慢性透析患者のCardio Ankle Vascular Index、Ankle Brachial Index及びToe Brachial Indexの経年変化に関する検討

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Secular changes of Cardio Ankle Vascular Index, Ankle Brachial Index and Toe Brachial Index in the chronic hemodialysis patients

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<結言>

透析患者は一般住民と比べて、動脈硬化に関連する心・脳血管障害で死亡するリスクが著しく高く[1)2)3)]、2015年末の日本透析医学会の集計[4)]では、慢性透析患者の死亡原因に占める心血管疾患の割合は36.8%（心不全26.0%、脳血管障害6.6%、心筋梗塞4.3%）であった。この原因の一つに、慢性腎不全患者は、透析導入前にすでに動脈硬化が進行している例が多いことが考えられており[5)6)]、また、末梢動脈疾患（Peripheral Arterial Disease: PAD）の罹患率が高いことも知られている[7)]。当クリニックでも、2005年３月からCardio Ankle Vascular Index（CAVI）とAnkle Brachial Index（ABI）の測定、2011年９月からはToe Brachial Index（TBI）の測定を開始し、透析患者の動脈硬化に関して報告してきた[8)9)10)]。

今回、私たちは、血液透析患者のCAVI、ABI及びTBIの測定データをもとに、それらの経年変化について検討を行ったので報告する。

<対象と方法>

当クリニックで外来血液透析を行った維持透析患者で、CAVI、ABI及びTBIの検査を行ったことのある117例、234肢を対象にした。

初回検査時の年齢は65.1±11.0（mean±S.D.）（40～91）歳。男性68例、64.6±11.6（40～91）歳。女性49例、65.8±10.2（43～86）歳。透析歴は642.3±1,120.9（０～6,174）日。原疾患は、糖尿病性腎症58例、慢性糸球体腎炎37例、嚢胞腎７例、腎硬化症５例、その他10例であった。

若くして
低値で発症した
人々の中に

LDSに起因する
腎動脈の解離で
腎不全に至る人
がいるのでは？

CAVI、ABI及びTBIの測定には、VaSera VS1000及びVS2000（フクダ電子社製）を使用し、血液透析開始前に測定した。

検討内容は⑴ 2005年３月～2016年８月までの間に測定した、CAVI、ABI及びTBIの初回検査結果と、性別、年齢、原疾患、透析開始から検査までの期間などとの関係、⑵ CAVIとABIは７年間、TBIは５年間の経年変化、⑶ 透析導入時期（導入から３ヶ月以内）に検査を行い、４年間以上定期的に検査を行った患者のCAVI及びABIの経年変化と、２年以上定期的に検査を行った患者のTBIの経年変化である。

CAVIの正常値は＜8.0、ABIの正常値は1.00～1.29、TBIの正常値は≧0.7と考えられている。検定はPaired t-test、Unpaired t-test、Mann-Whitney U-test、Correlation、Spearman's correlation及びone or two factor repeated measures ANOVAで行い、$p<0.05$を有意差あり、$p<0.1$を有意傾向ありと判定した。

<結果>

⑴ 血液透析患者117例、234肢の初回検査時のCAVI、ABI及びTBI

性別による検討では、CAVIは男性9.22±2.09（136肢）、女性9.31±2.21（98肢）、ABIは男性1.037±0.189（135肢）、女性1.025±0.152（98肢）、TBIは男性0.769±0.189（43肢）、女性0.807±0.190（23肢）で、男女間に差はなかった。また、ABIが0.90以下ではCAVIが正しく測定できないため、ABI 0.90以下の45肢（＜0.9は43肢）を除外した189肢でCAVIを集計したが、男性9.47±1.69（109肢）、女性9.42±2.08（80肢）で、男女間に差はなかった。

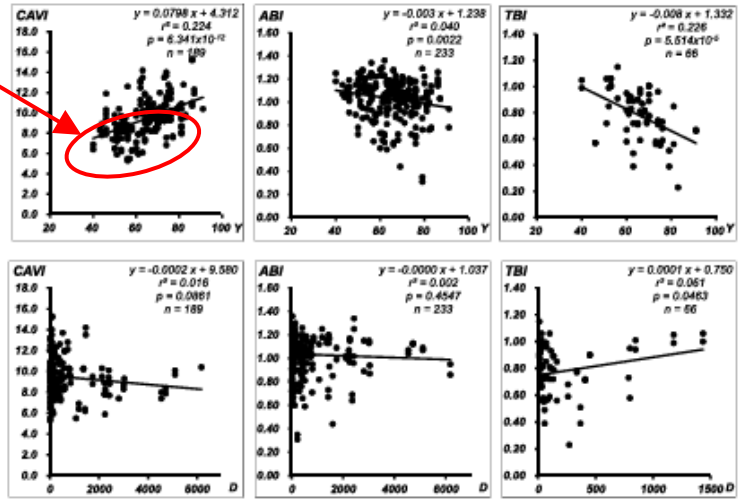

図１　血液透析患者のCAVI、ABI及びTBIと年齢及び透析期間との関係
上段は年齢との相関関係で横軸の単位Ｙは歳、下段は透析期間との関係で横軸の単位Ｄは日数を表す。

Unreliable Estimation of Aortic Pulse Wave Velocity Provided by the Mobil-O-Graph Algorithm-Based System in Marfan Syndrome

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Background—Several devices have been proposed to assess arterial stiffness in clinical daily use over the past few years, by estimating aortic pulse wave velocity (PWV) from a single measurement of brachial oscillometric blood pressure, using patented algorithms. It is uncertain if these systems are able to provide additional elements, beyond the contribution carried by age and blood pressure levels, in the definition of early vascular damage expressed by the stiffening of the arterial wall.

Methods and Results—The aim of our study was to compare the estimated algorithm-based PWV values, provided by the Mobil-O-Graph system, with the standard noninvasive assessment of aortic PWV in patients with Marfan syndrome (ie, in subjects characterized by premature aortic stiffening and low blood pressure values). Aortic stiffness was simultaneously evaluated by carotid-femoral PWV with a validated arterial tonometer and estimated with an arm cuff–based ambulatory blood pressure monitoring Mobil-O-Graph device on 103 patients with Marfan syndrome (50 men; mean±SD age, 38±15 years). Aortic PWV, estimated by the Mobil-O-Graph, was significantly ($P<0.0001$) lower (mean±SD, 6.1±1.3 m/s) than carotid-femoral PWV provided by arterial tonometry (mean±SD, 8.8±3.1 m/s). The average of differences between PWV values provided by the 2 methods (±1.96×SD) was −2.7±5.7 m/s.

Conclusions—The Mobil-O-Graph provides PWV values related to an ideal subject for a given age and blood pressure, but it is not able to evaluate early vascular aging expressed by high PWV in the individual patient. This is well shown in patients with Marfan syndrome. (***J Am Heart Assoc*. 2019;8:e011440. DOI: 10.1161/JAHA.118.011440.)**

Key Words: arterial stiffness • early vascular aging • Marfan syndrome • Mobil-O-Graph • pulse wave velocity

The evaluation of aortic pulse wave velocity (PWV) is a well-established method for assessing aortic stiffness, which represents a predictor of cardiovascular mortality and morbidity, independently of the main known risk factors for cardiovascular disease.[1] Currently, carotid-femoral PWV (cf-PWV) is widely accepted as a direct measurement of aortic stiffness and is recommended for this purpose.[2]

In recent years, other ways of estimating PWV have been proposed, to overcome the limitation of cf-PWV, which requires carefully trained personnel. Assessment of aortic PWV was from a single measurement of oscillometric blood pressure (BP), using patented algorithms considering BP signal has been implemented in some devices. Moreover, the estimation of aortic PWV, calculated by an equation derived from the relationship of age and mean BP (ePWV), has demonstrated a predictive value in healthy subjects beyond traditional risk scores; thus, some might wonder about whether measuring cf-PWV by tonometry should remain the recommended approach.[3]

The aim of our study was to compare the estimated algorithm-based PWV, provided by the Mobil-O-Graph system, with the standard noninvasive measurement of cf-PWV in Marfan syndrome (MFS) by tonometry. MFS is an autosomal dominant genetic disorder characterized by arterial stiffening attributable to altered synthesis of fibrillin-1 protein. This protein plays an important role in connective and elastic

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マルファンは蛇行湾曲しない
ロイス・ディーツとの相違点

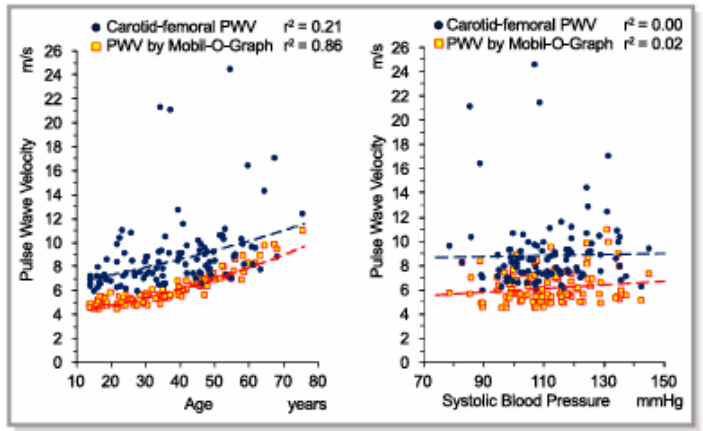

Figure 3. Distribution of aortic pulse wave velocity (PWV) values related to age (left panels) and systolic blood pressure (right panels) in different methodological approaches. Blue dots represent carotid-femoral PWV values measured by PulsePen tonometer. Yellow squares with red border represent aortic PWV values estimated by the Mobil-O-Graph. Dashed lines show the relationship between age and PWV (exponential regression analysis) and between systolic blood pressure and PWV (linear regression analysis).

estimated by Mobil-O-Graph of 98% (Figure 5), according to the formula:

$$\text{PWV by Mobil-O-Graph}^{®} = \text{age}^2/1000 + 0.038 \times \text{systolic BP}$$

Discussion

Currently, the Mobil-O-Graph is considered an attractive approach to estimate aortic PWV, performing easy and operator-independent measurements. The ARCSolver algorithm inbuilt in the Mobil-O-Graph was developed from invasive aortic PWV recordings in a large population of patients undergoing cardiac catheterization. According to the statements by the developers of the system, the ARCSolver algorithm estimates aortic PWV with a regression based on pulse waveform characteristics, age, and systolic BP.[18,19] Validation studies showed a good agreement between PWV provided by Mobil-O-Graph and aortic PWV invasively assessed.[18,19] Our study was designed to check if an algorithm essentially based on age and BP, which gives a reliable estimate of aortic PWV in the general population, is also able to identify conditions of early vascular aging.

A population of patients with a diagnosis of MFS was involved in our study. MFS is characterized by abnormal fibrillin-1 synthesis, which causes degradation of the elastin fibers in the arterial wall,[4] higher interfibrillar spaces, and decreased elastin fiber concentration.[24,25] The result of this process is increased aortic stiffness.[4,9,10,26]

The histological characteristics and the alterations in viscoelastic properties of the large arteries observed in young patients with MFS are similar to the alterations usually found in elderly individuals,[4] thus delineating in all respects a condition of early vascular aging. The main purpose of our study is, therefore, not only to study whether the Mobil-O-Graph is able to evaluate vascular damage in patients with MFS, but rather to verify if the Mobil-O-Graph is able to identify a condition of early vascular aging.

In recent studies,[9,10] our research group provided clear evidence that aortic stiffness evaluated as cf-PWV is significantly increased in patients with MFS, suggesting accelerated arterial aging.[4,27] cf-PWV emerged as an independent predictor of aortic diameter at the sinuses of Valsalva and at the sinotubular junction, which are considered at present the most reliable markers of risk of aortic dissection in MFS.[28] Other rigorous studies, conducted with arterial tonometry,[29] echocardiography,[30,31] or magnetic resonance imaging,[7,8,26,32] highlighted that the evaluation of aortic viscoelastic properties, and particularly of aortic PWV, could have a relevant clinical role in the estimation of aortic dissection risk in MFS.

The cohort enrolled in this study included several young adults (52% aged 18–45 years), with BP values, on average, lower compared with the general population values. The