ORIGINAL ARTICLE

Gunshot injury to the head: Management experience of Neuro-Surgery Department, King Abdullah Hospital, Bisha, KSA

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Abstract

Introduction: Gunshot injury to the head represents the majority of penetrating brain injuries. Detection of the entry and exit wounds and initial Glasgow Outcome Scale (GCS) assessment are important components in the management.

Material and Methods: This was a prospective observational study done at King Abdullah Hospital, Bisha, KSA during the period from September 2017 to May 2019. Karnofsky Score (KS) was applied to all cases in the study to evaluate the final post-joperative outcome. Data was then collected in a designed SPSS sheet and analyzed using SPSS version 20.

Results: 5-cases were managed all were males. Age was ranging between 19 to 56 years with the average age of 31.4 years. 3-of the patients were referred intubated with low GCS (3/5, 60%) and 2-cases (2/5, 40%) presented fully conscious. Most of the patients had hemorrhagic contusions (4/5, 80%) followed with those with acute subdural hematomas (2/5, 40%) and depressed fracture (2/5, 40%). All patients were operated with debridement of entry and exit wounds (if any), accessible hematomas were evacuated and dural repair was achieved. 1-patient was referred to a higher center after had been operated, 3-patients had a score of 100 (3/4, 75%) while the remaining 1-has a score of 60 (1/4, 25%).

Conclusion: Glasgow Outcome Scale is the gold standard tool for assessing the outcome of gunshot patients. Using a measurable tool for assessing the outcome (like Karnofsky score or Glasgow Outcome Scale) gives more accurate results and can help in comparing gunshot studies against each other to find out what is the best for patients.

Keyword: Gunshot to the head, Glasgow Outcome Scale, Outcome, Karnofsky score, dural repair, crainatomy

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Introduction:

Gunshot injury to the head represents the majority of penetrating brain injuries. Around 35% of patients die younger than 45-years and about ⅔rd of gunshot victims die at the scene. The overall mortality of gunshot head injury may exceed 50%.[1,2]

Sequel of gunshot injury to the head can be in 2-ways. Either through the primary insult or through secondary damage.

The primary insult can cause soft tissue injury, scalp and facial injury, dragging of devitalized tissue and bacteria intracranially and injury through gas combustion.[3] Primary injuries can also be caused by the comminuted bone fragments which can act as a secondary missile and cause vascular[4-6] and cortical tissue injuries.[7,8] The missile itself can cause direct damage through fragmentation of bullet,[9,10] ricochet off bone, deviations of bullet from its straight path[7,9,11] deformation of bullet at impact (which is called mushrooming), shock waves,[3] cavitation and coup-coutrecoup injury.[8] The degree- and extent of damage is primarily determined by the impact velocity.[7,12] If the impact velocity is more than 100 m/s (like in the cases of explosions) usually these injuries are considered fatal. Non-bullet missiles (e.g. grenade fragments)

are considered low velocity impacts. Low velocity muzzle (≈ 250 m/s) (e.g. handguns) usually causes injury by laceration and maceration along the path which can be slightly wider than the missile diameter. High muzzle velocity bullet (=600–750 m/s)(e.g. military weapons and hunting rifles) causes additional damage by shock waves and cavitation that may exceed bullet diameter by many folds.[8]

Secondary damage can be due to cerebral edema and decreased cerebral perfusion pressure (CPP), disseminated intra-vascular coagulopathy (DIC) or intra-cerebral hemorrhage (ICH) from lacerated vessel injury.[8,10]

The reported complications from gunshot injury include cerebral abscess "either from the dragged materials and skin or from communication with nasal sinuses", traumatic aneurysm,[6] seizures[13] and migration of a bullet.[7,11,14] The later may indicate abscess or hematoma cavity or a bullet inside the ventricle which can cause obstructive hydrocephalus.[13,15] Lead toxicity (Plumbism) can occur if the bullet stayed in the inter-vertebral disc space. The clinical features of Plumbism include anaemia, encephalopathy, motor neuropathy, nephropathy and abdominal colic.[16-18]

Clinical evaluation of patients with gunshot head injury is an important part of management. Entry and exit wounds should be identified. Usually entry wound will appear smaller due to bullet mushrooming. The closer the contact to the head, the smaller will be the entry wound. Also it has been noticed that, entry wound has beveled inner table while exit wound has beveled outer table of the skull bone and the overlying scalp. GCS is still the gold standard tool for assessing the level of consciousness.[1,2]

Management of cases with gunshot to the head has 2-main components; general management and specific management.

General management includes the general principles for managing patients with head injury "like elevating the head 30-45 degrees, hyperventilation to PaCO2 30-35 mmHg, giving prophylactic H2 agonists and antiepileptics", besides giving anti-meningitic dose antibiotics together with the tetanus toxoids.[19,20]

Specific management is the definitive surgical management. Patients with very low GCS or with fixed dilated pupils are not surgical candidates as the chance for meaningful recovery is almost close to zero and there is no rewarding outcome.[2,20,21] For those who are surgical candidates, aims of surgical intervention should include debridement of the devitalized tissue both along the entry and exit wounds, evacuation of the accessible hematoma together with obtaining adequate hemostasis,[8] removal of the accessible bone and bullet fragments,[7,22] separation of the intracranial compartments from the air sinuses and water-tight dural closure.[10,19]

The following tips and tricks should be considered upon doing surgery for patients with gunshot. Both entry and exit wounds should be accessible upon positioning and surgical draping. The whole devitalized tissue should be excised. The burned fractured irregular bone should be rongeured back to the clean bone. The sinus mucosa should be cleand, air sinus to be packed with muscles and covered with a graft. Dead brain tissue especially in the non dominant hemisphere should be removed using suction and bipolar coagulation with adequate hemostasis until the healthy brain is reached. Intra-ventricular bullet fragments should be removed using the endoscope to avoid later development of obstructive hydrocephalus.[8,15] Water-tight dural closure should be obtained to avoid the complications of CSF leak. If post-operative CSF leak is encountered and continued for more than 2-weeks, it should be considered as CSF fistula and must be surgically repaired.[8] In cases with a big bony defect, cranioplasty should be delayed for a minimal of 6-months to minimize the risk of infection and its devastating sequel.[12]

Materials and Methods:

This was a prospective observational study done at King Abdullah Hospital, Neuro-surgery center in Bisha, Saudia Arabia during the period

Table 1: *Age distribution among the study group*

Mean	**31.40**
Median	30.00
Mode	19a
Std. Deviation	14.741
Range	37
Minimum	19
Maximum	56

Table 2: *GCS level upon admission to King Abdullah Hospital*

Initial GCS	**Frequency**	**Percent**
5	1	20%
6	1	20%
13	1	20%
15	2	40%
Total	5	100%

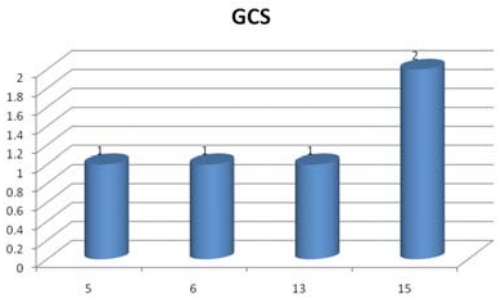


Fig.1: GCS level upon admission to King Abdullah Hospital

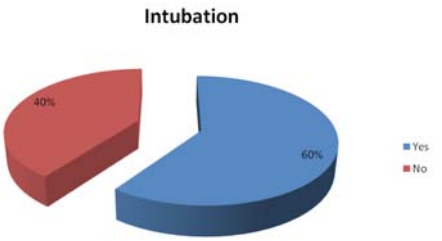


Fig.2: Percentage of intubated patients in the series

Table 3: *The location of the bullet in relation the initial GCS of the patients with gunshots.*

	Frequency	**Initial GCS**
No intracranial bullet	1	5
No intracranial bullet	1	6
In the bone	1	13
In the bone	2	15
Total	5	

from September 2017 to May 2019. The study included all patients brought to the emergency or referred to our hospital with gunshot to the head. Inclusive criteria include all patients admitted and operated in King Abdullah Hospital, Bisha within the given time-frame. All patients who were operated in another hospital and only came for routine follow up in our hospital were excluded from the study. Data was collected using a questionnaire investigating the pre and post-operative clinical features, radiological findings, bullet location, initial level of consciousness and neurological status. Karnofsky Score (KS) was applied to all cases in the study to evaluate the final post-operative outcome. All patients in this study had been consented to share in this study by a written informed consent and data confidentiality was insured. Approval of the local hospital ethical committee was obtained before starting the study. Data was then collected in a designed SPSS sheet and analyzed using SPSS version 20.

Results:

During the period from September 2017 to May 2019 we received 5-cases of gunshot to the head. All cases were referred to us from the nearby peripheral hospitals.

Age distribution: Patients' ages were ranging between 19 to 56 years with the average age of 31.4 years. (table 1)

Sex distribution: All patients in this study were males.

Initial level of consciousness: 3-of the patients were referred intubated (3/5, 60%); 2-of them (2/3, 66.7%) were with very low GCS and one (1/3, 33.3%) was intubated because of the irritability. 2-cases (2/5, 40%) presented fully conscious for the superficial location of the bullet. (table-2, figure-1)

Location of the bullet: In the 2-fully conscious patients the bullet was in the bone. In 2 of the patients the bullets were passed away with both entry and exit wounds (2/5, 40%). In the last case the bullet stayed in the bone with an under-

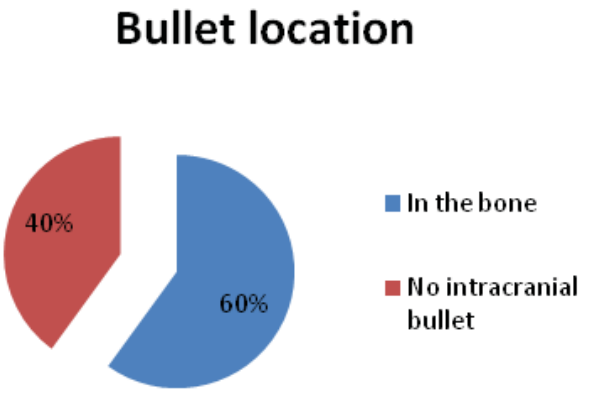


Fig.3: The location of the bullet

Table 4: *The type of associated injuries acquired with the gunshot*

Type of Injury	Frequency	Percentage
Hemorrhagic contusion	4	80%
Subdural Hematoma (SDH)	2	40%
Extradural Hematoma (EDH)	1	20%
Depressed Fracture	2	40%
Subarachnoid hemorrhage (SAH)	1	20%
Intraventricular hemorrhage (IVH)	1	20%
Intraparenchymal bone fragments	1	20%

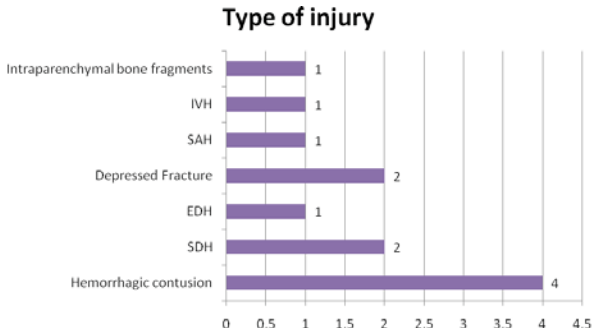


Figure 4: The type of associated injuries acquired with the gunshot

Table 5: *: Types of surgery done for the patients with gunshot*

Type of Surgery	Frequency	Percent
Debridement	2	40%
Debridement, hematoma evacuation, elevation of depressed fracture and dural repair	2	40%
Debridement and dural repair	1	20%

Table 6.1: *The statistics of the hospital stay in days*

Mean	3.80
Median	3.00
Std. Deviation	2.168
Minimum	2
Maximum	7

Table 6.2: *The duration of hospital stay in days*

Duration of stay	Frequency	Percent
2 days	2	40%
3 days	1	20%
5 days	1	20%
7 days	1	20%
Total	5	100%

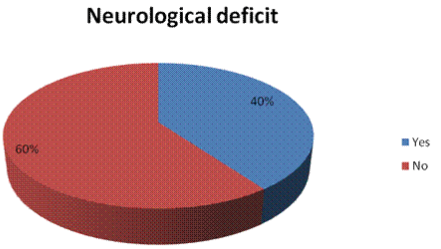


Fig.5: The presence of postoperative neurological deficit after extubation

lying hemorrhagic contusion. (table 3, Fig.3).

Associated intracranial injuries: Most of the patients had hemorrhagic contusions (4/5, 80%) followed with those with acute subdural hematomas (2/5, 40%) and depressed fracture (2/5, 40%). (table-4, Fig.4)

Type of surgery: All patients were operated with debridement of entry and exit wound (if any), accessible hematomas were evacuated and dural repair was achieved. In 2-cases dura was intact and dural repair was not required. 2-cases required elevation of the depressed fracture and bullets were retrieved in all 3-cases as the bullets were accessible in the bone. (table-5)

Duration of hospital stay: The average duration of hospital stay was approximately 3-4 days, with

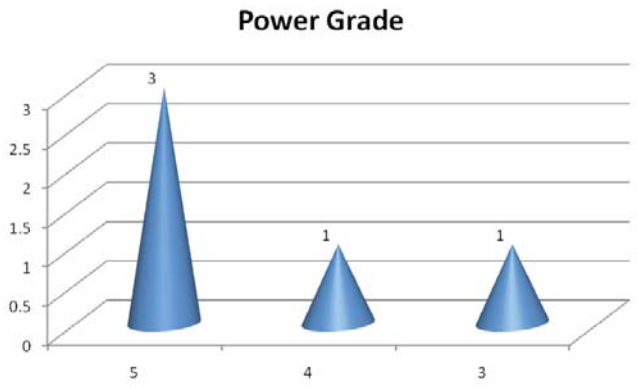


Figure.6: MRC Power Grading for the patients in the series

Table 7: *Outcome evaluation using Karnofsky score.*

	Karnofsky score	Frequency	Percent
Valid	100	3	60.0
	60	1	20.0
	Total	4	80.0
Missing	System	1	20.0
Total	5	100.0	

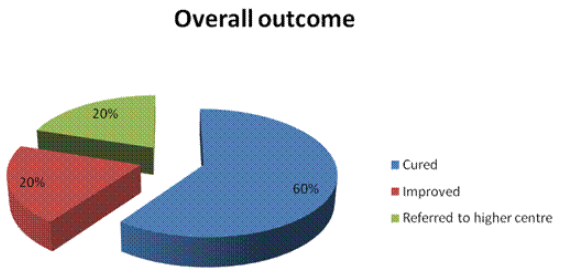


Figure.7: The overall outcome of the patients in the series

a minimal duration of 2-days and maximum of 7-days. The patient who stayed for 2-days, was actually referred to a higher center after he had being operated in our hospital. (table 6.1 & 6.2)

Neurological deficit: As most of the patients were referred from the other hospitals intubated, evaluation of their initial neurological status was not possible; therefore, the patients were adequately evaluated post-operatively after extubation. Only 2 of them (2/5, 40%) were having neurological deficit in a form of hemiparesis. One power grade (PG) 4 that improved with phsiotherapy while the other power grade-3. The later was referred to a higher centre upon the family request and further follow up is missing. (Fig.5 & 6)

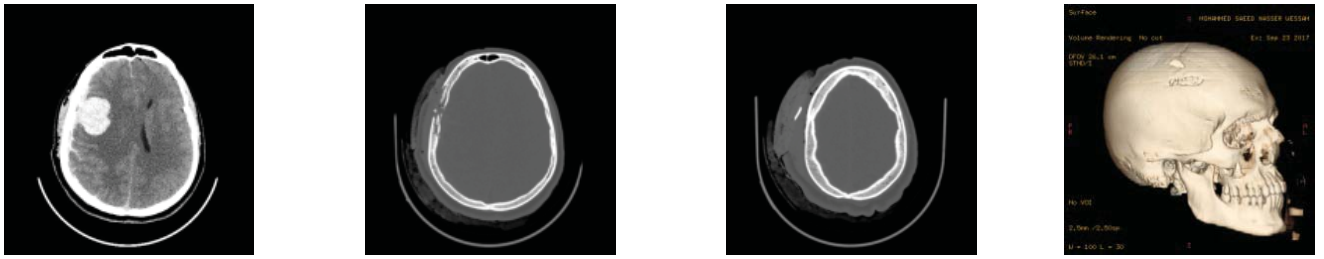
Outcome: For better evaluation the outcome was assessed using Karnofsky Score. Then the overall outcome was quoted into 5-main categories; cured, improved, static, deteriorated and died. 1-patient was referred to a higher center and hence both Karnofsky score and overall evaluation is missing. For the other 4 patients (4/5, 80%), three of them had a score of 100 (3/4, 75%) while the remaining one has a score of 60 (1/4, 25%). (table-7, figure.7)

Discussion:

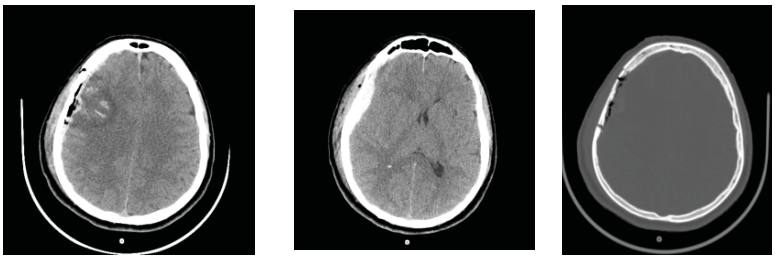
Although the reported case studies of gunshot injury to the brain are rare, but gunshot injuries are still considered among the commonest fatal penetrating brain injuries and most victims are young males in their 3rd decade of life.[1,23,24]

Due to the wide magnitude of injury caused by the bullet and the different bullet trajectories as it passes in, the patients may present with different clinical pictures ranging from a fully conscious to a deeply comatose patient.[4,11,25] The latter group usually carries poor prognosis with very high mortalities or lifelong morbidities. Therefore the initial GCS remains the best predictor for assessing the future outcome and prognosis of the patients.[2] The location of the bullet or the bullet fragments has no relation with the magnitude of injury as you can find a bullet entrapped in the bone without any neurological deficit and also you can find one with a big underlying brain contusion or intra cranial haemorrhage.[26] However a bullet in the bone rarely breaches the dura or needs dural repair intra-operatively.

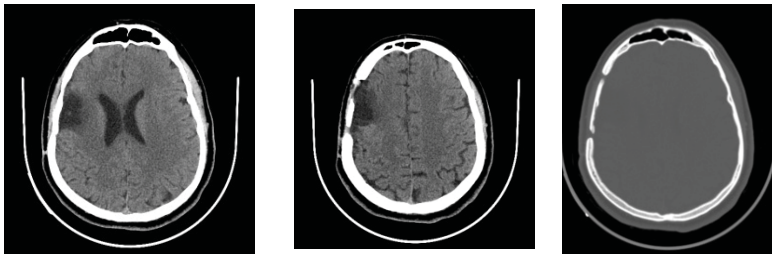
All patients with gunshot injury to the head should be operated with debridement to remove the devitalized tissue and foreign bodies, with dural repair if needed.[10] The evacuation of the hematoma, removal of bone fragments and bullet depends on being accessible or being in an eloquent area or a dominant cerebral hemisphere.[14]



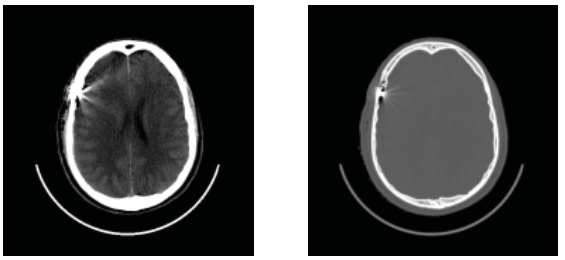
Case No.1 Preop



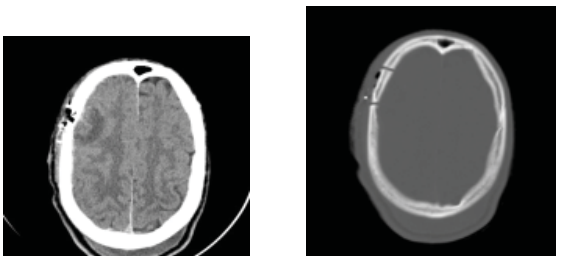
Day 1 Post-op



1 month post-op

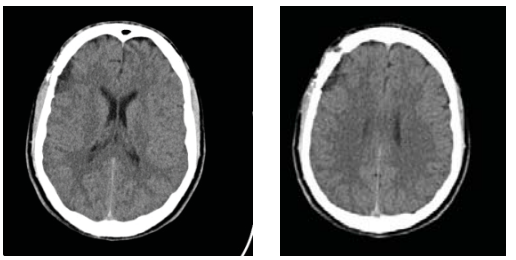


Case No.2 Pre-Op



2 days postop

The patient should be discharged soon post-operatively to avoid secondary hospital acquired infections and the devastating sequences of CNS infection.



1 month post-op

Conclusion:
GCS is the gold standard tool for assessing the neurological status, the future prognosis and outcome of patients with gunshot to the head.

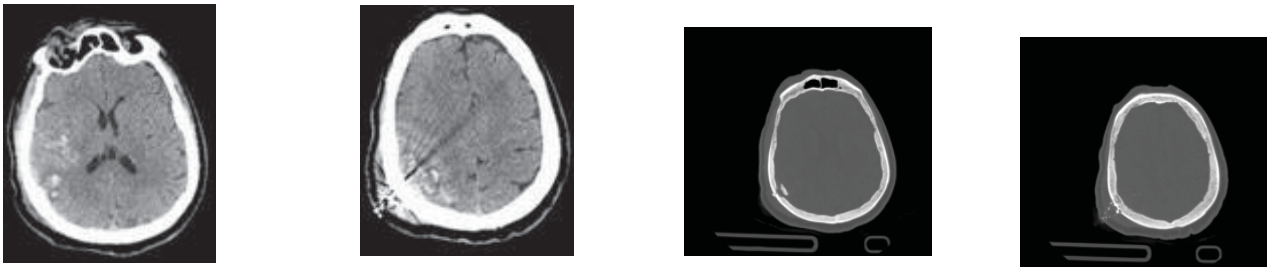
Using a measurable tool for assessing the outcome (like Karnofsky score or Glasgow Outcome Scale) gives more accurate results and can help in comparing gunshot studies against each other to find out what is best for patients.

Despite the small number of the cases in this study, the overall outcome remains acceptable.

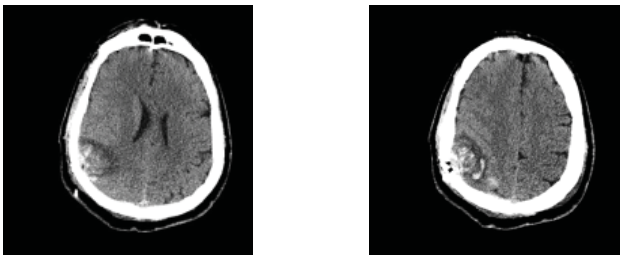
Conflict of interest: None

Funding source: None

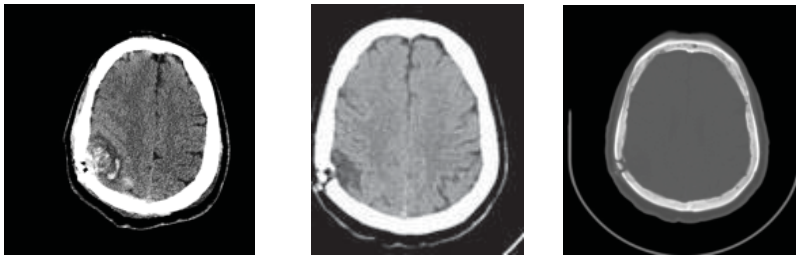
Role and contribution of authors:
Dr. Mohammed Awad Elzain, the conception and design of the work, analysis, interpretation of data for the work, writing the article including the literature review and operating on some of the patients in the series as the main primary surgeon.



Case No. 3 Pre-op



Case No. 3 Day-1 Post-op



Case No. 3 After Nine months

Dr. Umar Farooq, revised the article critically for important intellectual content and final approval of the version to be published, besides operating in some patients as the primary surgeon.

Dr. Boussad Kermoud, revised the article critically for important intellectual content and final approval of the version to be published, besides operating in some patients as the primary surgeon.

Dr. Naveed Chawla, collected the data, revised the article critically for important intellectual content and final approval of the version to be published, besides assisting the primary surgeons in operating the patients.

Dr. Osama Alfahl, revised the article critically for important intellectual content and final approval of the version to be published.

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