■血液循環の重要性
過去の高齢化社会の中で、成人病を中心とする健康問題が大きく取り上げられるようになり、感染症の死亡が著しく減少した結果、脳卒中・心不全といった成人病が死因の上位を占めるようになっています。これら疾患の発生原因は明確でない面も多く残されていますが、「血液循環」が原因であると深く関連していることが知られております。

血管障害（脳梗塞等）や心疾患（狭心症・心筋梗塞等）は突然発症する病気と考えられてきましたが、実際には様々な期間にわたって体の中で機能変化が進み、器質的変化に移行した段階で発症する病気であることなどが解ってきています。

医学の進歩により、その原因となる動脈硬化病の状態が明らかとなっている細胞の異常増殖で、動脈壁の平滑筋細胞の増殖によってはしまることが明らかになっており、平滑筋細胞は酸素供給の不十分な状態が続くことにより増殖をはじめることで、酸素の供給は血液によって行われることから、血液循環の不十分な状態を続けないことにより、これらの病気は予防でできないことが明らかになっています。

血液循環が不十分になると、赤血球を増加させ、血圧を抑えるべく酸素供給を確保しようとする状況から、血圧検査が行われております。しかし、血圧を抑えることが血流の供給が確保されているか否かは血圧の値から知ることはできません。

血液循環の中で最も重要なのは心臓ですから一般的に心臓だけの血液の循環が行われているように覚えることが多いです。左心室から拍出された血液は、全体に血液を巡り出していますが、体の中で最も大きな組織は筋肉であり、多量の血液は筋肉内に供給されます。血液を受け入れるのは毛細血管であり、その断面積は大動脈の断面積に比べ非常に小さくなっていますが、毛細血管では血圧が極めて低くなっていますので、血液を静脈を介して体の右に戻すことは容易ではありません。ところが、筋肉は血圧を下げる事ができ、血流を和らげたことで血液を受け入れ、収縮して血栓を内皮に押し出し、心臓と同じようにポンプとして働く動きをしています。

肺の心臓と同じように呼出によって肺動脈圧が低下して、肺が左心室から血液を吸いあげて、肺の毛細血管は血液で満たされ、吸気による肺動脈圧の低下と肺毛細血管の引がる一端の圧によって、その血液を左心室に向け押し出すというポンプとして機能しています。しかし、心臓の5〜4拍動に対して1回の呼吸で対応して、うまく血液循環のバランスを維持する助けとなっています。

このような態の運動や呼吸が血液循環に大きな比重を占めています。しかし、これら末梢の血液循環の状態を簡便に測定し、評価できる指標がありませんでした。そこで、末梢血液循環の状態の指標として有効である加速脈波を注目しました。当該病院はその指標をまとめております。

■Importance of Blood Circulation
Adult diseases and other health-related problems are becoming increasingly common subjects of discourse in the aging society of today. In particular, adult diseases have become the most common causes of death as a result of a remarkable decrease in the rate of mortality from infectious diseases. Impaired "blood circulation" is known to be a factor deeply involved in the etiologies of these adult diseases. Cerebrovascular disorders and ischemic heart diseases have been found to manifest themselves when many years of functional changes in the body proceed to the stage of organic changes. Advances in medical science have demonstrated that a causative factor for these diseases, i.e., pulpary sclerosis of arterial walls begins with the growth of arterial smooth muscle cells, which will begin to multiply under hypoxic conditions due to an insufficient supply of oxygen.

This suggests that these diseases may be prevented by keeping people from falling in the state of insufficient blood circulation. With aggravating blood circulation, the body will try to maintain oxygen supply by increasing the erythrocyte content of blood or by raising blood pressure.

For this reason, blood pressure is often employed as an indicator of circulatory insufficiency. Elevated levels of blood pressure, however, do not necessarily imply a sufficient supply of oxygen. Blood is ejected from the left ventricle and delivered to every part of the bodiespecially, into muscles, which are the largest tissue in the body. In the muscle, blood enters the capillary vessels. Since the combined cross-sectional area of all the capillaries is 800 times greater than that of the aorta, blood pressure becomes very low in the capillaries. So, it is not an easy task to return capillary blood back to the less powerful right ventricle via veins. On the other hand, the muscles draw in blood when they relax and soften, and push it out into the veins when they contract and harden. Thus, the muscles function as a kind of blood pump, similar to the heart.

Like the muscles, the lungs also act as pump. Blood is drawn in from the less powerful right ventricle and fills the pulmonary capillaries as the expiratory movement reduces the intrathoracic pressure; and then the blood is pushed out toward the left ventricle as inspirated air increases intrathoracic pressure and stretches the capillaries. Furthermore, respiratory movements are well coordinated with the heartbeats and will help maintain the balance of blood circulation.

As mentioned above, the muscular and respiratory movements play a significant role in the blood circulation.
■加速度脈波の意義
血流の循環状態を評価する手段としては図1に示す脈波流動状態の観察をすることが重要であり，
このような脈波状態の変化を観察することで脈波の脈波流動状態を観察すること
血液循環状態を診断することを目指すためです。

■加速度脈波の原理
加速度脈波の原理による血液循環機能の評価は
図2に示す方法で行います。

図2加速度脈波の原理（2）

■波形による血液循環の評価
図2上記に示された脈波流動パターンによる血液循環
状態の評価方法です。

■Significance of Acceleration Pulse Waveform
Monitoring the status of peripheral circulation, as Fig. 1, provides an important means of evaluating the status of blood circulation. For this reason, investigations were made into fingerphotography pulsecolorimetry which monitors variations in the amount of blood in the dermal capillary network. When these original waveforms are quadratically differentiated, we can extract different effective information components known as "acceleration pulse waveform", which is a good index of vascular circulation.

By analyzing acceleration pulse waveforms, we may predict cardiovascular diseases before the actual symptoms appear, etc. at the stage of the functional changes before the organic changes occur. Further, the waveform is effective in evaluating the effect of physical exercise on the status of blood circulation.

Thus, the acceleration pulse waveform provides valuable means of predicting and preventing adult diseases, as it is an accurate

■Evaluation of the Blood Circulation Status
The waveform patterns correspond to the following circulatory status.

A Usualy seen in healthy young people and suggests the state of blood circulation is good.
B Appears when the state of blood circulation is rather bad. These patterns also appear in those who suffered or are suffering from adult diseases.
C Indicates that blood circulation is insufficient. Caution should be exercised when this pattern is seen in 30s.
D, E, and F: Suggest the state of blood circulation is critical. Further, changes in the diameter of the veins differ greatly between these two groups.

■Significance of Acceleration Pulse Waveform
Indices which are extracted from acceleration pulse waveform provide valuable information concerning the status of peripheral circulation. These indices show the ratio of the height of point b to point c, and their pattern changes with the height of point b. Also, points a and b, and c are higher in the case of healthy young people, point d is placed at the lowest position, point e becomes higher over the baseline, and point f hardly falls below the baseline. It means that the state of blood circulation is good. On the other hand, in old people, point t falls below small blood pressure lower than point b, and point e is significantly low. It means that the state of blood circulation is not as good as those with pattern A or C. Further, changes in the diameter of the veins are significant, and these findings may be interpreted as follows: the larger vein diameters are caused by higher

pressures secondary to increased blood content of the veins. Similarly, the larger artery diameters indicate impaired flow of arterial blood into the veins. However, the vein narrows when physical exercise improves venous return, as exemplified by the movement of the acceleration pulse waveform pattern from E to B, since improved venous return causes a decrease in the pressure of the veins and in venous pressures. The above observations suggest that the acceleration pulse waveform pattern depends on the amount of blood in the veins and favorable changes may possibly proceed to cerebral hemorrhagic conditions on the basis of the above findings.
### Properties in waveform distribution

* Changes in waveform distribution with age (Fig. 5)
  It has been found that a larger number of old people begin to show patterns D, E, F, and G as their ages increase. This means that changes in the patterns of blood circulation with age are reflected in the acceleration pulse waveform.

* Comparison of blood pressure levels with the acceleration pulse waveform patterns (Fig. 6)
  It has been found that people show waveform patterns A, B, C, and D-G, no matter whether their blood pressures are normal, borderline or hypertensive. Patterns D-G are frequently seen in hypertensive people, but there are many other cases in which normotensive people have patterns D-G. Consequently, an unfavorable state of blood circulation does not always lead to a rise in blood pressure.

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