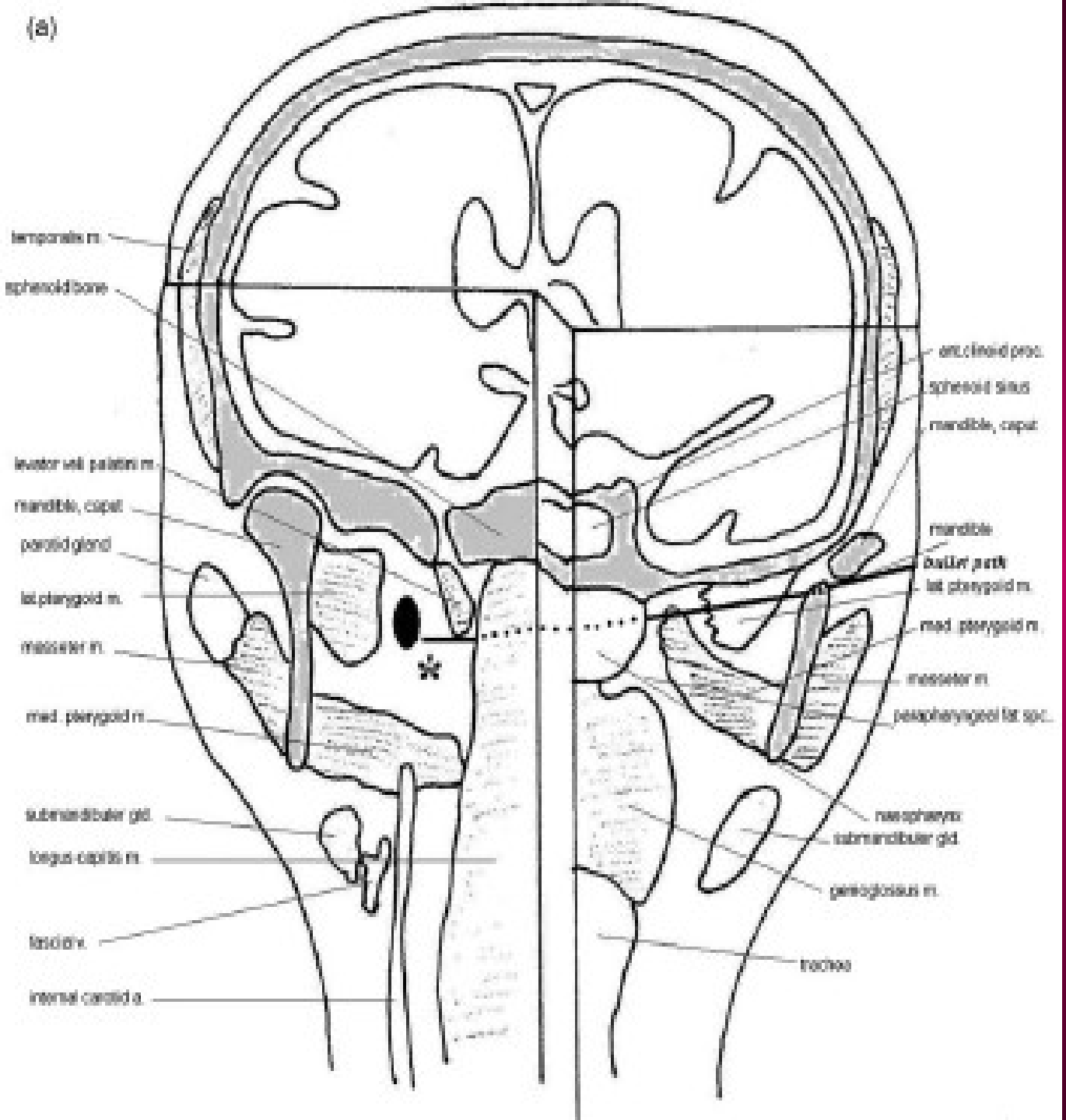
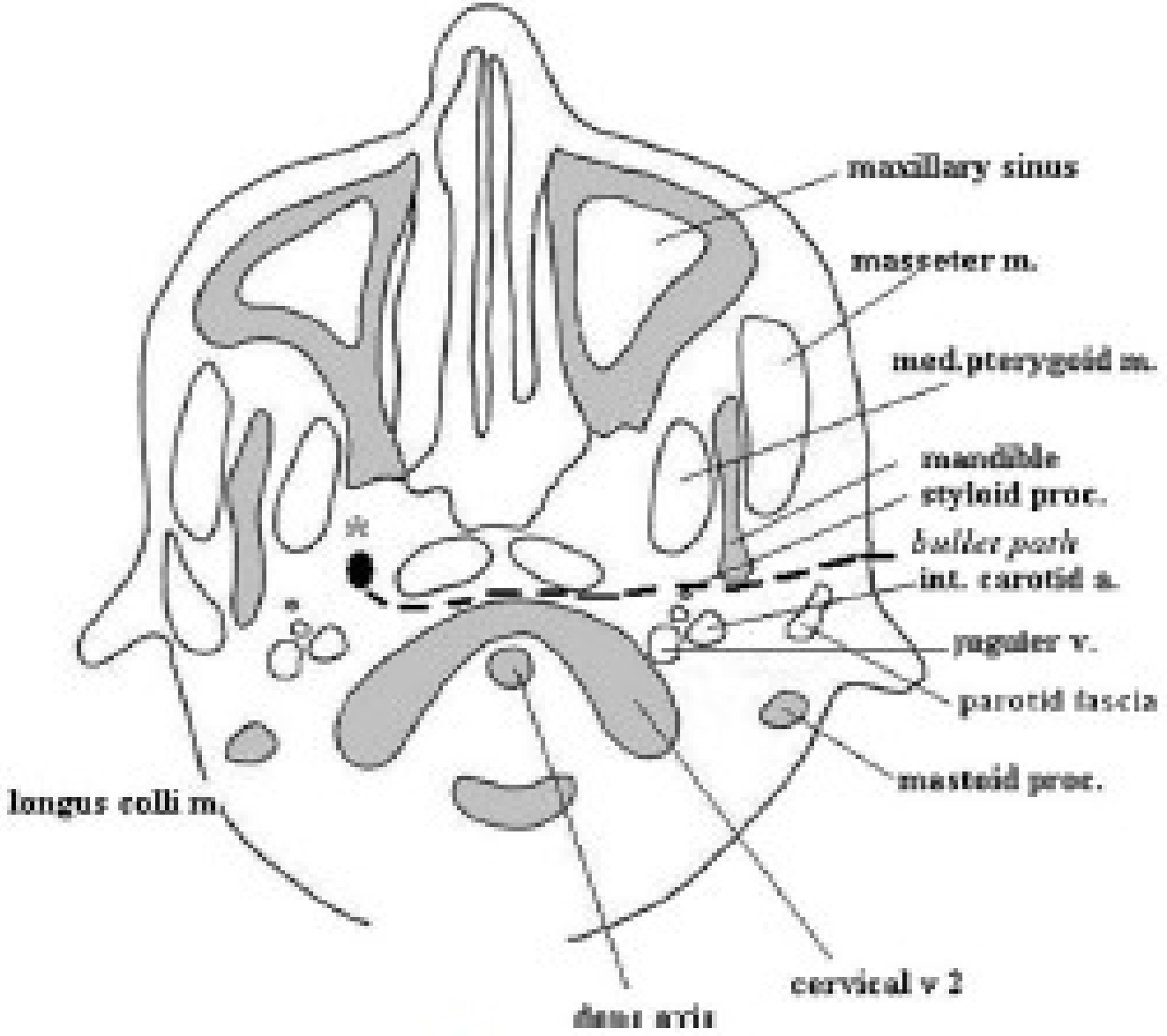
B50s L11C0 A2
W 250
C 68


(a)
temporalis m.
sphenoid bone
levator veli palatini m.
mandible, capat
parotid gland
lat.pterygoid m.
masseter m.
med. pterygoid m.
submandibular gld.
longus capitis m.
internal carotid a.
mandible
buccal path
lat. pterygoid m.
med. pterygoid m.
masseter m.
submandibular gld.
genioglossus m.
trachea


maxillary sinus
masseter m.
med.pterygoid m.
mandible
styloid proc.
bulbar park
int. carotid a.
jugular v.
parotid fascia
mastoid proc.
longus colli m.
cervical v 2

- ***REMOÇÃO DO PROJÉTIL***

RISCO X BENEFÍCIO

FERIMENTOS POR PROJÉTEIS MÚLTIPLOS

- *Peterson, 2008*


a
b
c

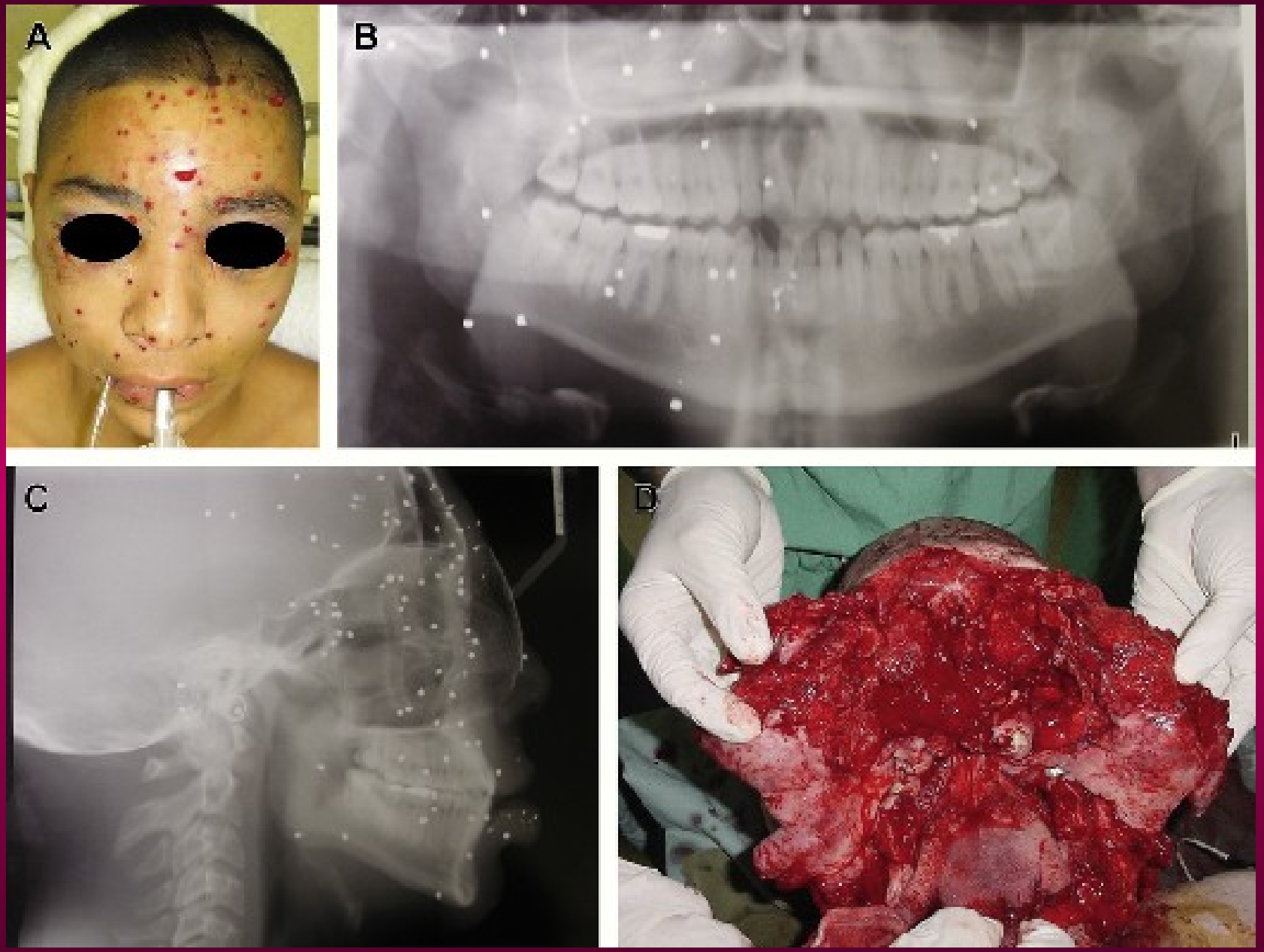

a
b


a
b

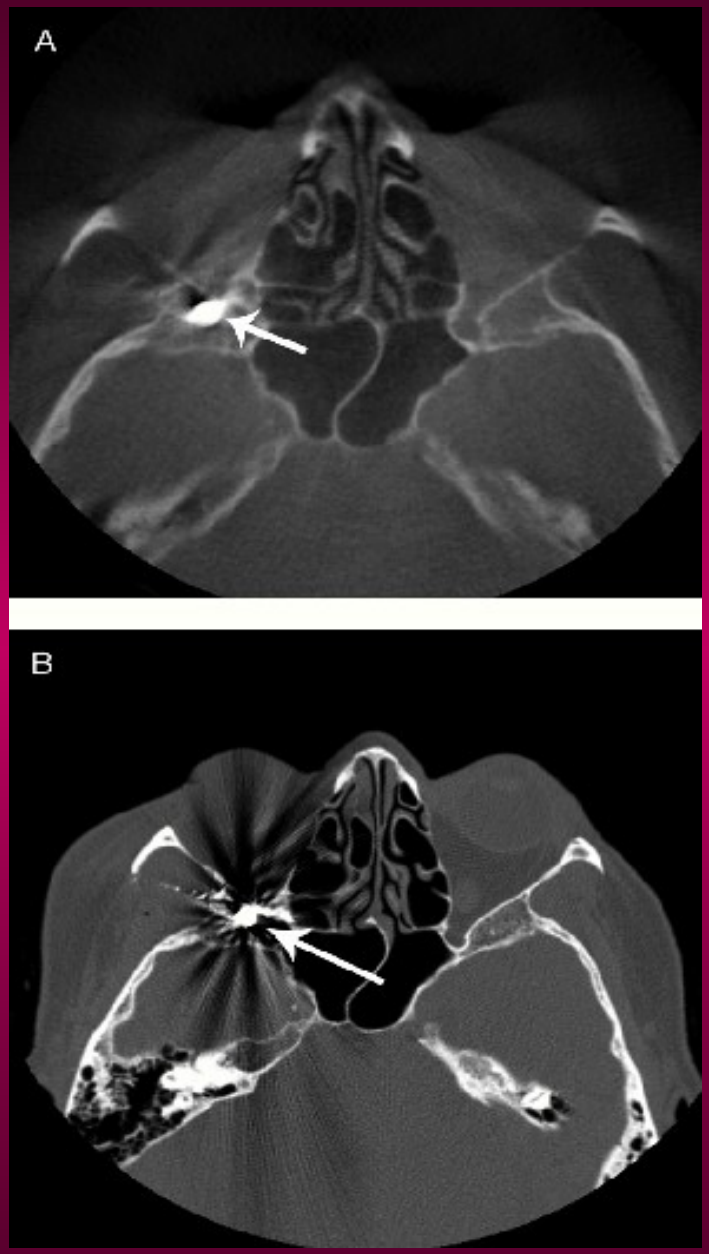
Michael, 2010

Michael, 2010

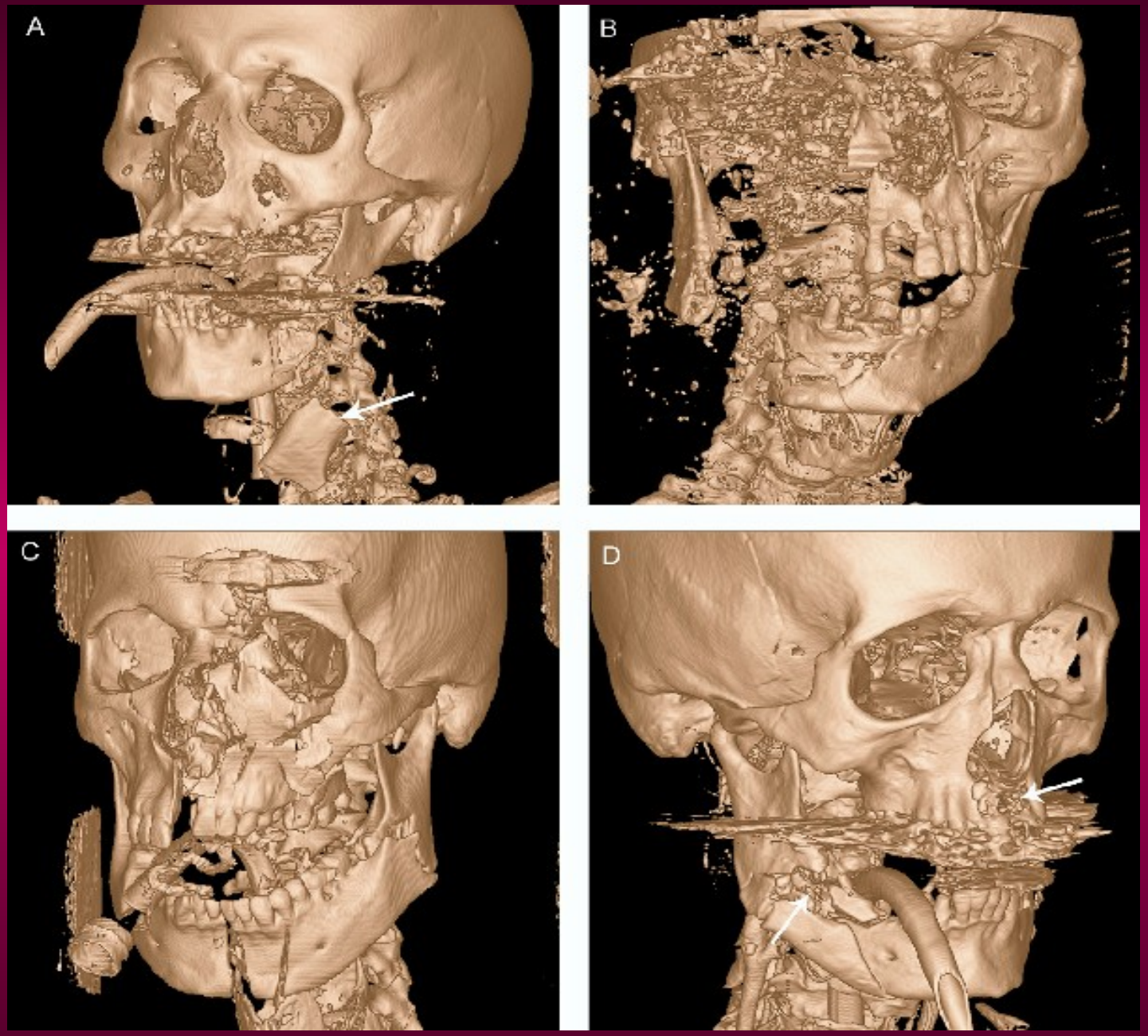
David, 2008



David, 2008



Constantin, 2009



Constantin, 2009

FIM

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- Muhammet Can et al. Dissecting firearm injury to the head and neck with non-linear bullet trajectory: A case report. Forensic Science International 197 (2010) e13–e17
- *Larry L. Cunningham et al.* **Firearm Injuries to the Maxillofacial**
- **Region: An Overview of Current Thoughts**
- **Regarding Demographics,**
- **Pathophysiology, and Management**