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Highlights

- Peripheral Emergencies
- Classification of Intervertebral Disc
- Pneumothorax An Emergency
- Digital Radiography using Bitewing

Discovering Thoughts, Inventing Future

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Comparision between Conventional Radiography (IOPA) and Digital Radiography using Bitewing Technique in Detecting the Depth of Alveolar Bone Loss

By Satvinder Singh & Karanprakash Singh
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Abstract- *Objective:* To assess the depth of alveolar bone loss by using Conventional radiography (IOPA) and Digital radiography (RVG) technique in periodontitis as it affects the connective tissue attachment and supporting bone around the teeth.

Methods: The study was carried out on 40 males and 10 females aged between 20 – 65 years who have generalized mild to severe chronic periodontitis. A series of conventional bitewing radiographs and digital bitewing radiographs (15,16,17,25,26,27,35,36,37,45,46,47) were taken for each patient. The Statistical software namely SPSS version 16.0 was used for data analysis. Paired t-test was performed on all the variables to evaluate between both the groups at $p \leq 0.05$.

Results: The overall results showed the mean statistical difference between both the conventional and digital bitewing radiographs as 0.4595. It was observed that overall digital bitewing radiographs averaged about 0.4mm greater bone loss than conventional bitewing radiographs.

Conclusion: It was concluded that digital radiographs showed better results when compared to conventional radiographs in terms of alveolar bone loss as RVG has superior image recording capabilities.

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Satvinder Singh [α] & Karanprakash Singh [σ]

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I. Introduction

Diagnosis is the process of assessing a patient's health as well as ensuing opinions formulated by clinicians. Oral diagnosis is the art of using scientific knowledge to determine the nature of oral diseases and distinguishing it from other diseases [1].

Radiography is a well established procedure in daily dental practice and is still the most basic and an important diagnostic tool available. Radiographs play an integral role in the assessment of periodontal diseases. Conventional bitewing and intra oral periapical radiographs are commonly used to detect alveolar bone loss associated with periodontal disease. They provide unique information about the status of the periodontium and a permanent record of the bone throughout the course of the disease. However, the quality of an X-ray sensitive film can be affected by multiple variables such as improper exposure, under-or overdeveloping and poor fixing [2].

Over the past few years, systems that can generate radiographic digital images without the need for radiography film have become available for use in clinical practice and are gaining popularity among practitioners. Such digital radiography can also reduce the radiation exposure. One of the most useful advantages of digital radiography is the knack it provides to the clinicians to send images to practitioners in a matter of minutes, for which it has become widely accepted as an alternative to film-based radiography [1].

A few studies (most of which were performed in vitro) that examined the use of digital radiography in evaluating crestal alveolar bone loss associated with periodontal disease listed out few of its main advantages over conventional radiography to be speed, convenience, lack of dark room procedures, image improvement tools and dose reduction. Thus the implementation of digital radiography in a dental practice seems to provide a solution for the future imaging requirements [2].

Nevertheless, according to some authors intra oral direct digital radiographs are not an equivalent substitute for conventional radiographs in evaluating alveolar bone levels [3]. Few of its disadvantages include cost of the device, cost of converting previous records to digital, learning to use the concept, thickness of sensor and lack of universal use of digital radiography [4].

In recent years, a digital imaging system – Radiovisiography (RVG) has offered an alternative and instant method for measurement of intraoral radiography [5]. It has been reported that RVG system provided approximately an 80% reduction in radiation dosage in comparison with conventional X-ray films [6].

The present study was aimed at the comparative evaluation of conventional and digital radiography (RVG) to measure alveolar bone loss in an attempt to help the clinician and practitioner to select the reliable radiographic method for imaging and detection of alveolar bone loss.

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II. Methods

This study was carried out among fifty patients who were randomly selected from the OPD of Department of Oral Medicine and Radiology in P.M.N.M Dental College and Hospital, Bagalkot. The study included 40 males and 10 females aged between 20 – 65 years.

Inclusion criteria

Patient having generalized mild to severe chronic periodontitis as assessed by measuring attachment loss and categorized as mild: 1-2mm, moderate: 3-4 mm, severe: ≥ 5 mm.

Exclusion criteria

Patients with drifted teeth, supraerupted teeth and those who were contraindicated for any radiographic procedure were excluded from the study.

A series of conventional bitewing radiographs (15,16,17,25,26,27,35,36,37,45,46,47) were taken for each of fifty patients having chronic periodontitis using Satelec dental X-ray unit operated at 70 Kvp and 8mA with a radiation exposure of 0.8 seconds. The film used was Kodak E – speed, number 2 of size 41x 31mm (Ekta speed, Eastman Kodak, Rochester, USA) and processing of the film was done manually using time temperature method. Radiographs were mounted on x-ray viewer and alveolar bone loss was measured by keeping divider on the CEJ to the most apical level of marginal bone. Later transparent ruler was used to evaluate the distances between the two points of divider (Figure 1). Similarly a series of digital bitewing radiographs (15,16,17,25,26,27,35,36,37,45,46,47) were taken for each of fifty patients by using RVG of Kodak 5000 system and Satelec dental X-ray unit operated at 70 Kvp and 8mA with a radiation exposure of 0.2 seconds. To ensure maximum hygiene, we covered the sensor with plastic sleeves and for each patient a new plastic cover was used. The system we used in our study contained a charged coupled device or CCD sensor. The measurement in RVG was done using Kodak 5000 digital software (Figure 2). Radiographically for the measurement of bone levels from both methods we considered normal bone level less than 2mm from the CEJ, and above that we measured as bone loss. Total 600 sites were measured and 3 readings were taken from each site and mean of 3 readings is taken as a final readings.

Figure 1: Measurement of alveolar bone loss using conventional radiography (IOPA)

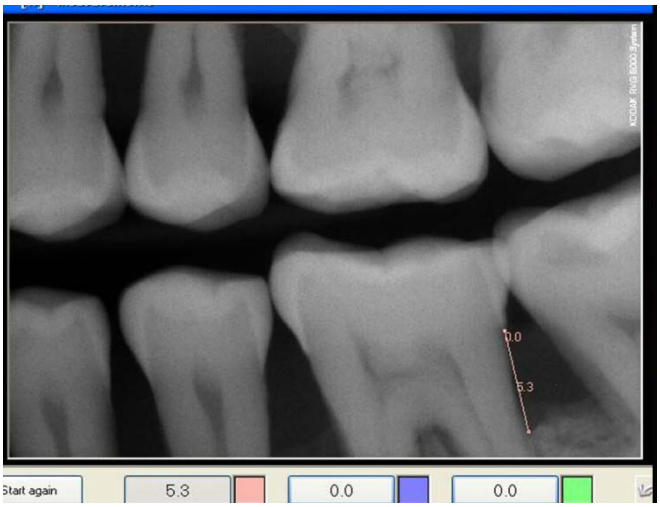

Figure 2 : Measurement of alveolar bone loss using Radiovisiography (RVG)

a) Statistical analysis

The Statistical software namely SPSS version 16.0 was used for data analysis. Paired t-test was performed on all the variables to evaluate between both the groups at $p \leq 0.05$. Relative agreement between the groups was done with Pearson's Correlation Coefficient.

III. Results

Fifty subjects were included in the study and total number of sites measured was 600. The overall results show that the mean difference between both the conventional and digital bitewing radiographs was -0.4595 and the standard deviation difference were 0.2409 which is statistically significant (Table-1). It was observed that digital bitewing radiographs evaluated about 0.4mm greater bone loss on an average than conventional bitewing radiographs.

Table 1 : Comparison of Conventional (IOPA) and RVG methods (bitewing technique) in total samples by using paired t-test

Method	Mean	SD	Mean Diff	SD Diff	p-value
IOPA	3.9400	0.6666	-0.4595	0.2409	0.000
RVG	4.3995	0.6777			

By using paired t- test, results showed differences between right and left side sextants. In right maxilla, conventional images showed mean bone loss of 4.1mm, while digital images indicated a mean bone loss of 4.2mm, which was statistically significant. In the left maxilla conventional images showed a mean bone loss of 4.5mm while digital images showed an average loss of 4.6mm, which was statistically significant (Table-2). Where as in right mandible conventional images showed averaged bone loss of 3.3mm, while digital images showed 4.0mm of averaged bone loss with a significant p- value. In left mandible conventional images showed averaged bone loss of 3.7mm, while digital images showed 4.0mm of averaged bone loss with a significant p- value (Table-3).

Table 2 : Comparison of Conventional (IOPA) and RVG methods (bitewing technique) in Maxilla by using paired t-test

Method	Mean	SD	Mean Diff	SD Diff	p-value
IOPA (Right)	4.1067	0.7610	-0.1560	0.4769	0.001
RVG (Right)	4.2627	0.8200			
IOPA (Left)	4.5200	0.9102	-0.1733	0.3784	0.000
RVG (Left)	4.6933	0.8660			

Table 3 : Comparison of Conventional (IOPA) and RVG methods (bitewing technique) in Mandible by using paired t-test

Method	Mean	SD	Mean Diff	SD Diff	p-value
IOPA (Right)	3.3467	0.7942	-0.7120	0.4355	0.000
RVG (Right)	4.0587	0.8505			
IOPA (Left)	3.7867	0.9803	-0.7967	0.4869	0.000
RVG (Left)	4.5833	0.9479			

RVG showed more bone loss in mandible than conventional radiographs but in maxilla both methods are showing almost similar measurement with a mean difference of 0.1mm only. Using Karl Pearson's correlation coefficient (r = 0.9359), there is a relative agreement of bone level measuring between conventional and digital bitewing radiographs (Table- 4). Significant correlation was found between the RVG and conventional methods in both right and left sextant of both jaws ranging from r = .82 to r = .91 with a significant p- value (Table 5).

Table 4 : Relative agreement of bone level between measurements from Conventional (IOPA) and RVG method using Karl Pearson's correlation coefficient technique (Total sample)

Methods	Conventional radiograph method (IOPA)	
	r-value	p-value
Radiovisiography (RVG)	0.9359	0.0000

Table 5 : Relative agreement of bone level between measurements from Conventional (IOPA) and RVG method using Karl Pearson's correlation coefficient technique

Methods	Conventional radiograph method (IOPA)	
	r-value	p-value
Radiovisiography (RVG) (Right maxilla)	0.8206	0.0000
Radiovisiography (RVG) (Left maxilla)	0.9104	0.0000
Radiovisiography (RVG) (Right mandible)	0.8620	0.0000
Radiovisiography (RVG) (Left mandible)	0.8730	0.0000

IV. Discussion

Radiographs provide unique information about the status of the periodontium and a permanent record of the condition of the bone throughout the course of the disease. Radiographs aid the clinician in identifying the extent of destruction of alveolar bone, local contributing factors, and features of the periodontium that influence the prognosis [2].

The diagnosis of periodontal disease is primarily based on clinical examination. The clinical findings of periodontal osseous destruction can be confirmed by radiographic examination, but the radiographs on its own cannot help in diagnosing the disease [7].

Radiographic digital imaging systems like electronic probing system, substraction radiography, CADIA (Computer Assisted Densitometric Image Analyses System), Dark field microscopy, DNA probes, Immunodiagnostic methods have been developed in recent times, which act as an adjunct in the precise diagnosis of periodontal disease [8].

Khocht et al (2003) stated that digital radiography offers many advantages over conventional methods [1]. It eliminates the need for film and film developing, and it allows for lower radiation exposure. The generated image is available immediately for evaluation on a computer screen and can be manipulated digitally to enhance viewing. In addition, digital tools are available to record electronic measurements and to cut, paste and colorize the image. The image can be easily filed on and retrieved from the hard disk or removable storage medium, or the images can be transferred electronically to third party carriers [9]

Apart from these, one more advantage is the immediate observation of radiographic images. Only few digital radiography devices provide immediate viewing like charged coupled devices or CCDs [10]. However phosphorous plate technology requires placement of irradiated sensor in a processing device to scan it and put the information into a computer so that image can be viewed. In conventional radiographic techniques, the delay in reading the image usually forces the clinician to change his gloves and linger elsewhere as the radiographs undergo development [11].

RVG is also useful in educating and motivating the patient [12]. During implant placement, using conventional radiography is a major inconvenience, as the entire aseptic procedure is disrupted and time is

wasted while the clinician awaits the development of the films several times during implant placement procedure [13]. It also allows the clinician to change contrast, enlarge images, place color enhancements or superimpose various textures on images [14].

However, as both advantages and disadvantages of any new invented device go hand in hand, the drawbacks include cost of the devices as well as converting previous records to digital, which are very high, thickness and rigidity of sensor that makes the patient uncomfortable, loss or breakage of sensor, which can prove very costly.

The clinical implications of radiography in the diagnosis of periodontal disease are twofold; to visualize the initial status of the bone tissue and to illustrate changes in bone tissue over time. When there are so many radiographic techniques, the clinician is in a dilemma as to which technique has to be used. This study was an attempt to help the clinician select the reliable radiographic method in imaging and detection of periodontal osseous destruction [15].

The results of the present study showed that overall the digital bitewing images averaged 0.4mm greater bone loss than did the conventional images with a significant p-value. Similarly, in a study conducted by Ahmed Kotch et al (2003) [1], digital radiography measured 0.3mm greater bone loss than conventional bitewings with significant p- value, which is relatively consistent with our results.

Given the overall difference between conventional and digital bitewing radiographs, we wanted to know if this difference was consistent across all sextants of the mouth. Therefore, we computed paired t- test for each of the four sextants available and our results showed measurement differences in RVG and conventional radiographs in all four sextants of the jaw.

RVG showed more bone loss in both maxilla and mandible than conventional radiographs, but in maxilla both methods are showing almost similar measurement with a mean difference of 0.1mm only. However, in the study of Ahmed Kotch et al (2003) digital radiographs observed bone loss only in the posterior mandibular region and measurements of bone loss in the posterior maxillary region were similar between the two radiographic methods [1].

Engebretson et al stated that there is no significant difference in conventional and digital radiographs as such but digital radiographs are more accurate in measurements than film- based radiographs [16]. In our study also, RVG showed more accuracy than conventional radiographs while measuring alveolar bone loss.

In the present study, we observed that in the normal clinical use, significant difference exists between alveolar bone loss measurements on digital and conventional radiographs in several regions in the mouth. This difference noted between the two imaging systems may be attributed to variations in measurements, which were done manually in case of conventional radiographs and digitally in case of digital radiographs, because RVG was showing 0.4mm greater bone loss than conventional radiographs while comparing the total samples. These variations may be due to flexibility of the conventional radiograph film and sensor used in digital radiography.

V. Conclusion

It can be hereby concluded that the digital radiographs have an upper hand when compared to conventional radiographs in terms of alveolar bone loss. Although RVG has superior image recording capabilities compared to conventional radiographs, its cost factor is an important point of consideration, which can limit its use.

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Peripheral Emergencies

By M. R. Omidi Varmezani
Spital Bülach- Zürich, Switzerland

Introduction- Peripheral arterial disease is one of the most prevalent conditions, and it frequently associated with an increased risk of vascular disease in other parts of the body and substantial functional limitation. The initial disease process results in peripheral arterial disfunction causes turbulent flow in the arteries supplying the muscles of the lower extremities. Impaired endothelial function and limited blood flow results in an oxygen supply-demand mismatch.

Early and adequate diagnosis is important for improving the patient`s quality of life and for reducing the risk of secondary vascular attacks. The presence of critical ischemia indicates the need for prompt revascularization because of high risk of limb amputation.

In the healthy condition is ABI-index more than 0.90, whereas in PAD is less than 0.90 at rest with a further decrease after exercise.

GJMR-D Classification : NLMC Code: WL 500

PERIPHERALEMERGENCIES

Strictly as per the compliance and regulations of:

Peripheral Emergencies

M. R. Omidi Varmezani

I. Introduction

Peripheral arterial disease is one of the most prevalent conditions, and it frequently associated with an increased risk of vascular disease in other parts of the body and substantial functional limitation. The initial disease process results in peripheral arterial disfunction causes turbulent flow in the arteries supplying the muscles of the lower extremities. Impaired endothelial function and limited blood flow results in an oxygen supply-demand mismatch.

Early and adequate diagnosis is important for improving the patient`s quality of life and for reducing the risk of secondary vascular attacks. The presence of critical ischemia indicates the need for prompt revascularization because of high risk of limb amputation.

In the healthy condition is ABI-index more than 0.90, whereas in PAD is less than 0.90 at rest with a further decrease after exercise.

II. Embryology

During the first 20 days of development, the human embryo has no cardiovascular structure. Over the next month, the heart and great vessels complete their development and look very much like they will at full gestation.

The digits arising from limb buds during this time (8 weeks). The limb buds are supplies of the intersegment arteries, which arise from the aorta.

The vascular patterns change as the limbs develop, chiefly by angiogenesis.

In the thigh the primary axial artery is represented by the deep artery of the thigh (profund femoris artery).

In the leg, the anterior and posterior tibial arteries represent the primeral axial artery.

III. Arteries of the Lower Extremities

The common iliac arteries form the terminal bifurcation of the abdominal aorta approximately at the level of the fourth vertebral body (Fig. 2). The internal iliac artery arises from the medial aspect of the bifurcation of the common iliac artery. (Heuser)

The common femoral artery is the continuation of the external iliac artery after it passes through the inguinal canal. The common femoral artery gives rise to the superficial circumflex iliac artery and the pudendal branches. The common femoral artery then bifurcates into the superficial femoral artery and the arteria profunda femoris (profunda). The femoral profundaartery comes off posterolaterally, and thus the femoral bifurcation is best seen angiographically with a 30° RAO or LAO view. The superficial femoral artery courses along the medial aspect of the thigh and continues on as the popliteal artery when it exits the adductor canal via the adductor hiatus. Prior to passing through the adductor canal, it gives rise to the superior genicular artery. It provides the superior, middle, and inferior genicular arteries, which have anastomoses with genicular branches from the superficial femoral and femoral profunda arteries. The popliteal artery continues below the knee until it bifurcates into the anterior tibial (lateral take off) and tibioperoneal trunk, which subsequently bifurcates into the peroneal artery and the posterior tibial artery, which is the medial-most artery. The anterior tibial artery passes between the tibia and fibula to run anterior to the interosseous membrane and eventually forms the arteria dorsalis pedis. (Heuser)

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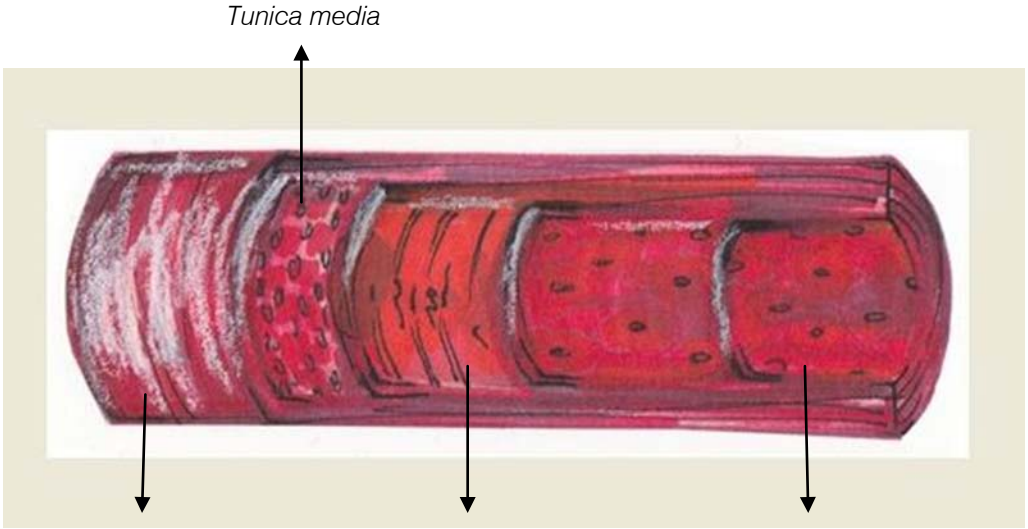
Figure 1 : Angiogram of the lower extremities to the level of the knee. (1) Common iliac; (2) internal iliac (hypogastric); (3) external iliac; (4 common femoral; (5) profunda femoris;(6) superficial femoral artery (SFA). Note the near total occlusion of the left SFA (7).

Figure 2 : Angiogram of the lower extremities below the level of the knee. Ant. tib., anterior tibial; Post. tib., posterior tibial. Note the occlusion of the right popliteal, with collaterals filling the posterior tibial.

IV. Structure of Arteries

The big arteries have three layers, innermost provide a selectively permeable barrier. The middle layers strengthen the vessel and provide vasomotion (vasodilatation and vasoconstriction). The outermost layer provie passage for vasa vasorum (vessels of the vessels), protection and anchoring.

Because of this construction have the arteries unique pathology (for example aging process or dissection). Almost all arterial diseases are associated with lumen changes and therefore hemodynamic changes.



Peripheral arterial disease classification

- Dissections / (pseudo) Aneurysm
- Occlusive disease (Arteriosclerosis)
- Congenital abnormalities
- Trauma
- Compression Syndromes
- Tumors
  - Primary
  - Secondary

V. Aneurysma

a) Femoral Pseudoaneurysma

Although true aneurysms involves all three layers of the wall of an artery (intima, media and adventitia), false aneurysms or pseudoaneurysms are regarded as either a blood leaking collection (after a rupture) out of an artery or vain, but limited adjacent to the vessel by the enclosing tissue without the 3 layers of vessel wall.

A peseudoaneurysm is as a matter of fact a hematoma outside the vessel wall. It must continue to interchange with the vessel lumen to be considered a pseudoaneurysm.

Generally is the pseudoaneurysm consequence of an arterial injury, for instance arterial catheterization or penetration trauma.

Femoral pseudoaneurysm (0.26%) is the second most common complication of vascular interventional procedures after bleeding. The incidence is detected as a major vascular complication rate, within 0.02% and 2%, accord-ing to different literature reports. Pseudoaneurysm formation is less associated with diagnostic procedures compared to interventional procedures. Color Duplex ultrasonography examination can be a sufficient and effective tool to confirm the diagnosis of pseudoaneurysm and may be a part of treatment with compression technique. (Demirbas)

b) Popliteal artery aneurysm

Aneurysms form for a variety of different internal and external factors like atherosclerosis, infection, etc. Popliteal artery aneurysms are rarely symptomatic and usually discovered on routine physical examination. They tend to occur in elderly and form the most common true peripheral aneurysm, more frequently than femoral artery aneurysms, but less frequently than abdominal aortic aneurysm. The prevalence of popliteal aneurysm in the general population is difficult to determine, but appears to be increasing possibly due to

more common use of imaging modalities and an aging population (Björck & Ravn).

A screening study of 1074 men identified popliteal artery aneurysm in 1 percent (Trickett). In another screening study of men between the ages of 65 and 74, abdominal aortic aneurysms were identified in 4.9 percent of patients (Diwan, Sarkar, & Stanley). Of these patients, 6.8 percent had femoral artery aneurysms and 9.6 percent had popliteal artery aneurysms.

US are often the initial imaging modality of choice, however CT is useful for assessment of vessels distal to the aneurysm.

c) Arterio Venous Fistula

An arterio venous fistula is an abnormal connection between an artery and a vein, bypassing some capillaries. When this happens tissues below the bypassed cappilaries receive less blood supply.

An AVF could raise secondary to trauma, postinterventional or congenital (for example Rendu-Osler-Weber-syndrome).

These lesions are extremely difficult to diagnose or treat because of varying of clinical manifestation and very high recurrence rate. The main locations are head-neck (40% of cases) and extremities (40% of cases).

The malformation caused by abnormal differentiation during embryogenesis, may not be evident until additional growth or vascular engorgement as a response to thrombosis, trauma or infection.

The vascular malformation could consist one or several feeding arteries and drainage veins plus nidus. Depend of type of malformation the therapy consist of sclerotherapy with or without flow control procedure by using balloon catheter or coils to occlude the drainage vein.

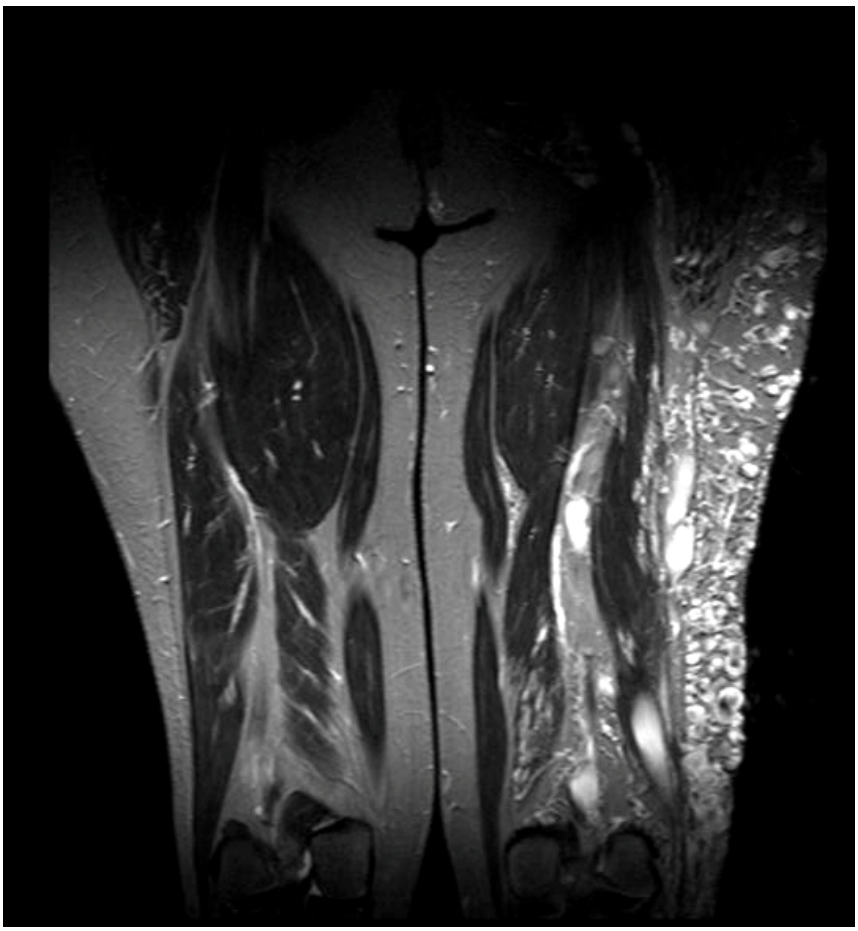


Figure 3 : An example of high-flow vascular malformation. Coronar MRI scan with contrast material enhancement shows dilated vessels within the muscle

d) Peripheral vascular trauma

Patients with Peripheral vascular injuries present daily in emergency departments. A basic understanding of both blunt and penetrating injuries to the extremities and the resultant vascular abnormalities that occur with these injuries helps minimize mortality and morbidity.

- Contusion
- Partial Transection
- Transection
- Arterio venous fistula

Figure 4 : 25 years old male after car accident, emergency operation with external fixation. Conventional DSA angiography shows dissection group. Collateralisation the foot arteries througout a. communicans and recurrens with acceptable perfusion of the foot. No extraluminal contrast material.

Management of peripheral vascular trauma utilizing endovascular techniques has increased in frequency as trauma surgeons have been more familiar with capabilities and more interventionalists experienced in these techniques become available.

In a review of the National Trauma Data Bank, Reuben et al found an increase from 2.1% in 1994 to 8.1% in 2003 in the use of EVIs for vascular trauma. Fifty-five percent of vascular injuries are from blunt mechanisms, and 45% are secondary to penetrating trauma. The blood vessels that are most frequently injured in blunt trauma are the iliac, internal carotid, and brachial arteries and the thoracic aorta. The most frequently injured vessels in penetrating trauma are the

brachial artery and the superficial femoral artery (SFA).(Chatt) Extremity vascular and iliac artery trauma are common in most urban trauma centers with significant morbidity and mortality. Iliac artery injury has a reported 40% mortality. Penetrating and blunt injuries to the popliteal artery have mortalities of 10.5 and 27.5%, respectively, and injuries to the tibial arteries have an amputation rate of 38% (Chatt).

Both multislice computerized angiotomography and magnetic resonance angiography are being increasingly used for the diagnosis and surgical planning. Magnetic resonance angiography enables 3-dimensional images to be obtained safely of the whole abdomen, the pelvis, and the lower limbs at one single study.

VI. Occlusive Arterial Disease

a) Definitions and classification systems

Intermittent claudication is a clinical diagnosis given for muscle pain caused by too little blood flow during exercise.

Symptoms of PAD as known are pain or color changes in the extremities, due to metabolic abnormalities because of reduced blood flow and O2 delivery.

The term peripheral arterial disease (PAD), also known as peripheral artery occlusive disease or peripheral vascular disease implies to the hemodynamic stenosis or obstruction of arteries. In the context of this paper peripheral arterial disease (PAD) refers to the diseases of the infrainguinal arteries**,** includes a subset of femoropopliteal and infrapopliteal segment.

Vascular disease of the upper extremity and coronary arteries have not been implied primarily Vessels continuity is maintained and blood flow is preserved apparently from proximal to distal. That`s why disease of the proximal arteries always have a crucial impact on all downstream arteries, so- called run-in effect. Conversely, run-off effect refers to affection of the proximal vessels (upstream circulation) by disease of the downstream vessels.

Consequently, due to the pathophysiological point of view, there is a composed interconnected vessel network distal to the abdominal aorta that construct a hydrodynamic functional unit.

However, for the purposes of endovascular therapy, separation of the peripheral vascular bed into vascular segments and territories is useful, mainly because of differences in vessel structure and morphology that prescribe different interventional strategies. (Lanzer)

b) Classification of PAD based on symptom severity

Intermittent claudication is a symptom produced consistently by physical exercise such as walking and is relieved by a period of rest. The severity of the symptoms can be determined in the clinical setting utilizing different classifications.

Standard classifications such as the Fontaine or Rutherford scales are commonly used in research settings and do not correlate well with the degree of disability experienced by patients.

The classification by Fontaine has two stages of claudication whereas the Rutherford classification is more differentiated.

Both categorise PAD in terms of symptoms (asymptomatic, intermittent claudication, ischemic rest pain or ulceration and/or gangrene) and severity (mild, moderate or severe).

The Fontaine classification classifies according to the spectrum and severity of the presented symptoms, the distance that a patient can walk before pain occurs (pain free walking distance) dividing into two groups based upon a PFWD of greater than or less than 200 metres. The Rutherford classification uses three groups based upon a combination of the results of a treadmill exercise test and ABI values. (Layden, Bermingham & Higgins)

Table 1 : The Fontaine classification

Grade I	Asymptomatic
Grade IIa	Intermittent claudication after more than 200 meters of pain free walking.
Grade IIb	Intermittent claudication intermittent claudication after less than 200 meters of walking
Grade III	Rest pain, paresthesia
Grade IV	Established gangrene. Trophic lesions
Grade III and/or IV	Critical ischemia. Threat o floss of limb

c) Etiology of PAD

Peripheral artery disease is often caused in the majority of patients by atherosclerosis and diabetes mellitus**.** Less commonly, the cause of peripheral artery disease may be blood vessel inflammation, for example vasculitides and obliterating thrombangitis of Winiwarter and Buerger, injury to the limbs, unusual anatomy of ligaments or muscles, or radiation exposure, are rare by comparison. In atherosclerosis, fatty deposits (plaques) build up in the artery walls and reduce blood flow.

In specific vascular beds other etiologies must be considered in differential diagnostics. For example, in the popliteal artery, an entrapment syndrome may occur due to outside compression of the artery by the

gastrocnemius, popliteus, or soleus muscles, as may aneurysms and cystic adventitial disease (compression of the artery by mucoid adventitia-derived cysts). (Lanzer)

VII. Epidemiologie and Pathophysiology: Atherosclerosis and other Causes of Peripheral Arterial Disease

Peripheral artery disease (PAD) affects 15%-20% of persons older than 70 years of age, though its prevalence is probably even greater if we include asymptomatic persons. (Serrano & Conejero) The Rotterdam study, a population-based analysis of over 7000 patients, showed a frequency of claudication ranging from 1% in those 55 to 60 years of age to.5% in those over age 80. (Garcia) PAD is associated with a great degree of impairment in vascular function and has a risk factor profile similar to CAD: age, gender, diabetes, to-bacco abuse, hypertension, and hyperlipidaemia.

Presence of PAD, by any of various criteria, is associated with increased mortality rate because of greater risk of CAD.

As coronary artery disease, the most common cause of symptomatic obstruction in the peripheral arterial tree is atherosclerosis, a primarily systemic inflammatory process. The response to arterial wall injury induces an inflammatory reaction, which over time forms the histopathological basis of PAD, identical to that seen in the coronary vasculature and brain vascular bed by development of atherosclerosis and subsequent plaque instability.

The histopathological basis of disease is identical to that seen in the coronary vasculature and other vascular beds.

Proper limit of alcohol intake and regular physical training have both determined as protective.

Vasculitides may induce PAD in a small group of patients, because they are not known to affect the peripheral vasculature.

The other rare though possible causes of PAD are thromboangiitis obliterans (Burger`s disease), Hypercoagulable states such as protein C or S deficiency or antithrombin III deficiency, and the vasospastic syndromes.

Major modifiable risk factors for PAD include diabetes and cigarette smoking. Critical prognosis of PAD, primarily as a harbinger of CVD morbidity and mortality has been well documented and widely recognized. Table 2 compares the annual incidence, prevalence and mortalityof patients with PAD, ACS, TIA and stroke.

	Annual Incidence	prevalence	Mortality
Stroke	0.73	4.6	28
TIA	0.50	4.9	6.3
ACS	2.3	12.6	45
PAD		8-12	4-25

Table 2 : the annual incidence, prevalence and mortalityof patients with PAD, ACS, TIA and stroke
Criqui M,et al. Circulation 1985; 71:510

The natural history of PAD is slow progression of symptoms over time, at the same time characterized by an increased risk of coronary and cardiovascular ischemic events.

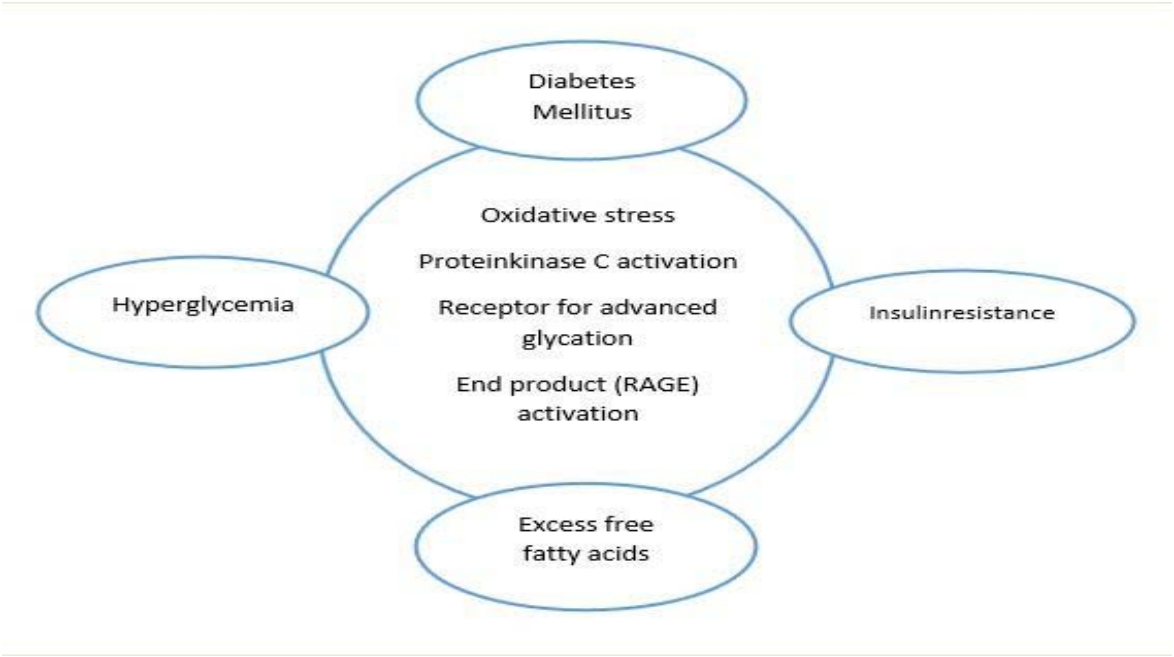
There is considerable variation within this overall pattern. In most patients, the disease progression is relatively benign. A great majority of patients will remain asymptomatic or with fairly stable symptoms; some may even show improvement. A large population study found that 5 years after diagnosis of PAD, 63% of patients showed angiographic progression, but 66% still had no limiting intermittent claudication. (Garcia) How about asymptomatic PAD? Is it really matter? Coexistence of peripheral arterial disease and coronary artery disease is common. PAD worsens the prognosis of patient with CAD. Dus patients with PAD should be treated for secondary prevention, regardless of diagnosis of CAD.

Comparison of patients with PAD versus age-matched controls shows an incidence of cardiovascular death of 0.5% in controls and 2.5% in the patients with PAD. Additionally, in persons with known coronary artery disease, the presence of PAD raises the risk of death by 25% in comparison with controls. It is thus important to examine for PAD, even in asymptomatic patients, in order to control the risk factors as soon as possible and reduce mortality4. (Serrano & Conejero) Whereas the clinical diagnosis of PAD is dependent on the vascular history, the epidemiologic studies have implied the multisystemic involvement of vascular disease and it is usual to find coronary or cerebrovascular disease in patients with vascular disease.

Clinical experiments have shown that up to 50% of patients with PAD also have symptoms of cerebrovascular or heart disease.

In the PARTNERS study, of all the patients who were screened for vascular disease, only 13% had isolated PAD with no other manifestation of cardiovascular disease. Thirty-two percent of the patients also had either coronary disease or cerebrovascular disease, and 24% had involvement in all 3 territories. The main cause of late death in patients with PAD is ischemic heart disease (up to 50% of deaths

in patients with PAD). Inversely, the prevalence of PAD in patients diagnosed with coronary disease reaches 30%4. The mortality in this group of patients is 2.5 times greater than that of the group with no clinical symptoms of PAD. (Serrano & Conejero)



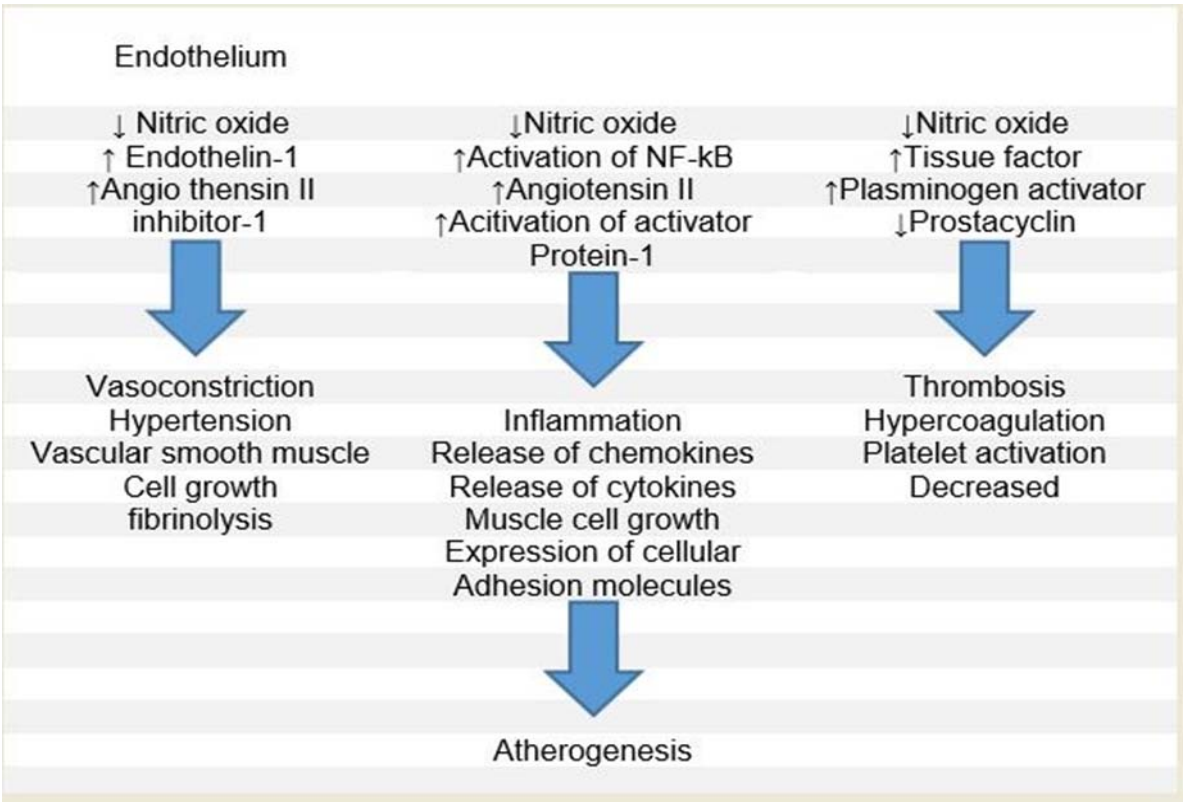


Figure 5 : Atherogenesis in diabetes. This model of endothelial dysfunction illustrates the central role of the inflammatory cascade in atherogenesis. Inflammation is now considered to be a major factor in all stages of atherogenesis in nondiabetic as well as diabetic patients. Adapted with from Beckman et al.23

VIII. Diagnostic Approach

a) Non-Invasive functional assessment

Although diagnostic and therapeutic decisions in patients with vascular disease are guided primarily by the history and physical examination, the use of non-invasive investigations has increased significantly in recent years, mainly as a result of technological advances in ultrasonography.

Without question, the ankle-brachial index (ABI) result can help diagnose peripheral arterial disease. ABI is easy to perform and most common vascular test to detect impaired vascular insufficiency of the lower extremities.

In its most simple form, the test compares blood pressure in the ankle to blood pressure in the arm. A Doppler ultrasound device and standard blood pressure cuff are used to register systolic pressures of both brachial arteries in the supine position at rest. Next, blood pressures are again obtained with the pressure cuff at the ankle, and the Doppler transducer is used to determine systolic pressures of the dorsalis pedis and posterior tibial arteries. As the blood pressure cuff deflates, the blood pressure in the arteries is recorded. A computer converts sound waves into a picture of blood flow in the arteries and veins.

The ratio of ankle pressure to brachial pressure (ABI) is then derived. A ratio of≥0.9 is found in patients without claudication. The patient is diagnosed with PAD when the ABI is≤ 0.90 and at least 0.5. Patients with rest pain usually have ABIs less than 0.5 and an absolute pressure less than 50 mmHg. (Heuser) In asymptomatic persons, an ABI <0.9 has a sensitivity >95% and a specificity approaching 100% as compared with arteriography4. (Serrano & Conejero) Duplex ultrasonography has a sensitivity of 80% and a specificity of 90-100% for detecting femoral and popliteal disease.

ABI and Doppler is non-invasive and accurate diagnostic tool to detect and evaluate the arterial flow dynamics in the affected area. But is that enough?

Non-invasive functional assessment says there is something wrong but no comprehensive qualitively significant and anatomical information. Without utilizing supplemented radiological depiction there is no ability to plan an intervention.

Spiral computed tomography and Magnetic resonance angiography are new, minimally invasive techniques for vascular imaging. CTA and MRA replaced already the invasive angiography. Multislice computerized tomography can also provide excellent 3-dimensional images and give information about the characteristics of the plaque, and all during a very quick study. A helical scan can cover the entire region of interest in one 10-40 second exposure.

Magnetic resonance angiography has the advantage of imaging a moving column of blood and does not require ionising radiation or iodinated contrast, but the technique has obvious drawbacks in terms of cost efficiency and accessibility to scanners. DSA is reserved for interventional procedures.

b) PAD Therapy

Lower extremity and specially femoropopliteal segment are the most common anatomic locations of atherosclerotic lesions.

Analysis of the distribution of peripheral arterial obstructive disease shows that more than 50% of all lesions are localized in the femoropopliteal region. Corresponding to the length of this vessel, diffusely stenosed segments and long occlusions dominate over focal stenoses. The natural history of isolated SFA disease predicts a low amputation risk (0–1%) without surgical revascularization. This benign natural history often drives physicians to avoid surgical or interventional treatment. Endovascular treatment with balloon angioplasty is well accepted for short segmental disease of the femoropopliteal artery. The immediate technical success of revascularization of the femoropopliteal segment by balloon angioplasty is reportedby almost all working groups to be very high, reaching from 80% to more than 95%. However, long-term results vary widely from 5-year patency rates of 68% in patients with stenosis and claudication to only 12% in patients with occlusion and critical ischemia. (Heuser) Treatment of patients affected by PAD consists of a non-pharmacological (life modification or life style changes) and pharmacological approach. Of course, modification of risk factors is the first measure to implement.

For pharmacological treatment of PAD, do not forget, you are treating a systematic disease, therefore such patients need to be identified and treated even more aggressively than patients with CAD only.

Treatment strategies of patients with peripheral artery disease have 2 major goals. One, to manage symptoms, optimizes the functional situation of the leg (symptom relief), and 2, to prevent events secondary to the multifocal distribution of the disease.

The drugs used in PAD can be directed at specific treatment of the claudication, in an attempt to resume physical activities, or at the secondary prevention of cardiovascular and neurovascular events, thus achieving a better vital prognosis for these patients.

Table 3 : Effect of medical Therapies in Subjects with peripheral artery disease(Serrano & Conejero)

	Reduction of events/year	Relative risk reduction	Number needed to treat
Aspirin vs. placebo	4.6%	15	140
Clopidogrel vs. aspirin	4.8%	24	94
Ramipril vs. placebo	4.4%	26	88
Simvastatin vs. placebo	6.1%	21	86

IX. Endovascular Techniques

a) Principles of Intervention

The very most important duty of an interventional radiologist is making a proper imaging to make a proper treatment plan. Do not forget interventional radiologist is a part of specialized team with surgeons, angiologist and internists. Communication inside the highly specialized vascular team is necessary to make a therapy plan with low risk for the patient.

Exact knowledge of peripheral vascular anatomy is required for optimum image acquisition and interpretation.

The development of duplex mapping, computer tomography (CTA), and magnetic resonance arteriography (MRA) is likely to obviate the need for much, of the strategic arteriography performed. DSA is reserved for interventional procedures.

Technological advances of non-invasive multidetector computer tomographic angiography (CTA) and magnetic resonance angiography (MRA) with three-dimensional imaging and their increasing ability to localize and to determine anomalies have transformed the indication and utilization for diagnostic digital subtraction angiography (DSA).

Both magnetic resonance angiography (MRA) and computed tomography scan (CTA) are used to detect, evaluate and follow up peripheral vascular lesions. Utilizing invasive digital substraction angiography (DSA) have now become reserved to specific settings, frequently exclusively in combination with interventional procedure standby or depending on actual validity of non-invasive studies in individual patients.

To allow definitive decisions on the need for and technical feasibility of peripheral arterial revascularization, diagnostic arteriography should provide a full anatomic and morphologic definition of arteries and lesions from the infrarenal abdominal aorta down to the arteries of the feet.

In cases with suboptimal MR or CT image quality or incomplete vascular definition, diagnostic angiography is prescribed to complete the study and to allow definitive statements. In patients with complex multilevel PAD, diagnostic angiography with intervention stand by might be preferable, allowing a single-stage definitive assessment and treatment decisions. (Schneider) In the world of modern angiography, many different purposes can be accomplished, the most important ones are: strategic planning and guiding endovascular interventions. Arteriography presently provides much of the information used for the strategic planning of vascular reconstruction. It is still the most common strategic method with which most vascular specialists are familiar and comfortable. Once endovascular therapy has been selected as the treatment approach of choice, arteriography is the best way to guide the intervention. Intermittent periprocedural arteriography is crucial to guide wire and device passage and assessment of the results of treatment. (Schneider)

b) Angioplasty/stenting

The number of percutaneous transluminal angioplasties performed for claudication has risen steeply in recent years. Percutaneous transluminal angioplasty seems best suited for stenoses or short occlusions of the iliac and superficial femoral vessels, with one-year patency rates of 90% and 80% respectively.

Angioplasty provides the best results in short lesions, preferably stenosis and non-calcified lesions in the common iliac artery. Its long-term results in these situations are good, with permeability figures of 70% at 5 years for patients with claudication41. However, when it is performed in longer lesions, especially when complete occlusions are recanalized, the permeability is clearly lower. The advantages of implanting a stent in iliac angioplasties have been assessed in clinical trials, with permeability figures just a little better for systematic stenting as compared with simple balloon angioplasty42-44. The best approach is probably to implant a stent selectively in those patients in whom balloon angioplasty shows an initially suboptimal result.

In general, we can say that short lesions, less than 10 cm, preferably with stenosis, are the most suitable for endovascular treatment45-48, especially angioplasty, whereas stents have shown a high rate of fractures with important clinical consequences. In longer lesions, the use of expanded polytetrafluoroethylene coated stents seems to afford advantages over the other methods, though randomized studies with a greater follow-up are required49. (Serrano & Conejero)

Evidence suggests that balloon angioplasty is the procedure of choice for iliac and femoropoliteal

artery occlusive lesions. Stent placement should be reserved for angioplasty failures. However, primary stent placement is indicated in total occlusions.

TASC lesions type A and B are best treated with angioplasty and stenting, while TASC lesions type C and D show better results with surgical treatment. (Brountzos)

Type A Lesions	• Single Stenosis ≤ 10 cm • Single Oclusion ≤ 5 cm
Type B Lesions	• Multiple Lesions each ≤ 5 cm • Single Stenosis or Oclusions≤ 15 cm (not Involving the Infrageniculate Popliteal Artery) • Single or Multiple Lesions in the Absence of continuous Tibial Vessels to Improve Inflow for a Distal Bypass • Heavily Calcified Oclusion ≤ 5 cm • Single Popliteal Stenosis
Type C Lesions	• Multiple Stenosis or Oclusion Totaling > 15 cm With or Without Heavy Calcification • Recurrent Stenoses or Oclusions That Need Treatment After 2 Endovascular Interventions
Type D Lesions	• Chronic total Oclusions of CFA or SFA (> 20 cm, Involving the Popliteal Artery) • Chronic Total Oclusion of Popliteal Artery and Proximal Trifurcation Vessels

Table 4 : Classification of femoropopliteal lesions (TASC II), Serrano Hernando F J et al. Peripheral Artery Disease: Pathophysiology, Diagnosis, and Treatment

c) Indications for Surgery

The indication for surgical treatment (conventional or endovascular) of PAD depends above all on the joint evaluation of 2 fundamental aspects, the clinical situation of the patient and the vascular bed that requires reconstruction (Table 4).

The clearest indication for revascularization is the patient with advanced stages of ischemia (III and IV), due to the high risk of loss of limb resulting from these situations. (Serrano & Conejero)

The development of new endovascular techniques has resulted in debate about their role in occlusive arterial disease. An expert group has drawn up a document dealing with the recommendations for treatment, known as the TASC (Inter-Society Consensus for the Management of Peripheral Arterial Disease), whose first edition was published in 2000 and with a second revision announced in 2007. This document includes multiple recommendations about the treatment of patients with PAD and establishes 4 categories (A, B, C, and D), according to the morphology and extension of the disease. (Serrano & Conejero)

d) Differential diagnosis of leg pain

Most leg pain results from different conditions, from wear and tear, overuse, or injuries in joints or bones or in muscles, ligaments, tendons or other soft tissues. Some types of leg pain can be traced to problems in lower spine. Blood clots, varicose veins or poor circulation can also cause leg pain.

In all cases of suggested PAD, nonvascular causes of symptoms (pseudo claudication) such as nerve root compression, spinal stenosis, hip arthritis, and others must be considered and excluded.

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Pneumothorax: An Emergency! How Do I Diagnose in a Primary Setup? *A Systematic Approach to Read X-Rays*

By Raghavendra Bhat, Dr. Parul Kodan, Dr. Gita Bhat, Dr. Sanmath Shetty, Dr. Meenakshi Shetty & Dr. Nita Bhat

Manipal University, India

Abstract- *Background:* Pneumothorax can be an important diagnosis in patient presenting with sudden onset shortness of breath. Timely diagnosis can be confirmed by a radiograph.

Aim: This review is an attempt to make a systematic and highly informative algorithm to read and analyse a radiograph in patient with pneumothorax.

Methods: Authors have combined their rich experience in the field with available standard text to make a simple and useful approach to radiographs with pneumothorax. The text is liberally illustrated for readers to get insight into radiographic approach which can be extremely useful in clinical practice.

Results: Correct interpretations of chest radiographs in the clinical setting can be lifesaving. Proper interpretation of Xray Chest can reveal about underlying lung, aetiology and associated life threatening conditions.

Keywords: *pneumothorax, hyperlucency, x ray.*

GJMR-D Classification : *NLMC Code: WF 746*

Strictly as per the compliance and regulations of:

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I. Review Article

Pneumothorax represents a common clinical problem.[1]The development of a pneumothorax with ensuing hypoxia and hypercapnia can be potentially life-threatening event. [2]Correct interpretations of chest radiographs in the clinical setting can be lifesaving! On x ray chest pneumothorax is seen as hyperlucency without lung markings (pulmonary vasculature) and the positive presence of the visceral pleural margin of the partially collapsed lung. A visceral pleural line is seen without distal lung markings. Lateral or decubitus views are recommended for equivocal cases.[3]

All that glitters is not gold – similarly all situations with hyperlucency are however not pneumothorax. There are many other causes for hyperlucency on a chest x ray and differentiating them from pneumothorax is crucial. A stepwise approach in reading a chest x ray with hyperlucency will avoid wrong diagnosis and facilitate correct and timely treatment.

Hence it is important for the clinicians to be able to navigate through various causes of hyperlucency. The following flow chart is made specially to help this.

In any x ray start by looking for hyperlucency, absence of lung markings, visceral pleural margin and any fluid level. For example look for *figure 1* and analyze the following:

Author σ : Kasturba Medical College, Mangalore, Manipal University.
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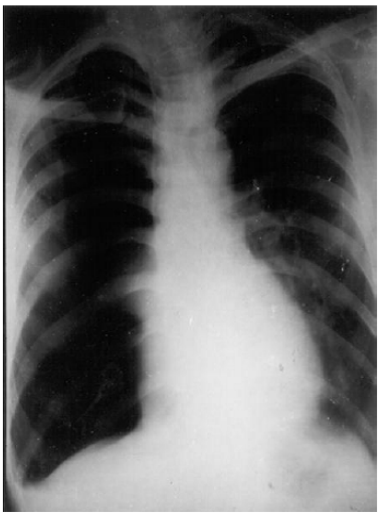


Figure 1

1. Hyperlucency on the right side
2. Absence of lung markings
3. Visceral pleural margin of the collapsed lung seen at the hilum. Note that the lung may almost completely be collapsed like a cricket ball to the hilum indicating that the underlying lung is unlikely to have major illness.
4. Observe a small fluid level in costophrenic angle (Hydropneumothorax on the right side).

Once pneumothorax is recognized, a careful look at x ray may reveal a lot of information about the cause, associated conditions and unravel about underlying lung. [4] However, when we recognizes the presence of pneumothorax we must have a streamlined approach for that. An approach is suggested below.

'Drill' for seeing an X-ray with pneumothorax:

A. Things to look for on the same side of pneumothorax.
B. Things to look for on the opposite side of pneumothorax.
C. Things to look for on both sides.
D. Things to look for under a pneumothorax.

a) Things To Look For On The SAME SIDE Of Pneumothorax

1. Air in soft tissue: Surgical emphysema (due to the cause of pneumothorax or introduced during the insertion of the intercostal tube.
2. Rib fracture: Traumatic (including pathological fractures)
3. Intercostal tube May indicate severity and also suggest as coexisting empyema or haemothorax. May be the source of air.
4. Costophrenic angle obliteration (suggesting associated pleural effusion+ Hydropneumothorax Fluid level
5. Is the collapse of the lung complete Collapses like a ball to hilum (major underlying lung disease in the almost completely collapsed lung is unlikely.
6. Is the collapse of the lung partial? There must be some reason for preventing complete collapse: *Look Outside the lung for*: Fibrous strands , small pneumothorax. *Look Inside the lung for*: T. B. infiltration, malignancy.
7. Pleural thickening Old lesion.

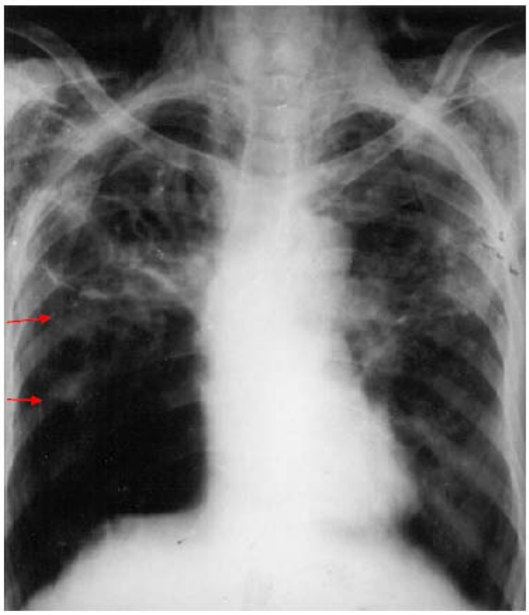


Figure 2 : Observe

1. Surgical emphysema on both sides.
2. Pneumothorax on the right side.
3. Intercostal tube on the right side.
4. Calcification on left side indicating possible old tubercular foci.

i. *Observe*

– Chest tube - used to treat the pneumothorax.

– Surgical emphysema - air in subcutaneous tissues, seen bilaterally, probably as a result of a chest tube (intercostal tube) introduction.

Look for a rib fracture whenever there is surgical emphysema.

Clinical clue: crepitus in the muscle planes overlying the surgical emphysema.

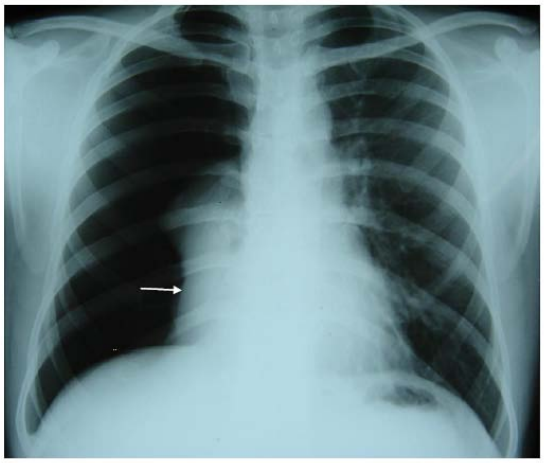


Figure 3 : In see the collapsed lung.

Lung tends to collapse like a cricket ball towards the hilum (compression collapse). Unlike the x ray in fig 1, the lung has failed to collapse to the hilum indicates the possibility of an underlying pathology.

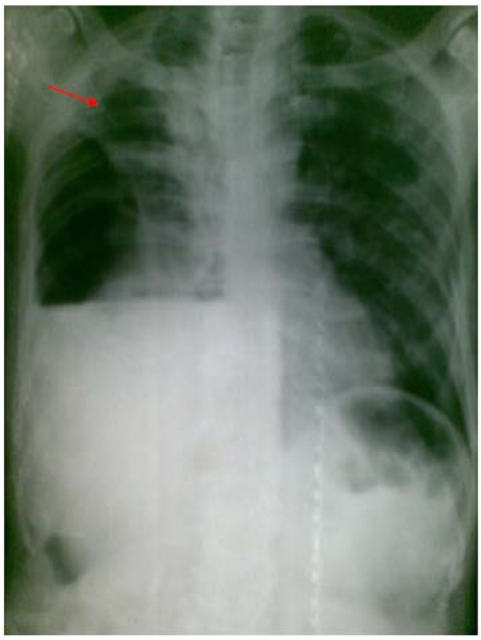


Figure 4

The most obvious finding in this Chest X ray in figure 4 is a horizontal fluid which is because of simultaneous presence of fluid and air in the thoracic

cavity outside the pleura. The hyperlucency is situated lateral to the margin of the collapsed lung (outlined by the visceral pleura). Therefore this hyperlucency is clearly due to presence of free air in the pleural cavity. The simultaneous presence of air and fluid indicated by a horizontal fluid level, helps to identify this situation as a hydropneumothorax. Note that the visible portion of the partially collapsed lung is not healthy- there is an apical cavity. The opposite lung also shows evidence of infiltration. The overall picture strongly suggests possibility of underlying tuberculosis as evidenced by the cavity, whose rupture is most likely the cause of pneumothorax.

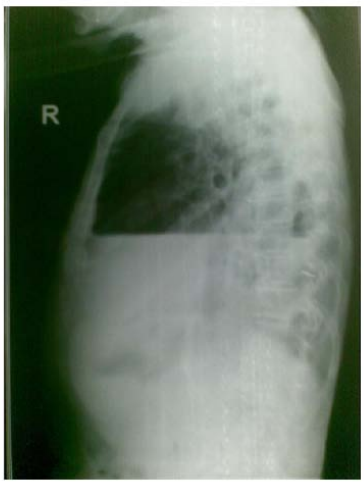


Figure 5

There is a clearly seen horizontal fluid level in the lateral view in Figure 5. Above the fluid level there is an area of hyperlucency without lung markings (free air). Margin of the collapsed lung though faintly visible is not seen as clearly as in the PA view.

Figure 6 :

Observe in figure 6 that the lung underlying the pneumothorax on the right side has partially collapsed. The upper and the middle lobes are having consolidation preventing a total collapse. This is an example of collapse consolidation.

b) Things to Look for on the Opposite Side of Pneumothorax

1. Air in a soft tissue: Surgical emphysema.
2. Trachea If shifted to the opposite side indicate
3. Heart a substantial pneumothorax possibly with air under pressure
4. Lung fields: Cavity, cotton wool infiltrates (T.B)

Figure 7

Figure 7 is an example of tension pneumothorax. There is a lot of free air outside the lung which has collapsed like a deflated balloon to thehilum of the lung(which also shows evidence of some underlying disease). The free air has resulted in hyperlucency without lung markings obviously because the vessels (which would have resulted in visible lung markings) have collapsed to the hilum with the lung. There is lot of free air outside the lung exerting pressure on neighborhood structures resulting in flattening of diaphragm, shift of mediastinum to the opposite side.

The pressure can also be exerted on the great vessels for which the veins (superior and inferior vena cavae) are more vulnerable (than aorta). *This can explain the hypotension and shock which can complicate the tension pneumothorax.*

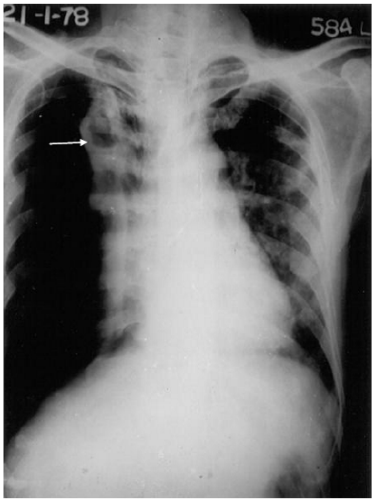


Figure 8

In Figure 8 observe:

1. Hyperlucency (unilateral on right side +no lung markings +
2. Margin of the partially collapsed lung.
3. Cavities inside the partially collapsed lung.
4. Tracheal shift to the opposite side.
5. Infiltration in the opposite lung.
6. Cardiac shift to the opposite side.

Note of caution: The scapular margin seen on the left side can erroneously be considered to be margin of the collapsed lung.

c) Things to Look for on Both Sides

1. Bilateral pneumothorax: TB, connective tissue disorders. like Marfan's syndrome
2. Look for mediastinal emphysema, surgical emphysema.

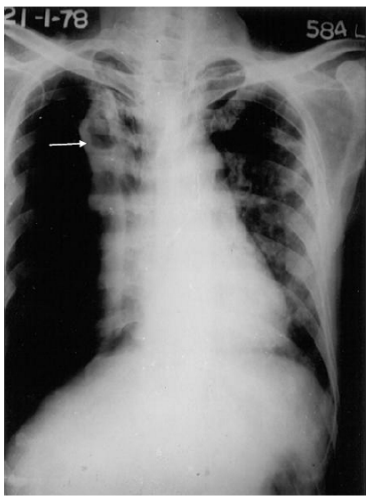


Figure 9

Observe in figure 9:

1. Hyperlucency
2. Absent lung markings Bilateral
3. Margin of the collapsed lung
4. Fluid level - on right side only
5. Hydropneumothorax on the right side Pneumothorax on left side. Most likely cause: bilateral tuberculosis - that's probably why the underlying lung has not collapsed completely. It is a wonder how the patient is alive!

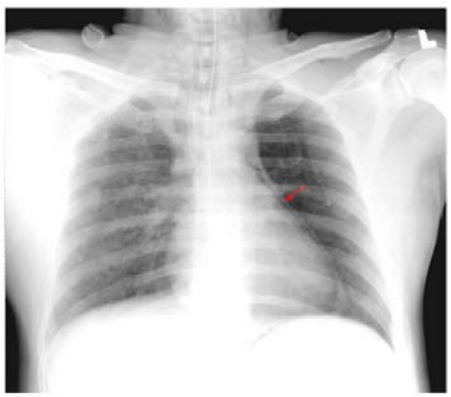


Figure 10

Observe in figure 10 ,the smooth outlining of the heart with a radiolucent shadow. This is suggestive of mediastinal emphysema .Also observe infiltration in both lungs.

d) Things to Look for "Under" the Pneumothorax

1. Visible lesions can be Infiltration, cavity, in a partially collapsed lung, emphysema(sometimes seen after expansion), bulla etc.
2. "Invisible" lesions: Bulla, sub pleural lesions.

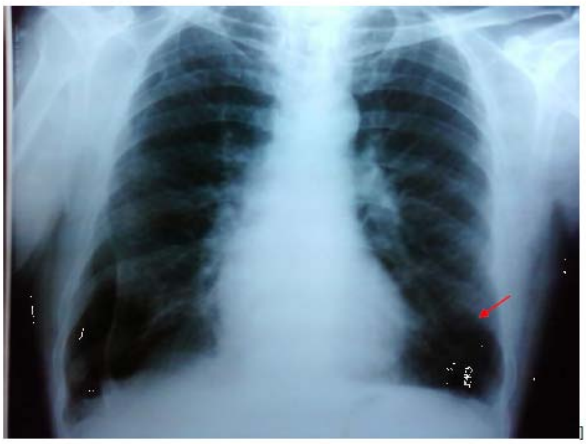


Figure 11

Observe in figure 11 ,COPD changes in this long term male smoker of 60 years age.

Notice the pneumothorax at the right lower zone. Though it is a small pneumothorax it is clearly visible – Hyperlucency without lung markings laterally and margin of the collapsed lung covered by the visceral pleura medially. Note the blunted costophrenic angle.

What caused this pneumothorax?

Look at the lower zone on the other side (red arrow) – you will observe a hyperlucent circular area but no pneumothorax- a *Bulla*, which can sometimes mimic a cavity or a pneumothorax.

A similar bulla on the right side must have resulted in the Pneumothorax.

Beware of the effects that could have happened but have not:Large pneumothorax + trachea/ Look for a lesion causing heart not shifted to opposite side volume loss in the disorder shifted to the same side eased lung: eg: fibrosis, tumour (an ominous sign when it is due to a tumour).

II. Localised Pneumothorax

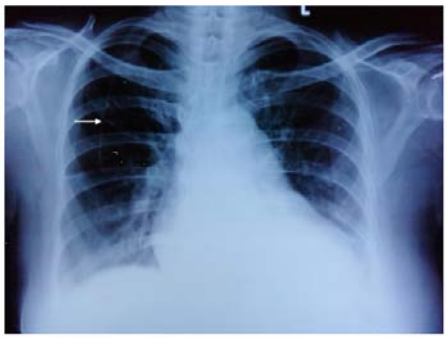
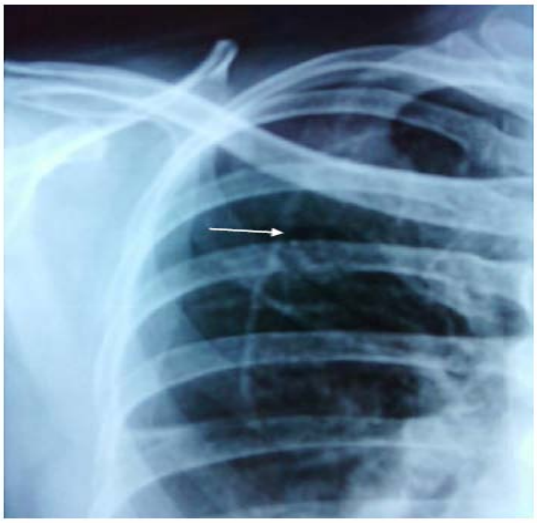


Figure 12

Please note that in this x ray (figure 12) *the outline of the collapsed lung margin on the right side is very faint.*

This is an example of localized apical pneumothorax. A prominent cardiomegaly and a prominent medial border of the scapula on the left side is two distracting features in this x ray.

Figure 13



In figure 13 we can see close up view of the localized apical pneumothorax. Please observe that free air in the pleural cavity (pneumothorax) is situated between the two (visceral and parietal) layers of pleura. The visceral layer outlines the outer border of the collapsed lung.

The treatment of the pneumothorax and its cause has to be individualized for each patient and is out of scope of this article. However underlying etiology, associated conditions and other information revealed by a X ray can be essential guiding tool in deciding the treatment.

III. Conclusion

A close look at x-ray can be highly informative and revealing. To diagnose pneumothorax timely can be life saving. This approach is an attempt to help students and physicians to systematically approach pneumothorax.

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Classification of Intervertebral Disc Degeneration (IVDD) using VESTAL

By Rayudu srinivas & K V Ramana
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Abstract- Spine is the most essential part of human body. Vertebrae and intervertebral discs are important parts of Spine. The Inter vertebral disc (IVD) is a complex and load bearing structure. IVD undergoes a process of change with age and leads to failures. This paper presents a novel model to detect IVD failures using Magnetic Resonance (MR) images. The proposed method makes use of Vertebrae Statistics description Algorithm (VESTAL) to create a template by extracting features from several MR images contains healthy IVDs. The proposed method measures IVD and vertebrae features like intensity, anterior width, posterior width and center length of IVD. A template is created by VESTAL algorithm by extracting feature from 220 healthy IVD images in this work. The proposed method is implemented on 45 case studies where IVD failure have taken place. Proposed method detected the failure region and classified the IVDwith 94% accuracy.

Keywords: *IVD, VESTAL, statistics, vertebrae, intervertebral, disc, classification.*

GJMR-D Classification : *NLMC Code: WE 740*

Strictly as per the compliance and regulations of:

Classification of Intervertebral Disc Degeneration (IVDD) using VESTAL

Rayudu srinivas [α] & K V Ramana [σ]

Abstract- Spine is the most essential part of human body. Vertebrae and intervertebral discs are important parts of Spine. The Inter vertebral disc (IVD) is a complex and load bearing structure. IVD undergoes a process of change with age and leads to failures. This paper presents a novel model to detect IVD failures using Magnetic Resonance (MR) images. The proposed method makes use of Vertebrae Statistics description Algorithm (VESTAL) to create a template by extracting features from several MR images contains healthy IVDs. The proposed method measures IVD and vertebrae features like intensity, anterior width, posterior width and center length of IVD. A template is created by VESTAL algorithm by extracting feature from 220 healthy IVD images in this work. The proposed method is implemented on 45 case studies where IVD failure have taken place. Proposed method detected the failure region and classified the IVDwith 94% accuracy.

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I. Introduction

Spine provides structure for human body. It undergoes a process of changes with age, stress and strains which causes various spinal problems like disc degeneration, disc herniation, vertebral compression fractures and bone spurs. The IVDs are the joints of the spine having load bearing structure [1]. They lie between the vertebrae bodies and are separated from them by a hyaline cartilage endplate. The IVD consists of the inner ring called Nucleus Pulpous (NP) surrounded by an outer ring called Annulus Fibrosis (AF). These structures differ in functional and molecular properties [2]. Nucleus pulpous has high water content and is compressible. It is essentially a semi-fluid like structure, where water and proteins make it, almost, in compressible substance. Reduction in the water content from NP leads to a loss of IVD height. Exposure to heavy mechanical stress over long periods is thought to be a factor leading to Inter Vertebrae Disc Degeneration (IVDD) [3]. The IVD does not possess self-repair capacity. Degeneration affects all areas of IVD, but some evidence indicates that the most noticeable changes occur in the NP.IVDD problem is the most serious problem because lower back pain is strongly associated with it [4-6]. IVDD is treated as serious because most of the patients are suffering from this problem [7]. Disc degeneration also trigger other problems like neck pain, numbness, tingling, loss of muscle strength, walking and standing difficulty and paralysis [8].

Backbone anatomical structure detection and labeling is a necessary step for various analysis tasks of the vertebral column such as IVDD, disc herniation, disc bulging. Appearance, shape and geometry measurements are necessary for abnormality detection locally at each disc and vertebrae as well as globally for the whole spine [9]. Manual step in detecting IVDD can be time consuming and will depend on the experience of the Radiologist/Doctor. Minor IVDD problems are difficult to detect manually. In some cases, if manual intervention is restricted to picking a set of points, errors are unlikely to occur and it does not take much time. However, it is desirable to automate the detection of IVDD and avoid the manual intervention especially if the size of the workload is large.

Automation of IVDD diagnosis reduces the large burden on radiologists who have to diagnose hundreds of cases each day using clinical MRI. Segmentation of MR images is a complicated task as there is no unique correspondence of grey-level ranges to different tissue types [10, 11]. The segmentation of IVD is a prerequisite for the Computer Aided Diagnosis (CAD) of disc degeneration, while it could also be useful for computer based planning prior to spinal surgery [12]. In T2-weighted sagittal MR images a normal disc appears like a bright ellipse because it contain more water content surrounded by a dark ring, whereas a degenerated disc appears darker and often has an irregular shape. These case are shown in fig 1. These features are used in Machine Learning techniques that have been widely and successfully used in CAD [13-15]. A novel method is proposed in this paper to detect disc degeneration, disc compression. In proposed method, the intensity values of the inter vertebrae, length width values are extracted to create a template. VESTAL [16] extracts the spinal canal from MR image it guides the proposed method to detect the vertebrae and IVD to extract IVD features.Normal image spinal canal appeared as bright and the path near the vertebrae body also continuous having smooth transition. In abnormal case the problematic disc appeared as dark

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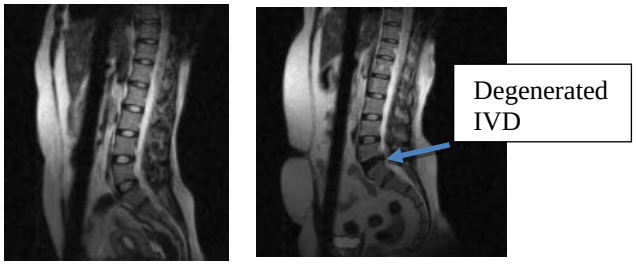
and the spinal canal near this region also appeared as dark.



A) Normal Image *b) Abnormal image*

Figure 1

II. Related Work

So far, most of the studies that deal with the quantification of disc features for diagnostic purposes have been based on manually segmented [17, 18]. In addition, very few researchers report on the automatic segmentation of IVDs. Labeling vertebrae and IVD plays key role to detect the IVDD.A framework has been designed by Tobias et al., that takes an arbitrary CT image, e.g., head-neck, thorax, lumbar, or whole spine, as input and provides a segmentation in form of labelled triangulated vertebra surface models [19]. This framework has been tested on 64 CT images even including pathologies. In 56 cases, it was successfully applied resulting in a final mean point-to-surface segmentation error of 1.12 ± 1.04 mm. One key issue is a reliable identification of vertebrae. For a single vertebra, they achieved an identification success of more than 70%. Increasing the number of available vertebrae leads to an increase in the identification rate reaching 100% if 16 or more vertebrae images.

Samuel et al., introduced a novel approach for segmenting articulated spine shape models from medical images. A nonlinear low-dimensional manifold is created from a training set of mesh models to establish the patterns of global shape variations. Local appearance is captured from neighborhoods in the manifold once the overall representation converges. Inference with respect to the manifold and shape parameters is performed using a higher-order Markov random field (HOMRF). Clinical experiments demonstrated promising results in terms of spine segmentation. Quantitative comparison to expert identification yields an accuracy of 1.6± 0.6 mm for CT imaging and of 2.0± 0.8 mm for MR imaging, based on the localization of anatomical landmarks [20].

Yiebin Kim et al., proposed a fully automatic method for vertebrae segmentation in the CT volume data. The method constructs 3D fences that separate adjacent vertebrae from valley emphasized Gaussian images. Initial curves for the 3D fences are extracted from intervertebral discs, detected with anatomical characteristics, and then optimized using a deformable model [21]. A minimum cost path finding method corrects any erroneous curves trapped into a local minimum. Final volume is labeled with help of the 3D fences by a fence-limited region growing method. This method has been applied to 50-patient data sets and has proved to be very successful.

Szu-Hao Huang et al., developed a fully automatic vertebrae detection and segmentation system. To produce an efficient and effective vertebrae detector, a statistical learning approach based on an improved AdaBoost algorithm is proposed. A robust estimation procedure is applied on the detected vertebra locations to fit a spine curve, thus refining the above vertebra detection results.In their implementation, the proposed AdaBoost-based detector is trained from 22 spinal MR volume images. The experimental results show that the proposed vertebra detection and segmentation system achieved nearly 98% vertebra detection rate and 96% segmentation accuracy on a variety of testing spinal MR images [8].

Kelm et al., proposed a fully automatic and robust approach for an automated scan alignment as well as for the segmentation and analysis of spinal disks and vertebral bodies in Computer Aided Diagnosis applications [22]. Experimental results based on 42 MR and 30 CT volumes show that their system not only achieves superior accuracy but also is among the fastest systems of its kind in the literature.A two-level probabilistic model for the localization of discs from clinical Magnetic Resonance Imaging data that captures both pixel- and object-level features was proposed by Raja et al. They used generalized expectation and maximization for optimization, which achieves efficient convergence of disc labels. Their two-level model allows the assumption of conditional independence at the pixel-level to enhance efficiency while maintaining robustness. A dataset that contains 105 MRI clinical normal and abnormal cases for the lumbar area were used and thoroughly tested their model and achieve encouraging results on normal and abnormal cases [9].

Max et al., proposed an unsupervised intervertebral disc segmentation system based on middle sagittal spine MR scans. This system employs the novel anisotropic oriented flux detection scheme which helps distinguish the discs from the neighboring structures with similar intensity, recognize ambiguous disc boundaries, and handle the shape and intensity variation of the discs [23]. The information is employed in a set of image descriptors, which jointly constitute an energy functional describing the desired disc segmentation result. The energy functional is minimized by a level set based active contour model to perform disc segmentation. This system is evaluated using a database consisting of 455 intervertebral discs extracted from 69 middle sagittal slices.

A unified framework was presented by Claudia Chevrefils et al., for automatic segmentation of intervertebral disks of scoliotic spines from different types of magnetic resonance image sequences. This method exploits a combination of statistical and spectral texture features to discriminate closed regions representing intervertebral disks from background in MR images of the spine. A total of 22 texture features (18 statistical and 4 spectral) are extracted from every closed region obtained from an automatic segmentation procedure based on the watershed approach. This method is validated using a supervised *k*-nearest neighbor classifier on 505 MR images coming from three different scoliotic patients and three different MR acquisition protocols [24].

A model, to study the cause of degenerative disc disease is diagnosed by Magnetic Resonance Imaging using artificial neural networks method for training and classification is proposed by Unal et al [25]. In this model cropped sample images of size 200x80 pixels regions were used. From grey level formatted MR images features were extracted using the wavelet transform. These obtained feature vectors are sent to multi-layered perceptron artificial neural networks as an input in order to make a classification. As a result of classification process, intervertebral degenerative disc disease is diagnosed with99.79% accuracy in 67 iterations using12 patients' images.

The 2D semi-automatic segmentation of both normal and degenerated lumbar IVDs from T2-weighted mid sagittal MR images of the spine was proposed by Sofia et al [26]. This task is challenged by partial volume effects and overlapping gray-level values between neighboring tissue classes. To overcome these problems three variations of atlas-based segmentation using a probabilistic atlas of IVD were developed and their accuracies were quantitatively evaluated against manually segmented data. They achieved dice similarity indexes of this method were 91.6% for normal and 87.2% for degenerated discs.

Raja et al., presented a method for automatic diagnosis of lumbar disc herniation using appearance and shape features. They jointly use the intensity signal for modeling the appearance of herniated disc and the active shape model for modeling the shape of herniated disc. They utilized a Gibbs distribution for classification of discs using appearance and shape features. They used 33 clinical MRI cases of the lumbar area for training and testing both appearance and shape models. They achieved over 91% accuracy in detection of herniation in a cross-validation experiment with specificity of 91% and sensitivity of 94% [27].

Shijie et al., proposed a framework on analyzing disc shapes based on a geodesic metric in an anatomical shape space. All disc shapes, containing both normal and abnormal ones, are formulated as elements in this space. Their experimental results demonstrationed a reasonable accuracy of classifying normal and abnormal intervertebral discs. They concentrated on the IVD shape study. The normal disc shapes are generally regular and similar to each other while the abnormal ones suffer various non-rigid deformations [28]. Gocmen et al., calculated the concavity index for each lumbar vertebra in adults, as well. Concavity index was established for each vertebral body by dividing the "central" vertebral height by the anterior vertebral height [29].

An accurate and automated method to detect the abnormal disc presented by Ming-chi and Cheng-An Fang. This method uses two standard models in conjunction with the threshold value to accurately identify the cartilage. Ming-chi and Cheng-An Fang, smooth out the images via morphological methods and find out the average height of the cartilage before they judge, if a certain cartilages are lower in height than the normal range. In comparison with the professional physician's manual segmentation, their image segmentation shows high accuracy, with the highest rate reaching 99.88% [30].

Roberts *et al*. [31] employed watershed techniques for automatically detecting and segmenting non degenerate intervertebral discs from a combination of proton density (PD) and T2-weighted MR images of the lumbar spine. Chevrefils*et al*. [32] combined watersheds with morphological operations to segment the discs from thoracic spine MR images acquired utilizing the multie-cho data image combination (MEDIC) sequence. Shil*et al*. [33] utilized the Hough transform to detect the spinal cord from whole spine MR images, and then located and segmented the discs with a self-adaptive window and edge detection methods. Wachter*et al*. [34] reported on the segmentation of cervical intervertebral discs from both T1- and T2-weighted MR images, utilizing active shape models and fuzzy connectedness methods, with promising results.

III. Methodology

To classify the degenerated disc, we are extending our work proposed in [16]. The proposed method labels the vertebrae and IVD using VESTAL algorithm. Then this method detects the abnormal region and identifies the severity of IVDD by measuring features of degenerated disc. To detect degenerated disc, proposed method performs the following five major subtasks.

1. Spine curve extraction
2. Vertebrae detection
3. Inter vertebrae detection
4. Labeling vertebrae and inter vertebrae and finally
5. Specify the region of degenerated disk(if any) and classify the images

a) Spine curve extraction

The MR images are scaled to uniform size. Apply Weiner filter to preprocess the images to remove noise. Canny algorithm is applied on preprocessed images to detect spinal canal path easily. The spinal canal path is detected using Spinal Canal Path Search (SCPS) method.

Algorithm : SCPS()
//IM [][] vector contain image information
//m*n size of the image
//img[][] is used for storing path of the spinal canal
//p, q intensity range of values of the spinal canal
// imgIntensity[][] intensity matrix

Comment only the detected region by canny is used for processing to optimize image processing
x = 0, y = 0, img[m][n] = {{0};{0}};
i =IM. getPixel(x,y)
if (p<i and i< q)

then
- img[x][y] = 1;
- imgIntensity[x][y]=i;
- SCPS(x+1,y)
- SCPS(x,y-1)

b) Vertebrae Detection

Location of vertebrae can be easily detected using spinal canal. This process saves time and reduces processing complexity. Only vertebrae regions are searched for detecting vertebrae.

*Algorithm:*VD()
//IM vector contains image information
//m*n size of the image
//img[][] is used for storing Vertebrae values
//p, q intensity range of values of the Vertebrae
// spinal canal is processed in any direction
// imgIntensity[][] intensity matrix
img[m][n] = {{0};{0}};
i =IM. getPixel(x,y)
if (p<i and i< q)

then
- img[x][y] = 1;
- imgIntensity[x][y]=i;
- VD(x+1,y)
- VD (x,y+1)
- VD (x-1,y)
- VD (x,y-1)

The vector img[][] contains vertebrae information and other pixels are not having intensities within the range of vertebrae.

c) Intervertebral Disc Detection

Form 3.2 the locations of intervertebral discs are detected. Intervertebral discs are in between these vertebrae. The region is detected using IVDS() algorithm which is similar to VD().These regions can be detected from the breaks in the intensities of the spinal canal and vertebrae. The shape of the IVD can alsobe detected using shape of vertebrae.

d) Labeling Vertebrae and IVD

Based on statics features extracted using above procedure 3.2 and 3.3, a template is created for each age group based on heights. In this method Indian standard height is considered to create template.

*Algorithm:*Template()
//m*n size of the image
//imgAvg[][] intensity average values image
// imgIntensity[][] intensity matrix
// N number of sample image for specific age group
for k= 1 *to* N
begin
*for*i= 1 *to* m
begin
for j=1 *to* n
begin
imgAvg[i][j]+=imgIntensity[i][j]
end
end
imgAvg[][]/=N
end

Vector img[][] contains location information about IVDs. Using this algorithm intervertebral for one MRI is detected. The same procedure is repeated for multiple quality images and obtain the average IVD values. The average IVD values, imgAvg[][] is used as template for that age group. This procedure is repeated for all age groups and updated based on requirement. While preparing template normal MR images are used, which is having elliptical shape and bright appearance.

e) Detecting Degenerated Region and classification of the MR Image

If spine image contains any abnormality, it can be detected using MR images using step 3.4 if image contains abnormal IVDs. These locations are regions to be considered as degenerated regions.The abnormal disc lost its shape and water content and appearance. So intensity values of abnormal disc generally lower than healthy disc. To detect abnormality in disc the above procedure is applied by considering changes in the intensity range for patient image. The calculated value are used for template matching to detect abnormality region. Based on the result image can be classified as normal and abnormal. If the image is abnormal image template matching procedure results specifies the mismatched region. Based on damage and properties of IVD also it classify the type of problem as degenerated or disc thinning.

IV. Results

MR Images are scaled to uniform size and data base of sample images were created. These images are used as input to SCPS() and obtain spinal canal. Using

this shape of spinal canal, vertebrae and intervertebral discs locations are detected. Figure 2 shows the stages of preprocessing MR image.

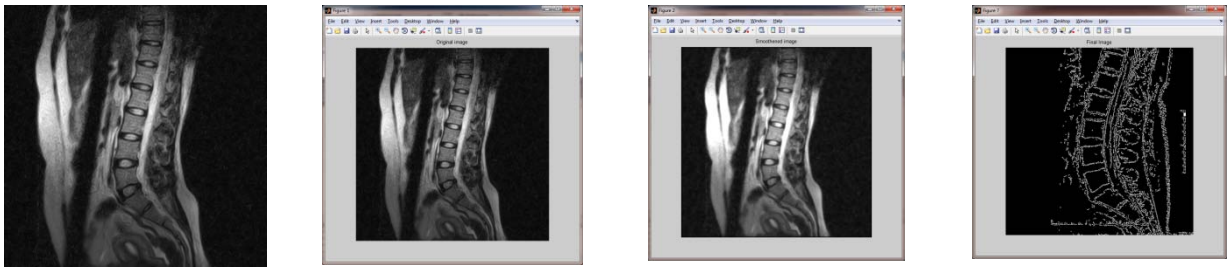


Figure 2 : Sample input image b) preprocessed image c) scaled image d) result of canny

Table 1 : cervical vertebrae statistical properties

Vertebrae No	Anterior width	Posterior width	Length	Height
C2	20	20	28	18
C3	21	21	28	19
C4	22	21	29	20
C5	24	26	29	22
C6	26	26	30	25
C7	28	27	32	25

The parameters measured for cervical vertebrae, cervical IVD, lumber vertebrae and lumber IVD using VESTAL are shown in table 1, 2, 3 and 4 and their corresponding relation in figure 3, 4, 5 and 6.

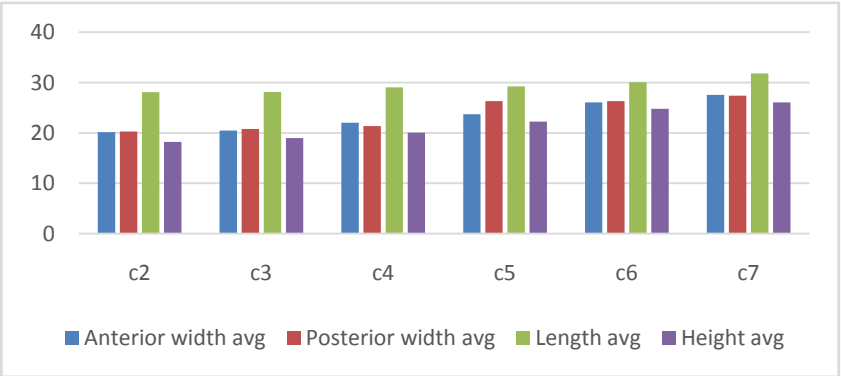


Figure 3 : Comparison of vertebrae features of cervical vertebrae

Table 2 : cervical IVD properties

IVD No	Anterior width	Posterior width	Length	Height
C2/C3	8.83	8.72	24.14	10.58
C3/C4	8.77	8.76	24.64	10.09
C4/C5	8.64	8.56	25.08	10.03
C5/C6	9.06	7.96	25.64	10.01
C6/C7	8.93	8.01	25.58	9.52
C7/T1	8.01	7.68	27.15	9.18

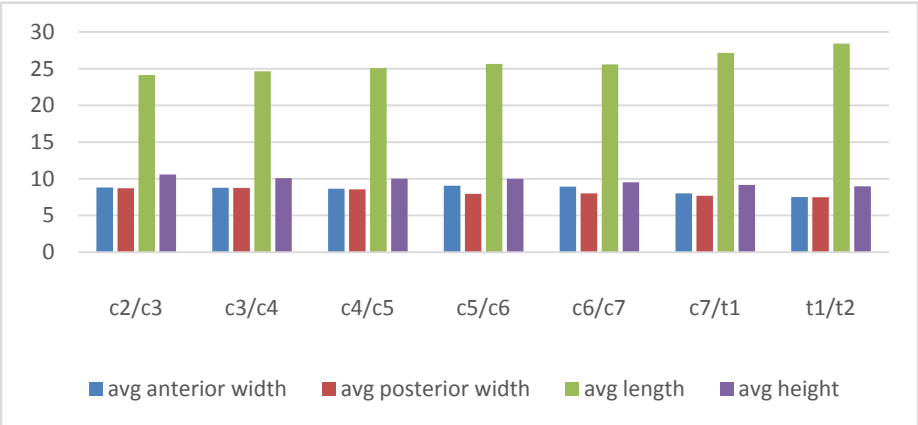


Figure 4 : Relation between cervical vertebrae properties

Table 3 : lumber vertebrae statistical properties

Vertebrae no	Anterior width	Posterior width	Length	height
L1	27	26	36	28
L2	29	28	37	29
L3	29	28	40	30
L4	29	26	41	30
L5	28	26	41	29

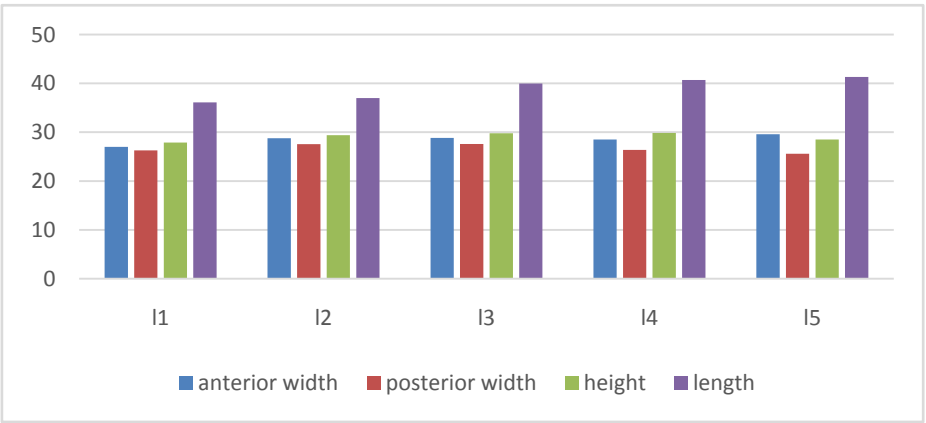


Figure 5 : Relation between lumber vertebrae properties

Table 4 : Lumber IVD statistical properties

IVD No	Anterior width	Posterior width	Length	Height
L1/L2	11	9	40	12
L2/L3	13	10	43	13
L3/L4	14	9	52	14
L4/L5	18	11	33	16
L5/S1	22	11	45	16

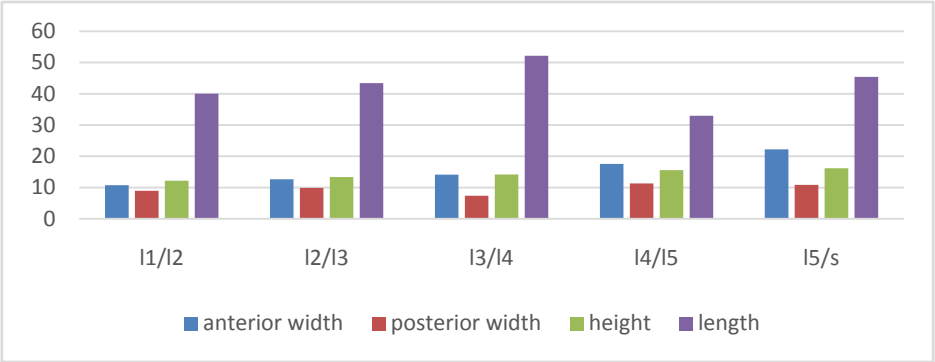


Figure 6 : Relation between properties of Lumber IVDs

From above results we conclude that the vertebrae and intervertebral widths are in increasing order for lumber vertebrae except for L5. The brightness of the IVD, width and height is increasing order with age from childhood to middle age. The bright ness decreases as age increases from over middle age. The statistical properties vary based on height, nature of the work done by patient.

V. Conclusions

In this paper, a novel method is proposed to extract feature of IVD to classify the MR images. The proposed method uses statistical properties and using these properties a template is created. The MR images are classified by comparing extracted feature of the image with template. Proposed method produces 94% accuracy in classifying MR images as normal and abnormal and further it classify degenerated or thinning. This method is very useful for detecting degenerated disc. In future this work can be extend for detecting other disc related problems like disc bulging and disc herniation.

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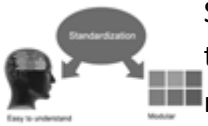

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- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
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Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
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- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
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- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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