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Doppler Ultrasound for the Existence of Blockage in Lower Limb Arteries

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Abstract

Purpose: The purpose for this research study was to develop the most efficiently reliable and accurate method to determine the presence of blockage in the lower limb arteries without any ambiguity. Blockage in the lower limb arteries comes due to the problems like the fats deposition or cholesterol rich substances inside the arterial walls. These problems cause the reduction in the arterial radius by narrowing the arteries.

Method: For this purpose the method was adopted with the fact that, change in the arterial radius arises due to presence of blockage inside the arterial walls which affects the speed or velocity of the flowing blood through that particular artery and hence produce a change in the waveform pattern of the received echoes. The method is the combine study of changing waveform pattern and changing speed or velocity of the blood flowing through the particular artery. 10 cases of different ages and sex were taken into consideration by using Doppler ultrasound technique.

Results: Results showed blockage in many cases but with varying degree of blockage. Some cases showed normal or early blockage and some show late or well blocked artery. Also some normal cases were taken for study, so as to evident the effectiveness of this method to determine the absence of blockage.

Conclusion: It was concluded that waveform pattern comparison along with the velocity comparison method is most careful, very accurate and appreciable indicator for the determination of existence of blockage in lower limb arteries.

Introduction

Presence of blockage in lower limb arteries is responsible for bad supply of blood or less than normal required supply of blood to the tissues, which may lead to the death of the corresponding tissue. Satomura described the use of Doppler ultrasonography technique for the determination of presence or flow of blood through the arterial walls in 1959. [1] He concluded that this technique can be reliably used for the diagnosis of atherosclerosis.(arterial disease) Then from 1960's to 1970 the use of Doppler ultrasonography was more clearly defined to be used for the confirmation of graft patency and measuring of lower extremity systolic pressure. [2] It was noted that arterial blockage

produced a characteristic change in the shape of waveform of received echoes, which could be easily recognized by simple comparison with the normal waveform of received echoes. [3] The change in the waveform can be used to diagnose the blockage of artery or vessel proximal to the area of observation. [4]

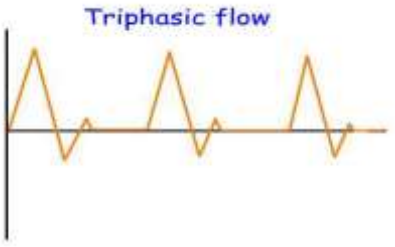
Lower Limb Arteries

There are many arteries in the lower limb, which starts from the main aorta. That is the common iliac artery which is further divided into internal and external iliac artery in the thigh region. Then there starts the common femoral artery which also further divides into deep and superficial artery to enter in the knee. Then popliteal artery starts around the knee and is also divided into anterior and posterior arteries. There is a fibular artery along the back side of the lower part of the leg to enter in to the ankle from where the dorsalis pedis artery starts and is further divided into metatarsal and deep plantar artery.

Method and Materials

Logic 200 and Madison machine was used for Doppler ultrasound study of the cases. Some cases were studied using logic 200 and some using Madison. Method of waveform pattern comparison along with the changing speed or velocity (of blood) observational method was adopted for study. Each of lower limb arteries may get blocked due to reduction in the arterial radius, which can be diagnosed with the help of Doppler ultrasonography. Arteries like the common iliac, common femoral, superficial femoral and popliteal artery shows triphasic pattern of waveform in normal conditions.

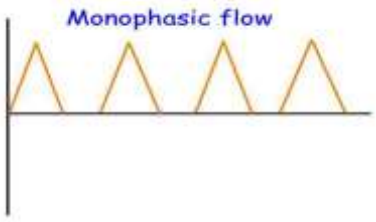
Fig. 1: Triphasic Pattern of Waveform



Any blockage in CIA, CFA, SFA and POPA change this triphasic pattern and the new pattern is not completely triphasic or somehow triphasic. Measure of this shift or deviation from the triphasic pattern represents the degree of blockage in these above mentioned arteries. The new changed pattern can be biphasic or monophasic.

Other arteries like the anterior tibial artery, posterior tibial artery and dorsalis pedis artery normally shows the monophasic type of waveform pattern, when these arteries are not blocked and working properly.

Fig. 2: Monophasic Pattern of Waveform



Any blockage in these arteries like ATA, PTA and DPA produce a change in the pattern like the reduction in the amplitude or mild spectrum. Measure of shift or deviation from the monophasic pattern represents the degree of blockage.

During the study each case was observed that, if any of these show a change in the regular waveform pattern or not. Also the velocity values were noted to be changing or not so as to evident the change in the arterial radius which produce the blockage.

Results and Discussion

This study determinates the use of Doppler Ultrasonography for the detection of blockage in lower limb arteries, which is responsible for the change in normal waveform pattern of the received echoes. A triphasic waveform pattern is obtained for lower limb arteries like common iliac artery, common femoral artery and popliteal artery when these are in normal healthy condition. While the other arteries like the anterior and posterior tibial artery, dorsalis pedis artery shows the monophasic pattern of waveform when these are in normal healthy condition. Any change in the normal patterns of waveforms is due to the presence of some blockage inside the artery. The findings of this study show that any change in the waveform pattern is due to reason of change in velocity of the blood through the artery and this change in velocity is due to the reason of blockage inside the arterial walls which reduce the arterial radius and thus affects the speed or velocity of the blood through the region of blockage. See the following relation:

$$V \propto 1/r^2$$

It should be noted that not only the whole length of the same artery can show change in the waveform pattern, it may also happen that only a certain region along the length of the same artery can show a change in the waveform pattern and this area is the region of blockage in the lower limb artery. And in case if the whole arterial length is showing a change in the waveform pattern then it means that the whole length is blocked and the image obtained will be showing mild spectrum. In case of complete blockage of artery, when no blood flow occurs through it then it shows no spectrum on the ultrasound image which is due to almost zero velocity and no production of Doppler shift through that region of complete blocking.

A patient (see image-01) who's LTPOPA was diagnosed with the Doppler ultrasonography and it was found that the artery is producing a monophasic pattern, which is incorrect, because the POPA shows a triphasic pattern in normal healthy condition. Also a change in the blood speed was observed which showed the change in the arterial radius. So as there is a change in the pattern and speed, it means that artery is blocked.

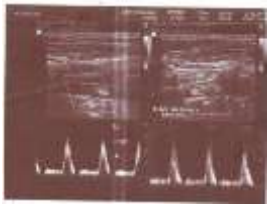


Image:-01(blocked POPA)

Another patient (see image-02) was diagnosed for any blockage in Common femoral artery and the obtained image was not triphasic, rather a monophasic pattern was obtained with a considerable change in the speed or velocity of blood through CFA, which indicated the blockage in the CFA.

Image:-02(blocked CFA)

Common femoral artery of another patient (see image-03) was also diagnosed and it was found the obtained image pattern was monophasic instead of being triphasic, a change in the speed or velocity of the blood was also observed. Hence this change clearly indicates the blockage in CFA.

Image:-03(blocked CFA)

Another patient (see image-04) was diagnosed for detection of blockage in common femoral artery and it was found that obtained was biphasic instead of being triphasic, also a small change was observed in the speed or velocity of blood, thus indicating an early diagnose of blockage in the common femoral artery.

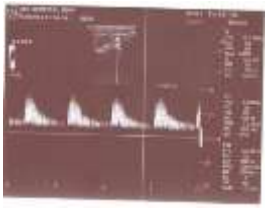


Image:-04(minor blocked CFA)

Next patient (see image-05) was diagnosed for blockage in the right femoral artery and the obtained image was observed not to be triphasic, rather a monophasic pattern of waveform was obtained with a change in the

speed or velocity of the blood through RTFA, thus indicating a blockage in the artery.

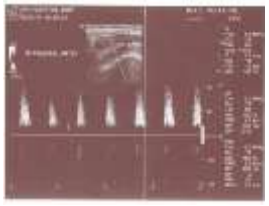


Image:-05(blocked RTFA)

A patient (see image-06) was diagnosed so as to get information about the blockage in Dorsalis pedis artery, which shows monophasic pattern in the normal healthy condition. It was found that DPA did not show any change in the required pattern and obtained image was monophasic which means that the artery is not blocked and working properly.

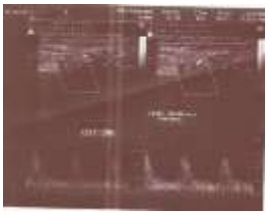


Image:-06(healthy DPA)

Next patient (see image-07) was diagnosed for any blockage in both left posterior tibial artery and left anterior tibial artery, these both arteries shows monophasic pattern in the normal healthy condition, and the obtained image of these both arteries showed no change in the required pattern and no change in the speed or velocity of blood through these arteries. As the obtained image is monophasic and speed was observed to be not changing, so it indicates normal healthy arteries without any blockages.

Image:-07(healthy LTPTA,ATA)

Another patient (see image-08) whose Superficial femoral artery was diagnosed and there was found a very little change in the waveform pattern and a minor change in the speed of the blood through that artery which indicated the early diagnose of the blocked artery or to say a minor blocking of the artery. You can see in the image that the obtained image is little different from the triphasic pattern, which is normally shown in the healthy condition of superficial femoral artery.

Image:-08(minor blocked SFA)

There was patient (see image-09) whose both Superficial and common femoral artery was diagnosed and compared for any blockage.

And it was found that no considerable blocking resides in both arterial walls and obtained image is very little different from the required triphasic pattern without a considerable change of speed or velocity of the blood through both arteries. So here, it indicates a very little blockage in arterial walls or to say the early diagnose of blockage in the artery.

Image:-09(minor blocked SFA, CFA)

There was patient (see image-10) who has his left leg cut in an operation due to diabetes. His both left and right common femoral arteries were diagnosed for comparison and for detection of any blockage in the right leg. The obtained image showed a minor blocking in the right CFA but as the left leg was so not present, so the left CFA showed a mild spectrum indicating the no supply of blood to that region.

Image:-10(minor blocked RT& well blocked LTCFA)

The advantage of this method is that, it is a non-surgical method and it can be done again and again as required by the operator without producing any harmful effects. The most important factor in this manner is the reproducibility of the image, which is affected because of lack of experience of the operator, and due to some physiological changes in the patients like change of arterial radius and the type of Doppler system which is being used for the diagnosis of blockage in the lower limb arteries. The success of this method is mainly dependent upon the skilled use of the machine, as there is a probable risk of getting abnormal waveform patterns due to less practical experience of the operator. This study suggests to observe the change in speed or velocity of blood through the lower limb arteries at certain points and notice the change in the waveform pattern so that to locate the region of blockage along the arterial length.

Conclusion

It is been concluded that when any of the lower limb artery is blocked then it produce a change in the waveform pattern of the received echoes. This change in the waveform pattern is actually due to change in the speed or velocity of the blood which is flowing through any certain artery. The change in the speed or velocity of the blood is due to change in the arterial radius. Radius of arteries gets

change due to presence of some blockage within the arterial walls. So any change in the arterial radius of the lower limb arteries is best understood or determined by the observation of change of waveform pattern. It should be noted that, in this study a careful notice has also been taken into account about the change in the speed or velocity of blood by using Doppler technique. This helps to evident the presence of some blockage inside the lower limb arteries, because any change in the speed or velocity of the blood through the artery is due to change of radius of the artery. So whenever a change is noticed in the waveform pattern, then the speed or velocity of the blood is also observed to changing or not. At the end it is been concluded that this method is a very safe, most careful and very accurate approach about to determine the presence of blockage in lower limb arteries

References

[1] Satomura, S. (1959). Study of the flow patterns in peripheral arteries by ultrasonics. J Acoust soc Japan, Vol. 15:151-158.

[2] Yao, S. T., J. T. Hobbs and W. T. Irvine. (1968). Pulse examination by an ultrasonic method. Br Med J, Vol. 4:555-557.

[3] Nayman, J. (1974). The use of the ultrasonic flow meter in peripheral vascular disease. Aust NZ Surg, Vol. 44:157-167.

[4] Persson, A. V., G. Gibbons and S. Griffey. (1981). Noninvasive evaluation of the aortoiliac segment. J cardiovas surg, Vol. 22: 539-542.