Original Article

Different Patterns for the 6-minute Walk Test as a Test to Measure Exercise Ability in Elderly with and without Clinically Evident Cardiopathy

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Objectives

Evaluate the correlation between peak oxygen consumption (VO_{2peak}), from cardiopulmonary test with the distance covered in the six-minute walk test (6MWT) in healthy elderly and with myocardial infarction (MI).

Methods

Thirty individuals were studied, with age range 65 – 87 years (76, 03± 4,75), divided into 2 groups: Group I – 14 with clinically evident coronary heart disease (CHD) and Group II – 16 without clinically evident CHD. They were submitted to cardiopulmonary test (CPT) and 2 types of 6MWT, standard test 6MWTs. Variables measure at rest and exertion were heart rate (HR) and respiratory rate (RR), blood pressure (BP), distance covered (DC), and Borg's rate subjective perceived exertion (RPE).

Results

The study showed significant, strong correlation between distances covered for both 6MWT, and (VO_{2peak}) obtained from cardiopulmonary test (CPT) for all elderly included in the study. When comparing the 6MWT with physiotherapist support (6MWTphy) and without support (6MWTw), statistically significant difference was observed, with higher average values of the DC, of the RH and RR and Borg's RPE in the 6MWTphy, both of the groups. Addtionally, the RH reached at final the exertion in 6MWTphy was similar to that obtained in CPT ($p<0,05$) suggesting that the 6MWT stimulates higher cardiovascular performance.

Conclusion

6MWTw, adopted a worldwide, by being submaximal imposes lower cardiovascular overburden as compared to 6MWTphy and is probably safer for elderly who are cardiopaths.

Key words

Elderly, walk test, cardiopulmonary test.

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Functional ability analysis through cardiopulmonary test (CPT) is widely used for prognostic and therapeutic evaluation of patients with congestive heart failure (CHF) [1-6]. However, its applicability poses restriction to elderly without and with cardiopathy, due to high cost, associated to ageing process inherent limitations[7,8].

The 6-minute walk test (6MWT) is a low cost, better tolerated choice option, in addition to allowing patients to determine the speed and the need for pauses, which stands as an additonal advantage for the elderly[9,8,10-12].

The submaximal[13,11] 6MWT is the renowned worldwide; however, there is a linear correlation between total distance covered and peak oxygen consumption (VO_{2peak}) obtained through cardiopulmonary test[14,15,9].

Most protocols use verbal stimulus, when significant increase of distance covered[12] can be observed.

Other authors, however, have shown that the pattern using 6MWT with support by examiner side by side with patient, giving pace to their walk in addition to verbal stimulus, improves test performance, which is shown by the distance covered when compared to 6MWT with no physiotherapist in normal individuals and in patients with chronic obstructive pulmonary disease.[16]

The primary objective in the present study was to evaluate the correlation between peak oxygen consumption obtained from cardiopulmonary test, and the distance covered in the 6-minute walk test in healthy elderly with myocardial infarction (MI). Secondly, compare walk test performance with and without monitoring.

Methods

This is a cross-sectional, observational study, to investigate 98 individuals who are 65 years old or older: 72 were post myocardial infarction patients, and 26 were elderly patients with no clinically evident cardiopathy. From those, sixty-eight (68) patients were not eligible, due to orthopedic pathologies and/or balance disorders (n = 55), or chronic pulmonary obstructive disease (COPD) (n = 13). Thirty (30) individuals who fulfilled inclusion criteria were selected consecutively. Patients' age ranged from 65 to 87 years of age, with mean at 76.03 ± 4.75. From the total, 18 elderly (60%) were females, and 12 (40%), males. The elderly were prospectively divided into 2 groups: Group I – made up of 14 elderly patients (8 females and 6 males), with confirmed myocardial infarction, on β-blockers, clinically stable, which means to say, with no signs or symptoms of heart failure or unstable angina, with mean age 76.4 ± 5.07 years (age range 65-85 years old), from the Cardiogeriatrics Outpatient Unit, Department of Cardiology, at the São Paulo Federal University (UNIFESP); and Group II – made up of 16 elderly patients (10 females and 6 males), with mean age 75.6 ± 4.58 years (age range 66-87 years old),with no clinically evident CHD at clinical exam, and electrocardiogram at baseline and on exertion, screened from the EPIDOSO Study (Epidemiology of the Elderly – Epidemiologia do Idoso), a longitudinal study, with a population of elderly patients (age ≥ 65), all São Paulo residents, after a regional census study carried out by the Ageing Study Center (Centro de Estudos do Envelhecimento) at the same institution. The study was approved by the Ethics Committee at the University hospital it was carried out. All participants signed the informed consent. Patients were examined and screened by a physician at the Cardiogeriatrics Service. Clinical examination included a detailed questionnaire of diagnoses, risk factors and conditions associated, medications being used, clinical exam and ECG. The groups showed to be homogeneous in regard to clinical and demographical characteristics (Table 1). The characteristics shown by the group of infarcted patients on β-blockers can be found in Table 2.

Table 1 – Clinical and demographic group data: age, gender, risk factors and number of risk factors

Variables	Total	Group 1	Group 2	p
	n = 30	n = 14	n = 16	
Age (mean)				
	76.03 ± 4.75	75.6 ± 4.58	76.4 ± 5.07	0.680
Gender (n, %)				
Male	12 (40%)	06 (42.86%)	06 (37.5%)	0.765
Females	18 (60%)	08 (57.14%)	10 (62.5%)	
Risk factors (n, %)				
Hypertension	14 (46.6%)	10 (71.43%)	04 (25.0%)	0.014
Diabetes Mellitus	04 (13.3%)	03 (21.42%)	01 (6.25%)	0.249
Dyslipidemia	23 (76.6%)	10 (71.43%)	13 (81.25%)	0.574
Currently smoking	02 (6.60%)	01 (7.14%)	01 (6.25%)	0.724
Sedentariness	11 (36.67%)	05 (35.71%)	06 (37.5%)	0.919
BMI > 27 (kg/m^2)	12 (40.00%)	06 (42.86%)	06 (37.5%)	0.765

Table 2 – Group data on infarcted patients on β-blockers (Group I): coronary angiography, ejection fraction, type of infarction, injured wall, and infarction time.

Coronary Angiography				
CAD*	**N**	**%**		
One artery	04	33.3		
2 Arteries	05	41.73		
3 arteries	02	16.7		
Lesion no obstrutive (<50%)	01	8.3		
Total	12	100.00		
Ejection Fraction (Echocardiogram)	**N**	**%**	**mrsn/dp**	
≤ 40%	01	9.09	0.35	(0.35)
> 40%	10	90.91	0.66 ± 0.09	(0.48 – 0.81)
Total	11	78.57	0.63 ± 0.13	(0.35 – 0.81)
Type of infarction	**N**	**%**		
With supraunlevelling of ST	13	92.86		
Without supraunlevelling of ST	01	7.14		
Injured wall				
Lower Wall	10	71.43		
Anterior Wall	04	28.57		

Tests were carried out in a climatized laboratory, with temperature ranging from18° to 22 °C, and humidity between 40 and 60%, in compliance with II Guidelines on ergonometric test by the Brazilian Society of Cardiology (2002)[17] and the National Ergonometry Consensus (1995)[18].

In both groups, the protocol by Weber and collaborators[19] was applied on the ergometric treadmill (Precor C964i-USA). Twelve-lead electrocardiographic records (ECG) were taken at rest and in supine position, and in modified 3-lead ECG positions - CM5, VF and V2 – as well as in orthostic position. During the test, through the use of computerized Ergo-S, Dixtal-Brasil and automatic recording of HR and ECG line at the end of each stage every 2 minutes during the course of test up to exhaustion, ending with recording every minute in the three recovery phases was carried out. In combination, peak oxygen consumption was obtained by a low pressure valve (Hans Rudolf-USA), connected to oxygen (O_2) and carbonic gas (CO_2) analyzers - Ametek-USA, O_2 Analyser S- 3A/L and CO2 Analyser CD- 3[A], interconnected to the Vacumed-Vista Turbofit system - Version 320-USA, with acquisitions every 30 seconds from resting position.

The 6-minute walk test (6MWT) was carried out on flat floor, being 25 meters on straight line, and always applied by the same examiner two or three days following cardiopulmonary test.

After being acquainted with the test, patients were submitted to two standard techniques. The first one applied the 6MWT according to the *American Association of Cardiovascular* & *Pulmonar Rehabilitation* (ACVPR)[20], and the *Guidelines for Six-Minute Walk Test* (6MWT) by the ATS[21], with verbal stimulation every 30 seconds. The second standard technique conducted the 6MWT with monitoring, as described by Cavalheiro et al[16], when the examiner would walk along, lead the pace and verbally stimulate patients every minute with incentive tag lines ("you're doing great", "walk as fast as you can").

Heart rate and respiratory rate, blood pressure and Borg's[22] PRE were recorded at rest and at the end of each test through a frequency meter - Polar® Eletro or Fitwatch/Finland; and a sphygmomanometer - B-D® Germany, as well as distance covered (in meters). Every test was repeated twice, with 30-minute intervals between the first test and first repetition (Opasich and collaborators)[23]. The second test was always the one to be recorded. Tests were carried out 60 minutes apart, or until physiological variables returned to baseline.

Statistical software for all the analyses was *Statistical Package for Social Sciences* (S.P.S.S.). Through that software, chi-square tests and Fisher exact test were applied for the purpose of comparison of nominal variables. For continuous data, non-paired Student t test was applied.

Variance analysis (ANOVA) was also applied with repeat measures to investigate statistically significant differences between the types of exercise used in the study. Bonferroni procedures was used for the cases where the ANOVA result pointed out some statitically significant difference.

Results

Results from the cardiopulmonary test did not show statistically significant difference between the groups as far as VO_{2peak} or anaerobic threshold. The only difference shown referred to heart rate and double product at rest, and exercise peak, secondary to the use of β-blocker in patients with previous myocardial infarction (Table 3).

Neither the 6-minute wallk tests with physiotherapist support (6MWTphy) nor without support (6MWTw) showed statistically significant difference in the groups under study based on mean values of distance covered [respectively, mean distance 532.03 ± 62 m / 483.9 ± 96.65 m; (p = 0.126), D= 467.19 ± 60 / 413.57 ± 84; (p= 0.07)]. Difference was shown only in regard to heart rate and double product at rest at exercise peak, secondaty to the use of β-blocker in patients with previous myocardial infarction (p<0.001; Table 4).

In normal elderly patients, Pearson correlation coefficient between VO_{2peak}, obtained from CPT, and the distance covered in the 6MWT was shown to be strongly correlated, both for the test with monitoring (r = 0.791; p = 0.002), and in the test without monitoring (r = 0.801, p = 0.002) (Figures 1 and 2).

Table 3 – Cardiopulmonary test related to oxygen consumption, anaerobic threshold, heart rate and double product at rest and at peak effort

	Group 1 n= 14	Group 2 n = 16	P
VO_{2peak} ml/kg/min)	19.94 ± 5.45	21.18 ± 3.51	0.4745
$VO2_{peak}$ ml/kg/min)	14.32 ± 3.07	15.67 ± 2.47	0.284
HR at rest (beats/min)	57.5 ± 5.76	71 ± 8.65	<0.001
HR_{peak} (beats/min)	104.71 ± 17.64	143.6 ± 12.8	<0.001
DP at rest(mmHg x bpm)	7430 ± 1240	8928.12 ± 1668	0.009
DP_{peak} (mmHg x bpm)	17537.14± 4988	25202.69± 3775	<0.001

Table 4 – Distance covered, heart rate (HR), sytolic and diastolic blood pressure, respiratory rate (RR) (at rest and peak effort) and perceived exertion scale described by Borg (PES) in normal elderly with previous myocardial infarction, based on walk tests with and without support

	Group 1 n = 14		Group 2 n = 16	
	TC6ac	TC6s	TC6ac	TC6s
Distance (m)	483.9±96.65	413.57±84.36*	532.03±62	467.19±60*
HR at rest (bpm)	60±6.9	59±5.3	72.69±9.9	72.5±9.8
HR_{peak} (bpm)	98.92±12.9	90.79±11.9*	124.06±10	112.19±10.5*
SBP at rest (mmHg)	133.57±11.5	132.86±9.5	123.75±13	121.88±11.6
DBP at rest (mmHg)	81.43±9.49	80.71±9.8	78.75±7.2	79.38±7.7
SBP_{peak} (mmHg)	163.57±12.15	157.14±11.38	166.25±12.04	154.38±10.3
DBP_{peak} (mmHg)	91.42±11.67	87.86±8.01	83.13±7.93	81.88±6.55
RR(rpm)	32.57±3.08	27.7±3.31*	29.5±2.47	27.7±1.36*
PEf	13.93±1.2	11.79±1.05*	13.38±0.71	11.63±0.8*

(0.05 between 6MWTphy x 6mWTw). PEf (Borg perceived exertion scale))*

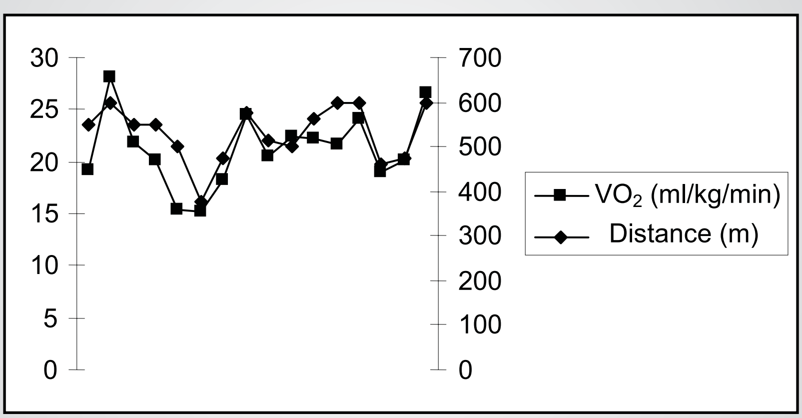

***Figure 1** – Dispersion diagram correlating oxygen consumption obtained from CPT and distance covered in the 6MWT with monitoring in "normal" elderly patients (r = 0.791; p = 0.002)*

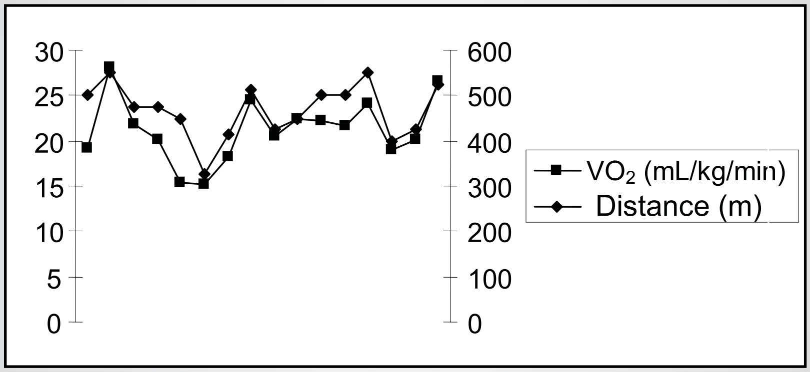

Figure 2 *– Dispersion diagram correlating oxygen consumption obtained from CPT and distance covered in the 6MWT without monitoring in "normal" elderly patients (r = 0.791; p = 0.002)*

Results obtained from infarcted elderly patients on β-blockers by applying Peasron correlation coefficient from CPT, and the distance covered in the 6MWT, were shown to be strongly correlated, both for the test with monitoring ($r = 0.768$; $p < 0.01$), and the test without monitoring ($r = 0.766$, $p < 0.01$) (Figures 3 and 4).

When comparing the 6-minute walk tests with physiotherapist support (6MWTphy) and verbal stimulation along with patient, and without support (6MWTw), and the test with verbal stimulation only (6MWTw) statistically significant difference was osbserved, with higher mean values of distance covered, of HR and RR, and of RPE in the 6MWT with physiotherapist support, both for patients reporting previous MI and for the elderly without clinically evident CHD. The 6MWTphy increased average distance covered by 70.33m, approximately 15% for patients with previous MI as compared to 6MWTw. In "normal" elderly patients, 6MWTphy improved performance of 6MTWphy by increasing average distance covered by 64.84 m, which means to say, approximately 12% (Table 4) (Figure 5).

Discussion

The search for alternative means to measure exercise capabilities has the major purpose of cutting costs and making easier use of those tools in extensive studies. Therefore, Guidelines recommendations for the ATS[21] 6MWT are not designed to limit the use of alternative protocols in scientific studies. There is also the need to search for method adaptation for the different populations to be studied, for objectives to be properly addressed as proposed.

The groups were homogeneous in regard to age and gender in the present study. Females predominated in both groups (60% in average), similarly to data made available by literature, showing higher percentage of women in later age groups. [24,25]

Based on CPT data in both groups of patients, the present study also found similar levels of VO_{2peak}, and different HR peak exertion levels. That was due to the fact that infarcted elderly patients (Group 1) reported HR at 57.5 ± 5.76 beats/ minute at rest thanks to prolonged

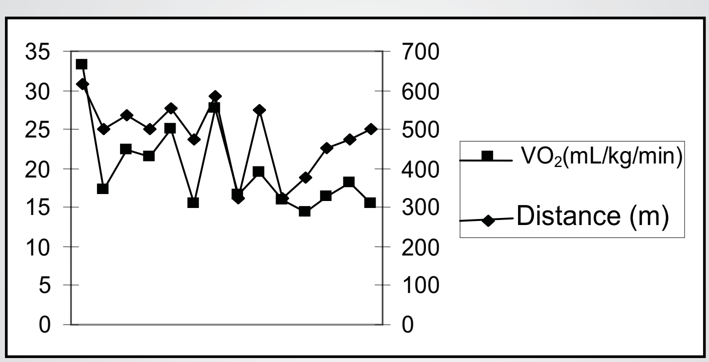

Figure 3 *– Dispersion diagram correlating peak effort oxygen consumption obtained from CPT, and distance covered in the 6MWT with monitoring in infarcted elderly patients (r = 0.768; p<0.01)*

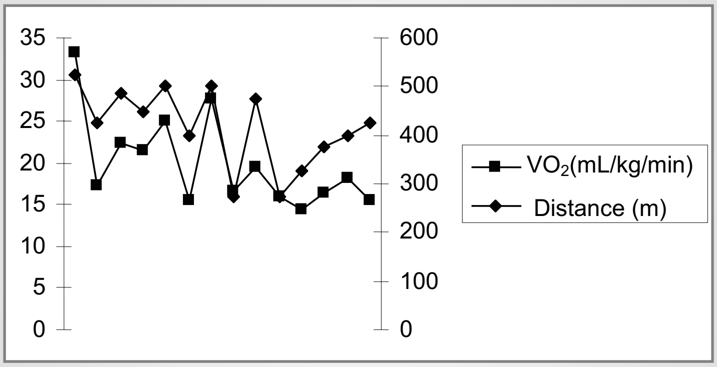

Figure 4 *– Dispersion diagram correlating peak effort oxygen consumption obtained from CPT, and distance covered in the 6MWT without monitoring in infarcted elderly patients (r = 0.766; p<0.01)*

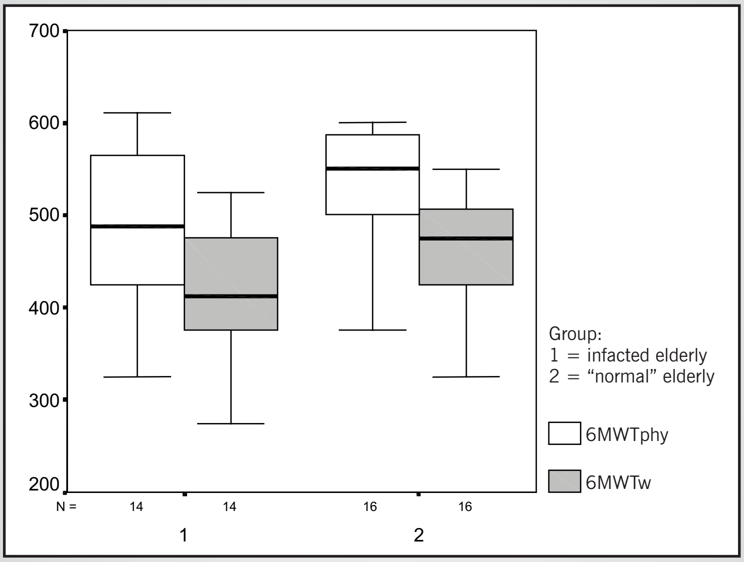

Figure 5 *– Distance covered in the 6MWTphy x 6MWTw in both groups*

use of β-blockers at such doses as to reach HR levels as recommended by the Brazilian and the American Guidelines for the treatment of CHD, thus suggesting that infarcted elderly that are clinically compensated by the use of β-blockers may report VO_{2peak} values close to those of elderly patients without evident cardiopathy. Such result was also observed in the 6-minute walk test, which showed similar physical performance in the two groups under analysis when total distance covered was measured during the test.

The present study showed significant, strong correlation between distances covered for both six-minute walk test standards (6MWT), for VO2peak, obtained from cardiopulmonary test (CPT), and for all elderly individuals included in the study. Reports in the literature have also shown there is moderate to strong linear correlation between the distance covered in 6 minutes and the VO_{2peak} obtained from the CPT in patients with congestive heart failure (CHF).[8,11,13,14,26,,27]

Both 6MWT – with monitoring and without monitoring – were well tolerated by all elderly patients participating in the study, with no need for pauses or interruptions due to symptoms. The cardiopulmonary test was also well tolerated. It was interrupted by two elderly patients with previous MI, since they had presented schemic response only through electrocardiographic changes. Therefore, as electrocardiographic is not part of the 6MWT, recommendations from the Guidelines must be followed in regard to 6MWT indications and contra-indications, as well as interruption factors if symptoms are presented. It should also be carried out in a hospital environment, with the same emergency support as required for CPT. [21]

Although the cardiopulmonary test – whether on the bicycle or on the ergometric treadmill – is the most accurate physical performance evaluation tool, it is not compatible to all elderly individuals. Peeters & Mets have demonstrated that 22% of all elderly patients with congestive heart failure were not able to finish the ergometric test due to treadmill speed and feeling of unstableness. All patients were able to finish the 6MWT, though.

The 6-minute walk test (6MWT) is dependent on motivation, learning, and diligence. Guyatt and collaborators have demonstrated that 6MWT with verbal stimulation is associated to significant increase of distance covered. However, when 6MWT is carried out with the support pattern, not only the stimulus as proposed by Guyatt and collaborators was applied, but the presence of a physiotherapist was included along with patient, to give pace to their walk, in addition to following the protocol by Cavalheiro and collaborators[16], which resulted in longer distance covered, as well as all other variables assessed when compared to the 6MWT with no support.

In the present study, effort level was submaximal in all groups of elderly patients under analysis for the 6MWT with no support, as found in the literature[21,13,11]. However, the 6MWT pattern with monitoring showed that heart rate (HR) reached at final exertion was similar to that obtained in maximum cardiopulmonary test ($p<0.05$), thus suggesting that 6MWT pattern stimulates higher cardiovascular performance.

Results from the present study have also shown that the 6MWT with an examiner monitoring the technique being used led elderly patients with previous myocardial infarction to reach – at test end – heart rate levels (up to 95% of HR from CPT) higher than those reported by elderly patients with no clinically evident cardiopathy (up to 87% of HR from CPT). That may be explained by the fact that in CHD individuals systolic volume is lower than normal, and HR is higher during exercise. That means to say that systolic volume decreases significantly while under exercise requiring over 60 – 70% of VO_{2max}, with the possibility of reaching HR higher than healthy individuals for similar effort level.[28]

Neither of the 6MWT patterns can directly define oxygen consumption or accurately quantify constraint factors on exertion by defining the different pathophysiologic mechanisms of different systems involved. Therefore, both indications and contra-indications, and interruption factors when symptoms are present must be followed as set forth in the Guidelines recommendations in regard to 6MWT. Since 6MWT cannot be risk-free, it is to be carried out in hospital environment with the same emergency support required for CPT.

6MWT patterns are valid and reliable, and accepted worldwide, both for heart condition patients[29] as well as for healthy individuals.[30] However, due to sample size in the present study, the same cannot be said about 6MWT with monitoring. Our results did show, though, that the 6MWT with monitoring would be more useful if compared to 6MWT with no monitoring if the purpose is to evaluate physical capacity, since this method would reflect closest to maximal cardiovascular performance.

Additional studies are necessary to particularly determine the safety of 6MWT with monitoring for the elderly patients with previous myocardial infarction. Since 6MWT - adopted worldwide - is submaximal, it imposes lower cardiovascular overburden as compared to 6MWTphy and is probably safer for elderly who are cardiopaths.

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