

## **Peak systolic and end diastolic velocity of external carotid artery of Maxillofacial Missile injuries**

**سرعة الانقباض و السرعة الانبساطية النهائية للشريان السباتي في جرحى المصابين في الوجه والفكين باطلاقات نارية او الانفجارات**

**Suha mohammad sami** Oral & Maxillo facial surgeon, kufa college of dentistry ,department of oral & Maxillo facial surgery . E-mail dr Suha Mohammad Sami @yahoo.com.

**Background:** Patients with a complete disruption of the artery owing to missile injury are frequently seen in the emergency room with hypovolemic shock ,or sever airway obstruction due to compression of the trachea by hematoma, or symptoms of acute cerebral ischemia or infarction . aim of our study to measure of peak systolic velocity and end diastolic velocity of external carotid artery in injured site and compare with non injured one .

**Patients & Methods:** Patients were selected from Maxillofacial department in the Specialized Surgeries Hospital. . thirty patients were examined , twenty nine were male ( mean 96,66% ) and female was one ( 3,34% ) .We prepared a specially designed case sheet including , life saving procedures , type of missile , clinical examination include site of missile injuries , investigation x-ray ,C T scan. .The ultrasonographic scanning of the carotid arteries was performed, the Doppler machine was -SIEMENS – sonoline ELEGRA .

**Methods :** The ultrasonographic scanning of the carotid arteries was performed with the patient in the supine position , using a high- frequency linear array imaging probe (7.5- 9 MHz) .

**Results** showed that mean peak systolic velocity of Ext carotid artery at non injured side was 62 . 92 cm / sec. and mean peak systolic velocity of injured side was 69.69 cm / sec. while the mean end diastolic velocity of Ext carotid artery at non injured side was 37.31 cm / sec. and injured side was 15.81 cm / sec.

**Conclusion** Ultrasound scanning gives a clear picture of soft tissues that do not show up well on X-ray images . mean peak systolic velocity of Ext carotid artery at injured side was higher than non injured side while end diastolic velocity of Ext carotid artery at injured side was lower than non injured side.

**أخلاصة:سرعة الانقباض و السرعة الانبساطية النهائية للشريان السباتي في جرحى المصابين في الوجه والفكين باطلاقات نارية او الانفجارات .**

المرضى المصابين الذين يعانون من تمزق تام في الشريان نتيجة الإصابة بعيارات نارية يشاهدون في وحدات الطوارئ يعانون من غيبوبة جراء النزف او تضيق في المجاري الهوائية من الخثرة او يشكون من أعراض حادة في نقص تجهيز شريان الدماغ او تموت جزء من الدماغ .هدف هذا البحث هو قياس سرعة الانقباض و السرعة الانبساطية النهائية للشريان السباتي في الجهة المصابة ومقارنتها بالجهة السليمة .

المواد المستعملة وطرائق العمل اختيار الجرحى من قسم جراحة الوجه والفكين في مستشفى الجراحات التخصصية – بغداد من كانون الاول 2008 إلى كانون الأول عام 2009 المحالين من قسم الطوارئ . عدد الجرحى ثلاثون تسعة وعشرين ذكور وأنثى واحدة فقط .

طريقة العمل اجري فحص الموجات فوق الصوتية السونار الدوبلر للشريان السباتي والمريض في وضع الاستلقاء في غرفة شبه مظلمة , اجري الفحص في 30-60 دقيقة استعملنا فيه بروب ذو تردد عالي (5.7-9 ) ميكا هرتزل وبعد وضع جيل (دهن ) على رقبة الجريح في الجهة المصابة والجهة السليمة .

**النتائج:** أعمار الجرحى تتراوح بين (15-57سنة) بتوسط 36سنة أظهرت النتائج إن:  
1- 60% من الجرحى نتيجة إطلاقات مقذوفه , 40% منها نتيجة إطلاقات مسدس أو بندقية و 20% نتيجة إطلاقات رشاشات ذات سرعه عاليه و 40% نتيجة إصابات شظايا 2- إن معدل السرعة الانقباضية للشريان السباتي في الجهة السليمة من الوجه والرقبة يساوي 62.92 سم / ثانية و معدل السرعة الانقباضية للشريان السباتي في الجهة المصابة يساوي 69.69 سم / ثانية. 3. إن معدل السرعة الانبساطية للشريان السباتي في الجهة السليمة من الوجه والرقبة يساوي 37.31 سم / ثانية و إن معدل السرعة الانبساطية النهائية للشريان السباتي في الجهة المصابة 15.81 سم / ثانية.  
**الاستنتاج:** فحص السونار الدوبلر غير مؤلم، لا يستعمل فيه إشعاع وهو فحص غير مؤذي ، معدل السرعة الانقباضية للشريان السباتي في الجهة المصابة أعلى منة في الجهة السليمة من الوجه والرقبة، بينما معدل السرعة الانبساطية النهائية للشريان السباتي في الجهة المصابة كان اوطى منة في الجهة السليمة .

## INTRODUCTION

The most common injury to the cervical carotid artery is a tangential or partial laceration of the artery ,and total transection is less frequent. Injuries to the extra cranial carotid arteries from penetrating trauma can occur via two basic mechanisms. In the first type, the projectile, or weapon, can directly penetrate the vessel wall and interrupt continuity of the wall to various degrees. This type of injury typically results in dissection or transection of the artery with thrombosis. In the other type , the percussive force of the projectile interacts with the tissue and can disrupt the vessel wall in varying degree, without directly striking the vessel itself. This mechanism is more likely to cause a dissection through intima disruption and subsequent formation of a false channel and thrombus <sup>1</sup>. Rich N M <sup>2</sup> reported that type of vascular injury either laceration , transection , incomplete transection , contusion and segmental spasm , contusion and thrombosis , contusion and true aneurysm , pulsating hematoma , arteriovenous fistula and external compression. Penetrating neck and facial wounds are potentially serious injurious often requiring urgent decisive action. Injury to vascular structures accounts for most of the immediate morbidity and mortality. Penetrating vascular injuries of the head , neck, and face may cause secondary injury to the nervous system through a variety of complication , the most common being hemorrhage and ischemia <sup>3</sup>. Injuries of the carotid artery caused by penetrating wounds of the neck are nearly 10 times as common as those caused by non penetrating trauma <sup>4</sup> , over 10% of all penetrating neck wounds result in significant carotid artery <sup>5</sup> , and more than 90% of such injuries are secondary to gunshot wounds <sup>6</sup> . Injury to the carotid artery may result in signs and symptoms related to blood loss , mass effect of neck hematoma , or cerebral ischemia . Penetrating neck injuries may potentially damage other vital structures in addition to the blood vessels . Structures may potentially be injured include the cervical vertebrae, spinal cord, upper airway and digestive tract, salivary glands, tongue, lower cranial nerves, brachial plexus, and branches of the aortic arch <sup>7</sup> . The type and extent of injury to vascular and surrounding structures in the neck are dependent upon the object producing the trauma . The damage created by gunshot wounds depends upon missile characteristics such as velocity , mass, caliber, composition , and angle of trajectory .Bullets , frequently do not travel in a straight line . Low velocity missiles commonly encountered in civilian wounds follow tissue planes and are deflected easily by bony structures . such as the cervical spine and the mandible , Bullets , however , often provide both an entry and an exit wound and a track of lead particles readily seen on plain x-rays. plain films taken in two planes will be especially useful in determining which structures are likely to have been injured . Shotgun wounds produce an injury different from all other types of civilian penetrating wounds <sup>8</sup> . There is currently a trend in vascular surgery toward less-invasive diagnostic methods <sup>9</sup> .Ultrasonography, a widely used diagnostic tool <sup>10</sup> . Both CTA and Color Doppler Sonography can replace the conventional angiography and is less invasive <sup>11</sup> ,Measuring peak systolic velocity (PSV) is the most important component of the carotid Doppler <sup>12</sup> .

**Materials and Methods :**

Patients were selected from Maxillofacial department in the Specialized Surgeries Hospital in the period from 2008 –2009 .They were referred from emergency unite presented with missile injuries affecting maxillofacial region .thirty patients were examined , twenty nine were male ( mean 96,66% ) and female was one ( 3,34% ) .Patients with intracranial missile injuries were excluded from this study .We prepared a specially designed case sheet including ,familial and medical history ,behavior concerning tobacco and alcohol usage , life saving procedures , type of missile , clinical examination include site of missile injuries ,entrance , exit and site of missile retained, associated injuries, investigation x- ray ,CT scan ,lab. Investigation. The ultrasonographic scanning of the carotid arteries was performed, the Doppler machine was -SIEMENS – sonoline ELEGRA . Using a high- frequency linear array imaging probe or transducer 7,5- 9 ( MHz) with a Hewlett-packard scanner .

**Measurement of Carotid Velocity .**

Identify the bifurcation and its branches, it is good practice to take peak systolic velocity measurements from the common carotid artery ,the internal carotid artery and the external carotid artery in order to have a record of the examination . These are obtained using spectral Doppler from the upper common carotid artery 2-3 cm below the bifurcation, the internal carotid artery from 1-2 cm above the bulb , or as high as possible , in order to allow the normal bulbar turbulence to settle , and from the lower external carotid artery . For routine measurements the sample volume is set at about half the total diameter and placed in the centre of the vessel in order to avoid the natural turbulence at the edge of he lumen and – wall thump- from inclusion of the vessel wall in the sample volume . The Doppler angle is kept as low as possible , ideally less than 60, certainly less than 70 , it is good practice to try and keep to a specific angle , such as 55 or 60 , in order to improve the reproducibility of results between examination . For tight stenoses it is better to reduce the size of the sample volume ,as this allows the area of the peak systolic flow signal to be better defined . The precise final location of the sample volume is chosen using a combination of the audible Doppler signal and the spectrum so that the clearest , highest- frequency audible signal and the best spectral trace are obtained <sup>13</sup> . Carotid ultrasound may be difficult or impossible if a patient has a dressing covering a wound or surgical scar in the neck. An occasional patient is difficult to examine because of the size or contour of the neck. Calcium deposits in the wall of the carotid artery may make it difficult to evaluate the vessel. A small amount of soft plaque that produces low-level echoes may go undetected. Ultrasound may not clearly depict the end segment of the carotid artery, but this is very seldom a site of disease <sup>14</sup> .

**RESULTS**

**Clinical findings and analysis.**

1. Patients age rang from 15 – 57 years and mean was 36 years ,most cases was from 20-29 years ( 40% ) .
- 2 .Type of missile, Eighteen patients ( 60%) were injured with bullets and twelve were injured with shell fragments ( 40\_% ) , twelve ( 40%) were hand gun bullets and six ( 20%) were rifle bullets.

Type of missiles	No. of patients	Percentage (%)
Fragments	12	(40%)
Handgun bullet	12	(40%)
Rifle bullet	6	(20%)
total	30	(100%)

Fig. (1) distribution Type of missiles.

3. The distribution of site of injuries, showed that cheek injuries in twenty one patients , neck injuries and lower lip injuries were found in fourteen patients , orbital injuries were found in teen patients , upper lip injuries were found in nine cases , injuries of infra temporal fosse were found in eight cases, injuries of the temple were found in five cases , five cases presented with nasal injuries , and two cases presented with fore head injuries Fig ( 2 ).

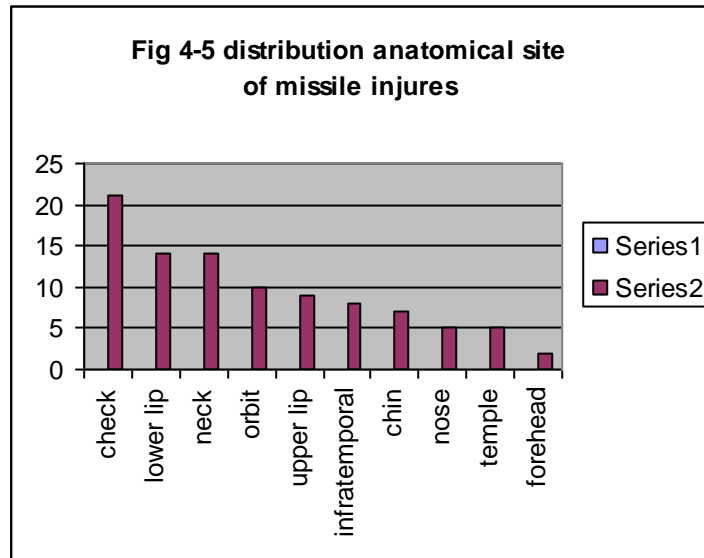


Fig ( 2 ) distribution anatomical site of missile injures.

4. Results of peak systolic velocity PSV and End diastolic velocity EDV of Ext carotid artery at non injured and missile injured side . Results showed that mean peak systolic velocity of Ext carotid artery at non injured side was 62 . 92 cm / sec. and mean peak systolic velocity of injured side was 69.69 cm / sec. while the mean end diastolic velocity of Ext carotid artery at non injured side was 37.31 cm / sec. and injured side was 15.81 cm / sec.

Type of velocity	At injured side	Non injured side
Mean of P S V	69.69 cm / sec.	62.92 cm / se.
Mean of E D V	15.81 cm / sec.	37.31 cm / sec.

Fig ( 3) Comparison between mean of peak systolic velocity and end diastolic velocity of ext carotid artery at injured and non injured side .



Fig ( 4 ) Clinical features after missiles injuries.



Fig ( 5 ) Intra operative photograph of Maxillofacial Missile injuries .



Fig ( 6 ) Post operative photograph.

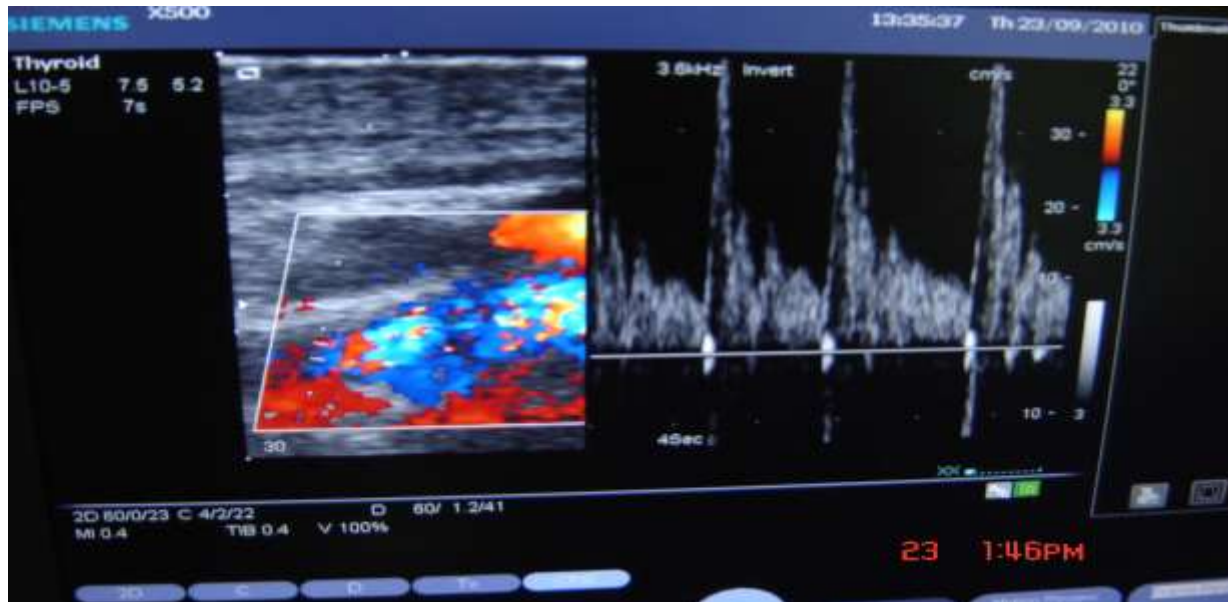


Fig ( 7 ) Duplex sonography illustrate peak systolic and end diastolic velocity of the affected missile injuries site .



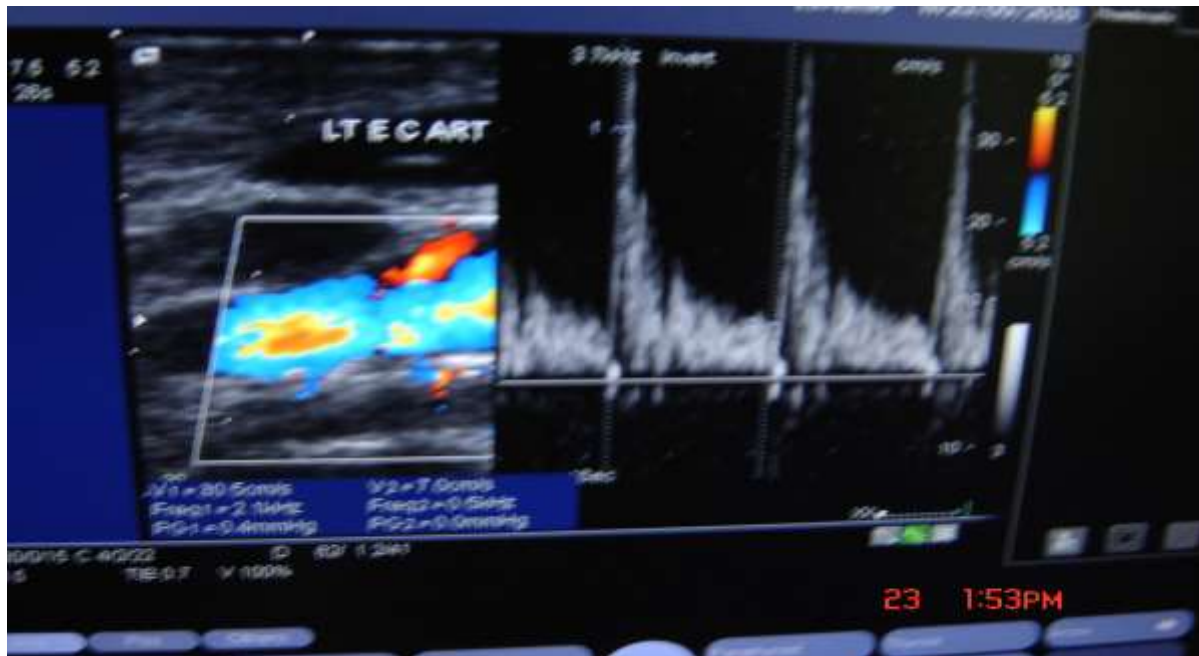


Fig ( 8 ) Duplex sonography illustrate peak systolic and end diastolic velocity of the non affected site at the same patient .

## **DISCUSSION.**

Missile injuries by their special nature have lessons applicable to the general understanding of facial trauma. Banks et al 1994 , war continues to be the best school for surgeons .Historically ,military conflicts had provided significant opportunities for the advancement of trauma surgery .

**1.Patients population .** Patients age rang from 15 – 57 years and mean was 36 years ,most cases was from 20-29 years (40%) , which was represent the age of students ,workers ,military members and officer man .This finding is consistent with other studies as that of Kassan A H et al 2000 <sup>15</sup> , Odhiambo V I et al 2002 <sup>16</sup> .

**2.Distribution of types of missiles :**

In our study missile were classified into : low velocity missiles (handgun bullets, air gun bellite , shotgun ) ,high velocity missile ( rifle bullets ) and fragments may be low or high velocity. Eighteen patients ( 60%) were injured with bullets this can explain the predominance of bullet injuries in our study may be the availability of firearms that are easily accessible to population, bullet wounds are a feature of terrorist or guerilla war , our results in agreement with Kummoona R. et al 2006 <sup>17</sup> , Banks P et al 1994 <sup>18</sup> they reported bullets produced more wounds because of the nature of the conflict.

**3.Distribution site of injuries of anatomical.**

The distribution of site of injuries showed that cheek injuries represented the most common site , may be due to the large surface area presented among our study and increase the probability of injury thought exit or entrance of the missiles .our results was in agreement with Kummoona R. et al 2010 <sup>19</sup> he reported that most entrance and exit wounds as well as retained missile were located in the cheek, chin, and mandibular body.

**4.Results of peak systolic velocity (PSV) and End diastolic velocity (EDV) of Ext carotid artery at non injured and missile injured side .**

Our results showed that mean peak systolic velocity of Ext carotid artery at non injured side was 62 . 92 cm / sec. and mean peak systolic velocity of injured side was 69.69 cm / sec, the increase in mean peak systolic velocity of injured side can be explained by the vasospasm in the acute stage of the injury and surgical procedure while persistent elevated mean peak systolic velocity is due to scars and carotid wall stiffness which was in agreement with A consensus conference in 2003 of the Society of Radiologists in Ultrasound recommended the criteria for estimating stenosis<sup>20</sup> . And in agreement with Lennard A Nadalo, Michelle C Walters, DO 2009<sup>21</sup> . which they reported that in general, the velocity of flow should become reduced with successful surgery. However, velocities may remain elevated after surgery due to scar formation, which results in carotid wall stiffness, which was in agreement with Brian Silver et al 2009<sup>22</sup> they reported that The velocity changes on spectral analysis reflect changes in hemodynamics , our result in agreement with Wenbo Luo et al 2007<sup>23</sup> pulsed Doppler observations of the injury site showed a statistically significant increase in the systolic and diastolic velocities , These patterns are unique only at the bleeding site. And in agreement with Robinson M L et al 1988<sup>24</sup> , they reported that peak systolic tends to increase in proportion to the severity of luminal narrowing beyond 50% diameter reduction.

.Ndubueze Ezemba et al 2006 reported that traumatic common carotid artery to internal jugular vein fistula is a rare . Penetrating neck injuries should be carefully evaluated and early treatment of common carotid – jugular fistula is necessary to prevent complications . while the mean end diastolic velocity of Ext carotid artery at non injured side was 37.31 cm / sec. and injured side was 15.81 cm / sec. the normal flow of external carotid artery showed on what is called peripheral vessels type of flow . In our study we find increase in the diastolic flow in the non injured side and this can be explained by hyperemia and vaso dilatation that necessary to provide collateral flow to the injured side .the mean diastolic velocity of Ext carotid artery at non injured side showed no significant increase velocity for the normal Ext carotid artery may be due to occlusion or functional occlusion .

our result in agreement with Bown J N et al 2009 they reported that there is evidence to suggest that asymptomatic patients with low EDV in the setting of carotid artery pseudo-occlusion found of duplex, may be safely managed medically .Our result in agreement with Michelle L. Robbin et al 2006 they reported that External carotid artery has a high resistance flow. It has a tall and sharp upstroke in systole and returns to baseline quickly with little flow during diastole.

## **Conclusion**

1. peak systolic velocity PSV of external carotid artery at injured side was higher than non injured side while End diastolic velocity EDV of external carotid artery at injured side was lower than non injured one.
2. Ultrasound is an accurate and inexpensive screening method for assessing carotid vessels and it provide morphological and functional details
3. carotid Ultrasound has to be a risk free procedure .
4. A combination of technology including MRA ,CTA and Doppler study should be utilized appropriately to improve diagnosis .

## **References .**

1. Sankhla Suresh K: Acute carotid artery injury. J Pediatr Neurosci, 1:27-30.2006. ssankhla@vsnl.com.Schwartz H C , Kendrick R W, pogorel B S: False aneurysm of the maxillary artery. An unusual complication of closed facial trauma. Arch Otolaryngol 109:616-618, 1983.
2. Rich N M Vascular trauma ,Surg. Clin. North Am .1973, 53 p 1367- 1392.
3. Bizhan Aarabi, Howard H. Kaufman, T. Forcht Dagi, Eugene D. George, Michael L. Levy, :Missile Wounds of the Head and Neck, Vol. 11. The American Association of Neurological Surgeons.page.315, 1999.



4. Ledgerwood A M, Mullins R J, Lucas C E.: Primary repair vs ligation for carotid artery injuries . Arch Surg. 115;488-93.1980.
5. Calcaterra TC, Holt CP. Carotid artery injuries. Laryngoscope 1: 849-53. 1972.  
Unger S W, Tucker W S jr, Mrdeza M A, Wellons H A jr, Chandler J G.: Carotid arterial trauma.Surgery.87: 477-87 1980.PUBMED.
6. Unger S W, Tucker W S jr, Mrdeza M A, Wellons H A jr, Chandler J G.: Carotid arterial trauma.Surgery.87: 477-87 1980.PUBMED.
7. Walsh M S : The management of penetrating injuries of the anterior triangle of the neck . Injury 1994, 25: 393-395.
8. Bizhan Aarabi, Howard H. Kaufman, T. Forcht Dagi, Eugene D. George, Michael L. Levy, :Missile Wounds of the Head and Neck, Vol. 11. The American Association of Neurological Surgeons.page.315, 1999.
9. Khaw KT. Does carotid duplex imaging render angiography redundant before carotid endarterectomy? *Br J Radiol* 1997;70:235–238 .
10. Masahiro Kamouchi<sup>a,c</sup>, Kazuhiro Kishikawa<sup>a</sup>, Yasushi Okada<sup>a</sup>, Tooru Inoue<sup>b</sup>, Setsuro Ibayashi<sup>c</sup> and Mitsuo Iida<sup>c</sup> *American Journal of Neuroradiology* 26:957-962, April 2005.
11. Khamin Chinsakchai, M.D.,Pramook Mutirangura, M.D.,Chanean Ruangsetakit, M.D.,Chumpol Wongwanit, M.D.,Nuttawut Sermsathanasawadi, M.D. **Successful Management of Asymptomatic Penetrating Carotid Artery Injury:** Siriraj Medical Journal . Volume 60, Number 4, 2008.
12. Andrei V. Alexandrov, MD; Dianne S. Brodie, RVT; Arline McLean, MD; Paul Hamilton, MD; John Murphy, MD Peter N. Burns, PhD : examinationCorrelation of Peak Systolic Velocity and Angiographic Measurement of Carotid Stenosis Revisited Stroke. 1997;28:339-342.
13. Paul L Allan, Paul A, Dubbins, Myron A Pozniak, W Norman Mc Dicken ;Clinical Doppler Ultrasound, Churchill Livingstone,P 39, 2002 .
14. Radiological Society of North America RSNA 2007, Internet.
15. Kassan A H,Laloo R , kariem G .: A retrospective analysis of gunshot injuries to the maxillofacial region . S A D J . 2000 ,55 ( 7), 359- 63 .
- 16.Odhiambo W A , Guthua S W , Macigo F G , Akama M K .: Maxillofacial injuries caused by terrorist bomb attack in Nairobi ,Kenya , J. Oral Maxillofaci . Surg .2002 31 : 374 -377 .
17. Raja Kummoona , Aliaa Muna : Evaluation of immediate phase of management of missile injuries affecting maxillofacial region in Iraq . The journal of craniofacial surgery .March 2006 , Vol. 17 ,(2) .
18. Banks P . Meier S , Hay wood I R ,Wilson SP, Sander R . Gunshot wounds. In : Williams J L I (ed) .Rowe and Williams. Maxillofacial injuries ,2<sup>nd</sup> edition .London , England .Churchill livingstone 1994 : p 665 .
19. Kummoona, Raja FDSRCS, Eng, FICD Management of Missiles Injuries of the Facial Skeleton: Primary, Intermediate, and Secondary Phases. Journal of Craniofacial Surgery: Volume 21 - Issue 4 - pp 976-981, July 2010 .
20. Brian Silver, MD, FRCPC, FAHA,, [Carotid Ultrasound . eMedicine](#) May 11, 2009.
- 21 . Lennard A Nadalo, MD, Coauthor(s): Michelle C Walters, DO, [Carotid Artery, Stenosis: Imaging, eMedicine](#), Jul 23, 2009.
22. Brian Silver, MD, FRCPC, FAHA,, [Carotid Ultrasound ,eMedicine](#).,May 11, 2009.
23. Wenbo Luo, MS, Vesna Zderic, PhD, Frederick A. Mann, MD and Shahram Vaezy, PhD, Color and Pulsed Doppler Sonography for Arterial Bleeding Detection, J Ultrasound Med 26:1019-1029 • 0278-4297, © 2007 by the American Institute of Ultrasound in Medicine .
24. Robinson M L, Sacks D, Perlmutter G S et al : Diagnostic criteria for color Doppler sonography A J R 1988, 151, 1045- 1049.