THE RESEARCH ON THE RELATIONSHIP BETWEEN THE SENESCENCE AND THE GAIT INDEX OF ELDERLY PEOPLE

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Based on the analysis of one hundred and thirty nine ordinary adults (at the age of 36~75) in normal work, this study reveal the change of gait index in the course of ageing. The ratio of double support phase to a walk cycle of the elderly group is bigger than the middle age group, the hyperextension in hip joint of the elderly group was insufficient and the elevate height of the swing leg was less than the middle people. The vertical force versus time curve indicates the significant difference of two groups.

KEY WORDS: gait, elderly, ageing.

INTRODUCTION: In China, so far the elderly group (≥60 years) represent about one hundred and twenty millions and about 10% of the total Chinese population, it is increasing at the rate of 3.2% every year, the growth speed is faster than that of the average of the world. In Beijing, the elderly group represents about 14.6% of the total Beijing population, especially in culture district like in Hai Dian District, the rate is about 20%. Furthermore, it has been estimated that in the year 2025, more than 30% of the total Beijing population will be age over 60 years old. Health of the elderly group attract our attention, it is a focus in the areas of biomechanics of the world. Tripping has been responsible for about 53% of falls and falls are the leading cause of accidental death for people aged over 75. There are many phenomenon reveal the senescence during walking, such as the decreasing of ligament elasticity, the absence of stability in walk etc. they can show the situation of the integrity body motion, especially for the lower extremity. In recent years, much work has been done on the division of gait cycle, stride speed and joint angle etc. Based on the analysis of this study reveal the change of gait index in the course of ageing and thus treats the gait index as the criteria in judging the physical senescence extent.

METHODS: *Subjects:* one hundred and thirty nine ordinary adults were recruited, twenty eight middle age people (at the age of 35-45, mean age 42.9 ± 5.0 years; sixteen female) and one hundred and eleven elderly people (at the age of 46-75, mean age 61.0 ± 7.9 years; fifty nine female).

Table 1. Subjects distributing.

age	subjects	Male	female
35—45	28	12	16
46—55	25	10	15
56—65	64	30	35
66—75	22	13	9

Instrumentation: A Panasonic 7000M normal speed camera was used to recorded kinematic data when the subjects were walking through the force plate. And simultaneously the kinetic data were measured by a 90 cm×45 cm 3D force plate. The camera was located at 8m from the movement plane. The field of camera view was approximately of 2 m on the horizontal. The proportional scale was placed on one side of the plate form. (Figure-1). All subjects walked at their normal, self-selected, comfortable walking speed with soft sole on a right way. Before testing they were asked to walk pass the force plate two or three times in order to make sure about the exact position where is the center of the force plate. For each subject left and right lower limb data from three trials at normal speed were analyzed. The measuring process is from the contacting on the plate form of left heel, then the right foot, to the left foot departing from the plate form and contacting on the ground.

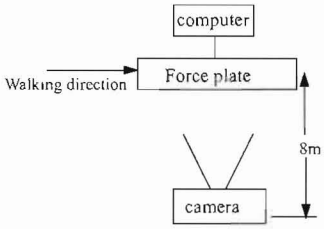

Figure 1. Instrumentation placement

The stride length is the distance between the two heels or toes during walking. One gait cycle is the process from one heel contacting on the ground to it's contacting again. Two different stages were defined in each gait cycle: stand stage and swing stage. And the stand stage includes the single support phase and double support phase. (Figure-2)

Statistical analysis: Statistical analysis was conducted on the average value. The significance of differences in middle group and elderly group was evaluated using Independent – Sample *t*-tests. In Table-3, " * " means the significance of difference was at the 0.05 level.

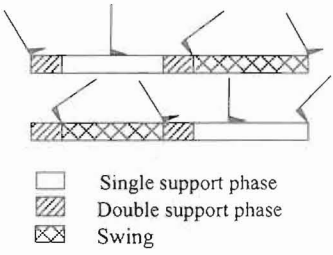

Figure 2. One gait cycle.

RESULTS AND DISCUSSION: The percentage distribution in time of the elderly and the middle age people during one gait cycle was shown in Table 2.

Table 2. The time percentage distribution of stand, swing and double support phase in one gait cycle.

	Standing	Swing	Double support
Middle age group	0.676 ± 0.021	0.334 ± 0.021	0.35 ± 0.041
Elderly group	0.630 ± 0.018	0.370 ± 0.018	0.260 ± 0.036

The time percentage duration of stand of the elderly group (67%) was longer than that of the middle age group (63%). Observed from the sagittal plane during double support phase, the heel firstly contacted the ground and absorbed the vibration while the fore muscles of ankle joint were keeping in temporary dorsiflexion. The comparison in the time percentage distribution of the double support phase indicated the significance difference ($P<0.05$) between the elderly (35%) and the middle age people (26%). This suggests the intension of being more stable was represented in the slow action during walking. The three important indexes, the stride length, stride frequency and stride rate, were shown in Table 3. The significant differences in data of the two groups indicate that the decreasing trend of the stride length, frequency and rate with ageing. During the ageing course, stride length decrease much greater

and produce more significant effect on the stride rate, as compared to the stride frequency. The same trend also exits after eliminating the influence of stature. So it suggests that the stride length and rate indicate not only the motion performance, but also the degeneration of body function by senescence.

Table 3. Difference between two groups in three important indexes.

	Stride length,	Stride length/stature	Stride frequency	Stride rate	stride rate/ stature
The elderly group	0.657 ± 0.098*	0.401 ± 0.055	1.620 ± 0.26*	1.063 ± 0.271*	0.6713 ± 0.1618*
The middle age group	0.856 ± 0.096*	0.496 ± 0.050	1.994 ± 0.183*	1.669 ± 0.174*	0.986 ± 0.1043*

Each hip joint angle curve of both groups has a crest and a valley during swing in one stride (Figure-3).

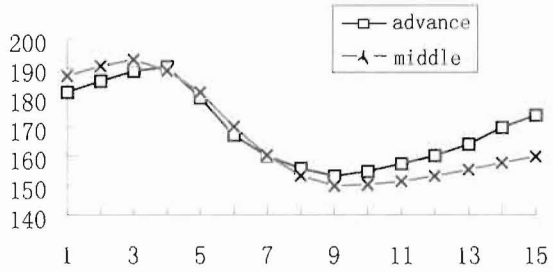

Figure 3. Hip joint angle – time curve

During the first one fifth of time, the human body moves forward gradually and the hip joint change from flexion to hyperextension after the body pass the stand position. The wave crests are the points of maximum hip joint angles, which are separately 190.4° and 192.8° of the elderly and the middle age people. The wave hollows are the points of minimum hip joint angles, which are separately 153.3° and 149.3° of the elderly and the middle age people. The hip joint of the elderly people has less amplitude of variation, as compared with the middle age people. This suggests that the hyperextension in hip joint of the elderly people was insufficient and the elevate height of the swing leg was less. It indicated that the increase in maximum hip extension was small. A force plate measured the kinetic dates of 3D forces in one stride. In this study, the reaction force on the ground inwardly directed perpendicularity indicated the significant difference of two groups. The curves of the elderly group were flatter than those of middle group. The age characteristics were mainly shown at the first and second peak value and the first valley value. So the three values were separately called peak value1st, peak value 2nd, peak value 3rd. The value of peak value 1st is related with the COG (center of gravity) vertical acceleration while the COG get the maximum height. Then the lower extremity flex for buffering the COG acceleration was changed into downward. The peak value 2nd is the valley value of the maximum downward acceleration. During the double support phase, the right heel contact the ground after the left leg extends and COG moves upward. The peak value 3rd is the time when the COG upward acceleration and the support force exerted by the ground reach the maximum. The peak values by body weight were divided and were made into the average across two groups (Table-4) for eliminating the influence of body weight. The data of J1/body weight and J2/body weight indicate the trend of decreasing with the ageing. The data of J1/G-J2/G, J2/G-J3/G and J3/G-J1/G indicate all the difference of peak decrease with the ageing. Another index to show the senescence in the curves is the time interval between the first peak value and the first valley value(ΔT). The data of the two groups indicate that buffering duration decrease with the ageing. The elderly people do not make a sufficient

buffering action by being anxious to put the swing leg down for more stable, as compared with middle age people.

Table 4. Difference between two groups in force parameters.

	Age	**J1/G**	**J2/G**	**J3/G**	**J1/G-J2/G**	**J3/G-J2/G**	**J3/G-J1/G**	**ΔT**
Middle age group	42.9 ± 5.02	0.865 ± 0.055	0.802 ± 0.047	1.049 ± 0.077	0.062 ± 0.05	0.247 ± 0.052	0.185 ± 0.072	0.087 ± 0.014
Elderly group	61.0 ± 0.94	0.840 ± 0.03	0.784 ± 0.07	0.997 ± 0.047	0.055 ± 0.08	0.0212 ± 0.036	0.213 ± 0.036	0.082 ± 0.028

CONCLUSION: The time percentage duration of double support in a trip cycle was increased with ageing. The increase in maximum hip extension was small with ageing. The reaction force on the ground decrease with the ageing.

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