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GUNSHOT WOUND TO THE NECK WITH THROMBOSIS OF THE COMMON CAROTID ARTERY IN THE DELAYED PERIOD. (ANALYSIS OF CLINICAL OBSERVATION)

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Conflict of interest
The authors declare that they have no conflicts of interest

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Abstract

A case of non-penetrating neck injury with contusion and dissection of the common carotid artery with transition to the internal carotid artery is presented in a clinical observation. The clinical picture of the development of brain failure after thrombosis of the common and internal carotid arteries and regression of brain symptoms after reconstructive surgery is presented. A mathematical model of the lesion mechanism is analyzed separately. It is concluded that in case of a non-penetrating wound of the neck with a traumatic weapon, the revision of the underlying tissues should be mandatory.

Keywords
neck injury, carotid artery dissection with thrombosis, reconstructive surgery, a mathematical model of defeat

Алшақ кезеңдегі мойынға оқ тию жарақатымен қосарланған жалпы ұйқы артериясының тромбозы. (Клиникалық бақылауды талдау)

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Аңдатпа

Клиникалық бақылауда ішкі ұйқы артериясына ауыса отырып, жалпы ұйқы артериясының контузиясы мен стратификациясы бар мойынның енбейтін жарақаты көрсетілген. Жалпы және ішкі ұйқы артерияларының тромбозынан кейін ми жеткіліксіздігінің дамуының клиникалық көрінісі және реконструктивті операциядан кейін ми симптомдарының регрессиясы ұсынылған. Зақымдану механизмінің математикалық моделі бөлек талданады. Мойын жарақатсыз жарақат алған кезде, тиісті тіндерді тексеру міндетті болуы керек деген қорытынды жасалды.

Түйін сөздер
мойынның жарақаты, тромбозы бар ұйқы артерияларының стратификациясы, реконструктивті хирургия, зақымдалудың математикалық моделі

Огнестрельное ранение в шею с тромбозом общей сонной артерии в отсроченном периоде. (Разбор клинического наблюдения)

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Конфликт интересов
Авторы заявляют об отсутствии конфликта интересов

Аннотация

В клиническом наблюдении представлен случай не проникающего ранения шеи с контузией и расслоением общей сонной артерии с переходом на внутреннюю сонную артерию. Представлена клиническая картина развития мозговой недостаточности после тромбоза общей и внутренней сонных артерий и регресс мозговой симптоматики после реконструктивной операции. Отдельно проанализирована математическая модель механизма поражения. Сделан вывод, что при непроникающем ранении шеи травматическим оружием, ревизия подлежащих тканей должна быть обязательной.

Ключевые слова
ранение шеи, расслоение сонных артерий с тромбозом, реконструктивная операция, математическая модель поражения

Relevance

Various injuries with damage to soft and underlying tissues is an inalienable price for the development of scientific and technological progress.

The etiology of injuries is diverse and determined, as the way of life of various socio-economic segments of the population and is determined by many factors, ranging from interpersonal violence and terrorism and ending with accidents [1].

The neck, as an anatomical region, unites many organs and, first of all, vessels, nerves, trachea, esophagus. Most of these formations are quite difficult to access for research and surgical revision. This determines the special position of neck wounds in emergency surgical practice. Sometimes the urgency of the situation, the threat of the development of lethal complications does not leave time for a scrupulous examination of the victim.

The experience gathered by generations of civil and military surgeons has not turned the care of patients with vascular and neck injuries into a simple and clear procedure and, despite the progress of medical science, the results of their treatment need to be improved. The approach of different surgeons to the treatment of injuries of the major vessels of the neck differs significantly in many fundamental points. Some surgeons are supporters of the mandatory revision of the so-called penetrating neck wounds [2-13].

Others adhere to a more wait-and-see tactic, justifying it with a relatively high percentage of negative revision results [14, 15, 16, 17, 8, 10, 11, 12, 13]. There are few publications on this issue in Russia; the most complete is the monograph by A.I. Yunina [14].

In the most representative analysis of neck injuries conducted by D. Demetriades and M. Stewart [3], damage to the major vessels was present in 33.5% of the victims, the mortality rate was 11%, 4 (13.7%) had injuries of parenchymal organs of the neck (in 26 - the thyroid gland, in 18 - the salivary glands).

Analysis of 492 clinical observations allowed Abakumov M.M. et al [15] to reveal some regularities in the course of lesions in this localization. The authors divided all lesions into superficial and deep; however, surgical practice shows that even at first glance, superficial damage to soft tissues does not guarantee the safety of the underlying structures. In surgical practice, there are cases when a complication develops in a delayed period after the initial surgical treatment [16]. This is especially true for gunshot wounds.

Another side is the fact that damage to the carotid arteries, with their subsequent thrombosis, in essence, is a model of acute cerebrovascular accident of the ischemic type, and in this case, the dynamics of the development of neurological deficit with its subsequent regression is of great interest, and the identification of the mechanism of damage is forensic.

We present our own experience of observation and treatment of a patient with a gunshot wound to the neck.

Clinical observation. Patient: K. medical record number No.14895, born in 1984

Date and time of admission: 12.12.20 .. 1.55

Diagnosis at admission: Gunshot wound to the neck, left hand, right thigh.

The wound was made from a nonlethal pistol CCA (reference "Osa" is a barrelless pistol, a multifunctional complex of civilian weapons of non-lethal action, designed for active self-defense, signaling and illumination of the area. Today it is the most powerful non-lethal weapon available to citizens on the Russian market. Type of ammunition - 18 × 45T - beanbag round equipped with a rubber bullet with a metal core. Such a traumatic element at a distance of self-defense retains energy sufficient to suppress criminal attacks on the personality of the defender. The initial energy of the traumatic element is from 85 to 91 joules [17].

12.12.20 .. 3.20-3.50 PST of neck wounds. PST of wounds of the right thigh. PST of wounds of the left hand.

Osteosynthesis of the third metacarpal bone of the left hand.

13.12.20. 11.30 Examination by a neurosurgeon:

Neurological status: Consciousness at the level of moderate stun. Glasgow Coma Scale 13 points. Inhibited, partially disoriented in time. Meningeal symptoms: no. Pupils OD = OS. The photoreactions of the pupils are vivid. The movement of the eyeballs in full. N.trigtminis exit points are painless; the sensitivity on the face is preserved. Eye fissure D = S, the left nasolabial fold is smoothed. There is no spontaneous nystagmus, hearing is preserved. Swallowing and phonation are not disturbed, the soft palate is mobile during phonation, the pharyngeal and palatine reflexes are lively D = S. Full head and shoulder girdle movements. Tongue in the midline. Sensitive area: no pathology. Muscle tone is reduced in the left extremities. Muscle strength is reduced in the left extremities: in the arm - 2 points, in the leg - 4 points. Tendon reflexes from the upper and lower extremities are alive S>D. There are no pathological foot reflexes. The coordination sphere and higher cortical functions were not investigated due to the severity of the condition.

Figure 1. Bullet removed 12.12.20. 13.05 Transferred to the department of surgery -1. 13.12.20. 9.40 General condition progressively worsens, cerebral symptoms began to increase: lethargy, adynamia; weakness in the left limbs.

Lumbar puncture: a colorless, transparent liquid was obtained.

Echoencephalography: no displacement of the midline structures.

Diagnosis: ACVA on ischemic stroke in the right hemisphere. There are no data for head injury. 13.12.20.. 11.40 Ultrasonic doplerography of the neck vessels: CCA contusion with detachment of the intima and CCA thrombosis.

13.12.20.. 13.00-14.50 Clinical diagnosis: bullet wound of the neck, contusion of the CCA wall, dissection of the CCA wall. Thrombosis of the right CCA. ACVA in the right SMA.

Surgery: Prosthetics of the right CCA with a synthetic explant.

Surgery description: 13.12.20 ..16.00 Examination by a neurologist at Anaesthesiology & ICU.

Neurological status: At the time of examination, the phenomena of drug sedation persist. On artificial respiration.

Kernig's symptom on the right is 160^0. A glance at an object does not fix. Pupils OD=OS, live photoreactions. Corneal reflexes are lively, symmetrical. Eye fissure D=S. The left cheek is sailing. There is no spontaneous nystagmus. Tongue in the oral cavity along the midline. Reacts to painful stimuli by flexing the right upper limb. It is not possible to adequately investigate muscle tone due to drug sedation. Twitching of the muscles of the right extremities is periodically noted. The left lower limb is rotated outward. Motor sphere: muscle tone is reduced in the left extremities. Muscle strength is reduced in the left extremities: arm - 2 points, leg - 4 points. Reflex sphere: tendon reflexes from the upper and lower extremities are low, S>D. Babinsky's symptom is positive on 2 sides.

Diagnosis: Acute ischemic cerebrovascular accident in the right middle cerebral artery. Left hemiparesis. Thrombosis of the right CCA. Condi-

tion after prosthetics of the right common carotid artery.

14.12.20.. 15.15 Examination by a neurologist (the next day after the surgery)

Neurological status: consciousness at the level of moderate stun. Glasgow Coma Scale 13 points. Lethargic, adynamic. Understands the addressed speech. Follows simple instructions.

Moderately expressed cerebral symptoms. Kernig's symptom 150º.

Smelling is not impaired. The fields of view are roughly preserved. Pupils OD=OS, direct and friendly vivid photoreactions. The movement of the eyeballs in full. The n.trigtminis exit points are painless. Hypesthesia of the left half of the face. Corneal reflexes are lively, symmetrical. Eye fissure D=S, the left corner of the mouth is lowered. There is no spontaneous nystagmus, hearing is preserved. Swallowing and phonation are not disturbed, the soft palate is mobile during phonation, the pharyngeal and palatine reflexes are lively D=S. Full head and shoulder girdle movements. The tongue deviates to the left, there is no atrophy. Left hemigipesthesia. The tone in all the studied muscle groups of the left extremities is reduced. Decreased muscle strength in the left extremities: arm-plegia, leg-4 points. Tendon reflexes from the upper and lower extremities are alive, S>D. Babinsky's symptom on the left. The FNT is performed with the right hand with intention. Controls the functions of the pelvic organs. No higher cortical dysfunctions were found.

27.12.20.. The patient's condition is satisfactory. Transferred to the Department of Neurology for neurorehabilitation.

Neurological status: consciousness is clear. Glasgow Coma Scale 15 points. Contact, adequate, oriented in space, time and self.

There are no general cerebral symptoms. Kernig's symptom 160º on both sides.

Smelling is not impaired. The fields of view are roughly preserved. Pupils OD=OS, direct and friendly vivid photoreactions. The movement of the eyeballs in full. The n.trigtminis exit points are painless. Hypesthesia of the left half of the face. Corneal reflexes are lively, symmetrical. Eye fissure D=S, the left corner of the mouth is lowered. There is no spontaneous nystagmus, hearing is preserved. Swallowing and phonation are not disturbed, the soft palate is mobile during phonation, the pharyngeal and palatine reflexes are lively D=S. Full head and shoulder girdle movements. The tongue deviates to the left, there is no atrophy. Light hemihyperesthesia on the left. The tone in all the studied muscle groups of the left extremities is reduced. Decrease in muscle strength in the left extremities: in the hand proximally - 2 points, distally - 0 points, in the leg - 3 points. Tendon reflexes from the up-

Figure 2.
Sonogram of the damaged vessel

Figure 3.
View of the resected common carotid artery (CCA)

Figure 4.
Dissection of the posterior wall of the CCA with a break in the bifurcation and thrombosis

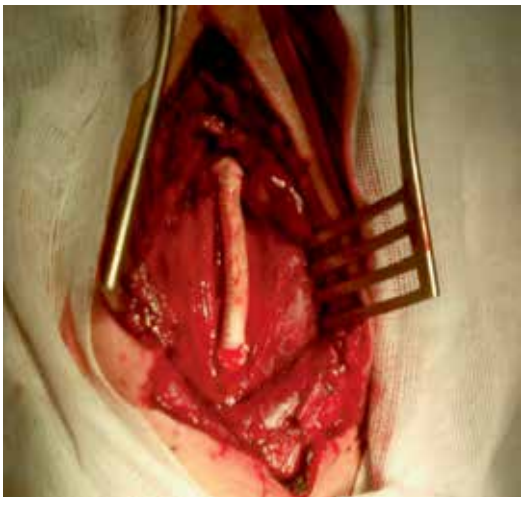

Figure 5.
Prosthetics of CCA with a synthetic explant

per and lower extremities are alive, S>D. Babinsky's symptom on the left. FNT with the right hand is satisfactory. Controls the functions of the pelvic organs. No higher cortical dysfunctions were found.

Treatment: antioxidants, antihypoxants, neuroprotectors, neurometabolites, anticoagulants, vase active drugs, antispasmodics, exercise therapy, massage.

N/B: restorative measures: exercise therapy and massage of the left upper limb are limited, due to the presence of a fracture of the third metacarpal bone in the patient.

30.12.20 .. The patient was discharged at his own request to continue treatment at the place of residence.

Discharge condition: overall status. The overall condition is satisfactory. Consciousness is clear, Glasgow Coma Scale = 15 points. Active position. The skin is pale pink, moderate moisture, clean. Healing of postoperative wounds without complications. In the lungs, vesicular breathing, no wheezing. Breathing is rhythmic. Respiration rate 16 per min. Heart sounds are clear. The rhythm of the heartbeats is correct. Heart rate 70 beats. in min. Blood pressure on the left arm is 120 and 80 mm Hg. The abdomen is not enlarged. The muscles of the anterior abdominal wall are actively involved in the act of breathing. On palpation, the abdomen is soft, painless. Symptoms of peritoneal irritation are negative. The liver is not enlarged. Symptom Pasternatsky neg. at both sides. Bowel and bladder habits are normal.

Neurological status: there are no general cerebral and meningeal symptoms.

Smelling is not impaired. The fields of view are roughly preserved. Pupils OD=OS, direct and friendly vivid photoreactions. The movement of the eyeballs in full. The n.trigtminis exit points are painless. Sensitivity disorders on the face are not noted. Corneal reflexes are lively, symmetrical. Eye fissure D=S, the left nasolabial fold is smoothed. There is no spontaneous nystagmus, hearing is preserved. Swallowing and phonation are not disturbed, the soft palate is mobile during phonation, the pharyngeal and palatine reflexes are lively D=S. Full head and shoulder girdle movements. Midline tongue, no dysarthria.

Light hemidysesthesia on the left.

The tone in all the studied muscle groups was not changed. Decrease in muscle strength in the left extremities: in the hand proximally - 3 points, distally - 1 point, in the leg - 4.5 points. He walks within the department without the help of another person. Manner of walking is not changed.

Tendon reflexes from the upper and lower extremities are alive, S>D. Upper symptom Rassolimo on the left. Babinsky's symptom on the left.

Coordination is not broken.

Controls the functions of the pelvic organs.

No higher cortical dysfunctions were found.

Discharge diagnosis:

Primary: Gunshot wound to the neck. Contusion injury of the right common carotid artery with the development of thrombosis. Condition after prosthetics of the common carotid artery with a synthetic explant.

Complications of the primary: Brain infarction in the right middle cerebral artery dated 13.12.20 ... Rough hemiparesis on the left.

Secondary: A gunshot wound to the left hand with a fracture of the third metacarpal bone. Osteosynthesis of the third metacarpal bone.

A gunshot wound to the right thigh.

We distinguish between superficial wounds (before platysma) and deep (when the wound channel "penetrates" through the platysma into a more dangerous zone). Naturally, deep neck wounds can penetrate into the oral cavity, pleural cavity, pharynx, esophagus, larynx and trachea, and then they can be classified as penetrating [15].

Obviously, this issue does not have an analytical solution, but the methods of numerical analysis have shown their great efficiency in solving such problems [18, 19]. At SSU named after Chernyshevsky, a mathematical model of the probable damage mechanism was built.

A rubber bullet with a metal core was simulated, the human neck was composed only of muscles (the water content in the skin was about 75%, in the muscles about 80%, in the subcutaneous adipose tissue about 95%). It can be seen that the bullet is slightly deformed, and a cavity is formed in the neck. The calculation time is 1 millisecond.

Extrapolating the results of an intraoperative finding and numerical analysis (modeling) to the anatomy of the neck (the location of the triangles of the neck, muscles, fascia and vascular bundle), the sequence of events is as follows - the bullet passed through the skin and underlying tissues, but did not significantly damage the deep fascia. The damage to the carotid artery was mediated by surging shock, and, therefore, such injuries will always lead to damage to the underlying tissues.

Conclusion

In our observation, we met with dissection of the CCA with subsequent thrombosis and the development of ischemic cerebrovascular accident. Dissection can be spontaneous, traumatic, or iatrogenic [20].

Despite the fact that the case of traumatic dissection of the carotid artery was described for the first time back in 1872 [21], even at the moment the

true incidence of the disease is unknown, since the dissection can be asymptomatic, often has a nonspecific character, and the phenomena of cerebrovascular insufficiency are sometimes arrested independently and invisible to patients [20].

Until now, there is no unequivocal opinion regarding the mechanism of development of neurological deficit in this disease. In 1991, Weiler C. et al. summarized the experience of 11 patients with dissection and stroke. Six of them had acute cerebrovascular accident (ACVA) occurred as a result of embolism in an intracranial artery, while the remaining five - as a result of a decrease in perfusion pressure in the corresponding area of the brain caused by a sharp compression of the true lumen of the artery [22]. Based on this, the authors concluded that only half of the patients develop stroke because of cerebral artery embolism, while in the other half, dissection leads to a decrease in blood flow in the distal intracranial cerebral arteries. Five years later, Steinke et al. examined 67 patients with dissection of the carotid arteries [23]. Among them, cerebral infarction was detected in 37 (55%) patients out of 67 examined, the cause of which, from the point of view of the authors, was an embolism intracranial by thrombotic masses from the site of ICA dissection, which was confirmed by the results of autopsy of patients who died from stroke: branches of the middle cerebral arteries (MCA) on the affected side were thrombosed. The hemodynamic mechanism of the development of ischemic brain damage was identified only in 16% of cases. Christian Lucas et al. obtained similar results: only 7.7% of patients with dissection had a hemodynamic mechanism, while 92.2% had an embologic stroke [24]. Beninger D.H. also speaks in favor of the leading role of thromboembolism in the development of cerebrovascular accidents. et al. [25].

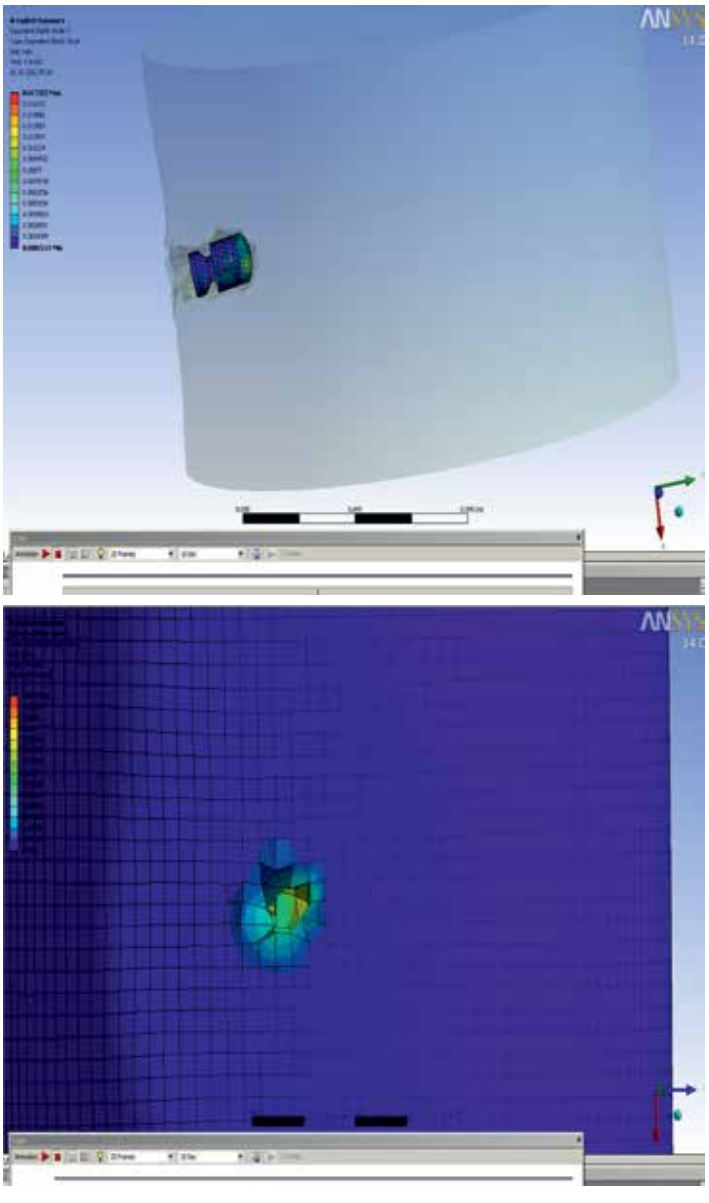

Figure 6.
Description is provided in the text

Since the 19th century, analysis of the clinical course of neck injuries has revealed certain patterns [30-34]. In our clinical observation, we tried to show that even a non-penetrating injury to the neck can lead to damage to the carotid arteries.

Table 1.
Clinical manifestations by age

	Schievink et al. [26]	Lucas et al. [27]	Mokri et al. [28]	Vilela et al. [29]
Headache	72%	14%	11%	38%
Cerebrovascular disease (OCVA + TIA)	63%	65%	72%	82%
Incomplete Horner's syndrome + cranial nerve paresis	37%	8%	22%	14%
Neck pain	No ind.	9%	5%	No ind.

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