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Research Article

AGE RELATED VARIATIONS IN SUPERIOR MESENTERIC ARTERY BLOOD FLOW USING DUPLEX DOPPLER SONOGRAPHY

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ABSTRACT

We aimed to determine changes in the hemodynamic parameters of superior mesenteric artery (SMA) with increase in age using noninvasive duplex doppler ultrasonography.

126 apparently normal individuals in fasting state were selected for SMA Doppler ultrasonography and divided into 4 age groups, Group 1 was 15-30years age group, Group 2 was 31-45years, Group 3 was 46-60years and Group 4 >60years. Resistive index (RI), Pulsatility Index (PI), peak systolic velocity (PS) and PS/ED was recorded in each individual.

Comparison of RI, systolic velocity and PS/SD between the 4 age groups shows that the mean value is highest in >60years and least in 31-45years, this difference is statistically significant. Comparison of PI shows that the mean value in 46-60years is highest and least in 31-45years. This difference is statistically not significant.

With increase in age the Doppler spectrum of the superior mesenteric artery shows changes, which are characterized by increased vascular resistance and decreased blood flow.

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INTRODUCTION

Hemodynamic changes in the superior mesenteric artery (SMA) reflect the changes in the intestinal circulation and are influenced by the pathophysiologic mechanisms of the underlying bowel diseases. Duplex Doppler sonography is a noninvasive tool that provides simple and reproducible measurements of blood flow.¹ Superior mesenteric artery (SMA) can be readily examined with abdominal duplex scanning because of their location anterior to the aorta.² Measurement of luminal diameter and blood velocity allows estimation of blood flow and peripheral resistance, and the detection of arterial occlusive disease.³ Mesenteric arterial flow velocities have been well described in normal subjects in the fasting state, post prandial, and after pharmacologic stimulation.⁴ In this study we evaluated Duplex Doppler sonographic parameters of the superior mesenteric artery in patients of different age groups with normal abdominal ultrasonography in adult population.

MATERIALS AND METHODS

Population

The patients were referred to our department for ultrasound abdomen for various clinical indications. A total of 126

subjects above 15 years with normal abdominal ultrasonography were selected, all the patients were fasting and had no systemic illness. Patients with pathological findings on ultrasonography and age less than 15 years were excluded from the study. For the ease of study, the subjects were divided into 4 groups, Group 1 was 15 to 30yr age group, Group 2 was between 31 to 45yrs, Group 3 was between 46 to 60yrs and Group 4 above 60yrs.

METHODS

All patients underwent ultrasonography of abdomen using Toshiba Xario 100 ultrasound Doppler machine with a 3 to 5 MHz curvilinear probe. We visualized the superior mesenteric artery arising from the aorta in the epigastric region posterior to the neck of pancreas (Fig 1). Once an adequate image of the vessel was achieved through longitudinal abdominal scans and with the aid of the color doppler signal, we measured the blood flow velocities within the vessel from a point 2cm distal to its origin from the aorta. Doppler sample gate was positioned in the center of the lumen of SMA and the angle of insonation of 60 degrees or less was determined for each data point to convert the Doppler shift frequencies to velocities (Fig 2). We measured the RI, PI, velocity (PSV) and PS/ED, Measurement of each parameter were in the fasting state.

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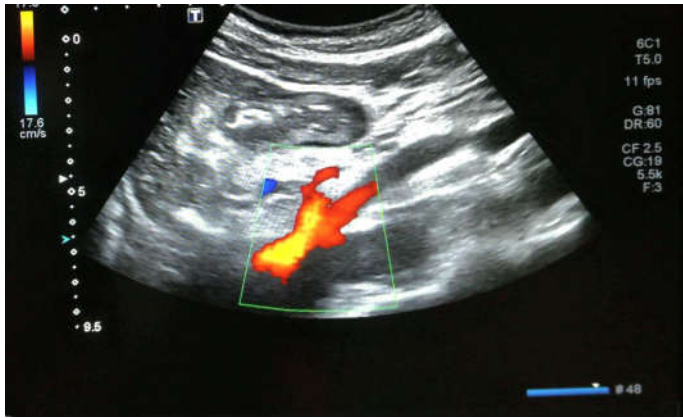


Fig 1 Color Doppler showing origin of SMA from aorta

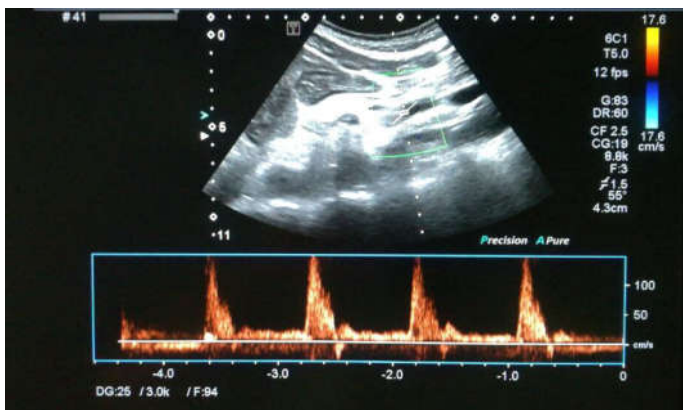


Fig 2 Spectral waveform of SMA

Statistics

Statistical comparisons were made using the One way ANOVA test

RESULTS

Table 1 One way ANOVA test for comparison of the four parameters between the 4 groups

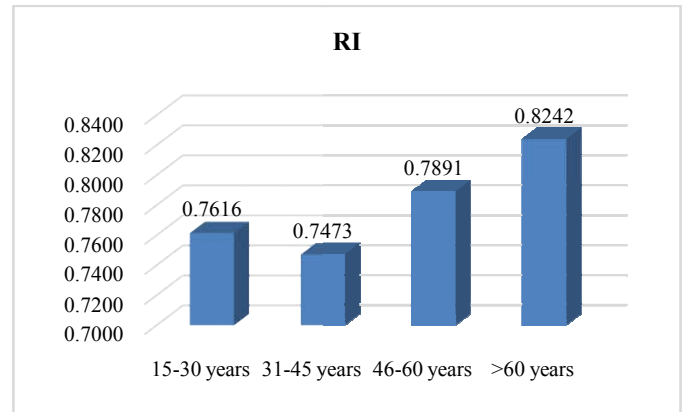
| | | N | Mean | Std. Deviation | Statistics/ mean squares | df2(welch) / F(Anova) | p value |
|---------------|-------------|-----|----------|----------------|--------------------------|-----------------------|--------------|
| RI | 15-30 years | 50 | 0.7616 | 0.150961 | 4.523 | 62.023 | 0.006 |
| | 31-45 years | 30 | 0.747333 | 0.064484 | | | |
| | 46-60 years | 22 | 0.789091 | 0.057314 | | | |
| | >60 years | 24 | 0.824167 | 0.093665 | | | |
| | Total | 126 | 0.774921 | 0.11322 | | | |
| PI | 15-30 years | 50 | 1.7976 | 0.986473 | 0.566 | 0.565 | 0.639 |
| | 31-45 years | 30 | 1.796667 | 0.897396 | | | |
| | 46-60 years | 22 | 2.05 | 1.124142 | | | |
| | >60 years | 24 | 2.026667 | 1.03245 | | | |
| | Total | 126 | 1.885079 | 0.995143 | | | |
| Velocity-cm/s | 15-30 years | 50 | 47.4836 | 25.24553 | 2913.866 | 4.563 | 0.005 |
| | 31-45 years | 30 | 45.79867 | 22.24409 | | | |
| | 46-60 years | 22 | 59.47818 | 24.72707 | | | |
| | >60 years | 24 | 67.05667 | 29.11244 | | | |
| | Total | 126 | 52.90492 | 26.32923 | | | |
| PS/ED | 15-30 years | 50 | 4.1672 | 1.524996 | 8.739 | 5.647 | 0.001 |
| | 31-45 years | 30 | 4.166667 | 0.973913 | | | |
| | 46-60 years | 22 | 4.918182 | 1.257222 | | | |
| | >60 years | 24 | 5.25 | 0.784081 | | | |
| | Total | 126 | 4.504444 | 1.311519 | | | |

Resistive index (RI)

Comparison of RI using one way ANOVA test shows that the mean value in >60 years (0.824167) is highest followed by 46-60 years(0.789091),15-30 years(0.7616) and least in 31-45 years(0.747333). This difference is statistically Significant with

a test value of 62.023 p value of 0.006 as shown in table 1 and graph 1.

There was significant increase in RI with increase in age.



Graph 1 Comparison of RI using one way ANOVA test.

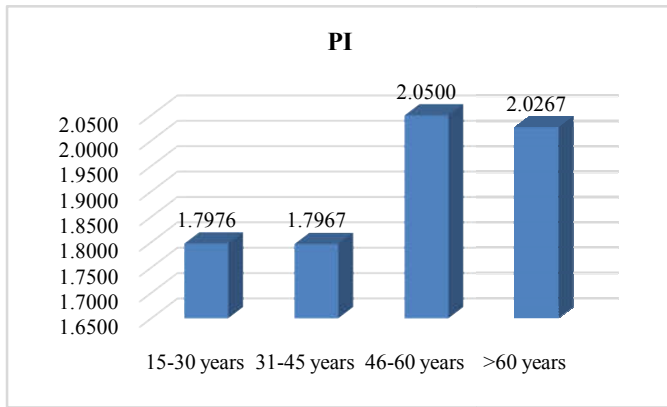
Pulsatility index (PI)

Comparison of PI using one way ANOVA test shows that the mean value in 46-60 years (2.05) is highest followed by >60 years(2.026667),15-30 years(1.7976) and least in 31-45 years(1.796667). This difference is statistically Not Significant with a test value of 0.565 and p value of 0.639 as shown in table 1 and graph 2.

PI did not increase significantly with age.

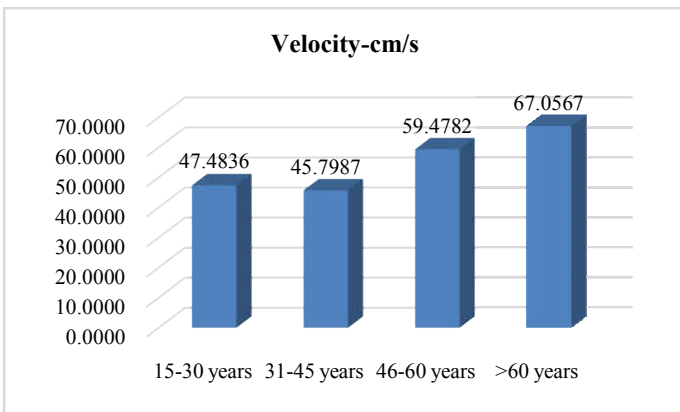
Velocity-cm/s

Comparison of Velocity-cm/s using one way ANOVA test shows that the mean value in >60 years (67.056667) is highest followed by 46-60 years(59.478182),15-30 years(47.4836) and least in 31-45 years(45.798667). This difference is statistically Significant with a test value of 4.563 and p value of 0.005 table 1 and graph 3.



Graph 2 Comparison of PI using one way ANOVA test

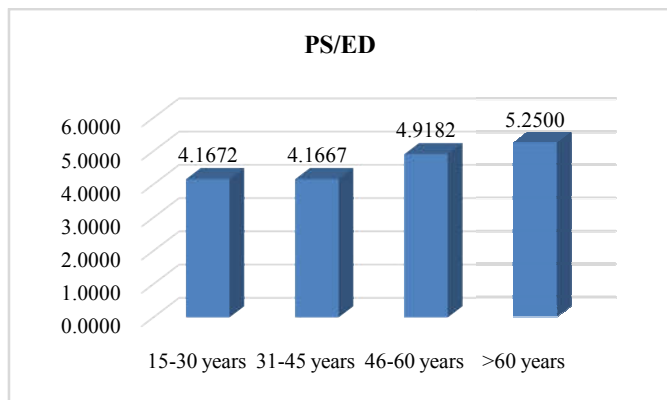
There was significant increase in Velocity-cm with increase in age.



Graph 3 Comparison of Velocity-cm/s using one way ANOVA test

PS/ED

Comparison of PS/ED using one way ANOVA test shows that the mean value in>60 years (5.25) is highest followed by 46-60 years(4.918182),15-30 years(4.1672) and least in 31-45 years(4.166667). This difference is statistically Significant with a test value of 5.647 and p value of 0.001 table 1 and graph 4. There was significant increase in Velocity-cm with increase in age.



Graph 4 Comparison of PS/ED using one way ANOVA test

DISCUSSION

Initial diagnosis of significant visceral artery stenosis can be made using a duplex ultrasound scan.⁵ Many studies have been conducted comparing superior mesenteric artery blood flow variations during fasting and postprandial periods; we could

also find studies comparing blood flow of SMA in inflammatory bowel disease. We could not find any study which analyzed variations in SMA blood flow in different age groups. In this study we documented the variations in mesenteric blood flow indices in different adult age groups.

Doppler indices include the systolic/ diastolic ratio, resistive index and pulsatility index, these compare blood flow in systole and diastole, show resistance to blood flow in peripheral vascular bed and help determine the perfusion. With Doppler ultrasound it is possible to identify the vessel and direction of blood flow. Changes in the spectral wave form measured by indices comparing flow in systole and diastole indicate the resistance of the whole vascular bed supplied by the vessel and changes resulting due to pathologies.

In this study we divided subjects into 4 groups, Group 1 was 15 to 30yr age group, Group 2 was between 31 to 45yrs, Group 3 was between 46 to 60yrs and Group 4 above 60years. We studied resistive index RI, pulsatility index PI, velocity and analyzed PS/ED.

Comparison of RI shows that the mean value in>60 years (0.824167) is highest followed by 46-60 years(0.789091),15-30 years(0.7616) and least in 31-45 years(0.747333). This difference is statistically significant with a test value of 62.023 and p value of 0.006. Comparison of PI shows that the mean value in 46-60 years (2.05) is highest followed by >60 years (2.026667), 15-30 years(1.7976) and least in 31-45 years(1.796667). This difference is statistically Not Significant with a test value of 0.565 and p value of 0.639. Comparison of Velocity-cm/s shows that the mean value in>60 years (67.056667) is highest followed by 46-60 years(59.478182),15-30 years(47.4836) and least in 31-45 years(45.798667). This difference is statistically Significant with a test value of 4.563 and p value of 0.005. Comparison of PS/ED shows that the mean value in>60 years (5.25) is highest followed by 46-60 years(4.918182),15-30 years(4.1672) and least in 31-45 years(4.166667). This difference is statistically Significant with a test value of 5.647 and p value of 0.001. Measured indices indicated that there was significant decrease in superior mesenteric artery blood flow with increase in age probably due to age related atherosclerotic changes in the vessels.

CONCLUSION

We conclude that the age plays an important role in determining the superior mesenteric artery blood flow. Doppler spectrum of the superior mesenteric artery shows detectable changes, there was significant decrease in blood flow characterized by increased vascular resistance with increase in age. This study also provides mean values of doppler indices of SMA in different age groups which can be used as a reference in the evaluation of pathological conditions of bowel.

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