ECCENTRIC BUT NOT CONCENTRIC MUSCLE WORK IS RETAINED WITH AGE IN LEVEL WALKING

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INTRODUCTION

It is well established that even in the absence of illness or disease aging degrades many physiological properties of skeletal muscle leading to reduced muscle strength and power (4). Loss of strength and power with age is however dependent on the type of muscle contraction with lengthening (eccentric) vs. shortening (concentric) contractions having smaller decrements (2). Loss of eccentric strength with age is further attenuated at higher angular velocities that approach those used in walking (5).

The functional consequences of the relative retention of eccentric strength with age are largely unknown. Eccentric contractions dissipate mechanical energy (i.e. do negative work) and are used by all lower extremity muscle groups in walking (1). Since eccentric but not concentric strength is well maintained with age at joint angular velocities used in walking, we hypothesize that old compared to young adults maintain eccentric (negative) work but not concentric (positive) work during level walking. The purpose of the study was to compare negative, positive, and total muscle work in the lower extremity between young and old adults during level walking at 3 speeds.

METHODS

Ground forces and 3D kinematics were obtained from 20 young (21 yr) and 20 old (77 yr) volunteers during 1.2, 1.5, and 1.8 m/s level walking after obtaining written informed consent. Inverse dynamics were used to derive 3D joint powers throughout the stride. Positive, negative, and total work were derived from these data and assumed to be due to muscle forces. 2-by-3 ANOVAs (age by speed) with $p<0.05$ were used to identify age differences and age by speed interactions followed by post hoc t-tests in the case of significant interactions.

RESULTS AND DISCUSSION

No significant interaction or age effects were seen for total negative work summed across all joints (fig 1a). A significant interaction was seen for total positive work such that the increase in positive work with increased speed was attenuated in old vs. young adults (fig 1b). Negative work was statistically identical at each joint between age groups (table 1). Significant interactions were observed for positive work at the knee and ankle joints. As in total positive work the increase in knee and ankle positive work with increased speed was attenuated in old vs. young adults. Also, positive knee work was ~30% lower in old vs. young at all speeds (t-tests, $p<0.05$).

The retention of hip concentric muscle function agrees with our previous data showing a preferential use of hip muscle work vs. work from distal knee and ankle muscles in old vs. young adults during walking (1). Previously seen reductions in knee and ankle work in walking (1) can now be more accurately interpreted as reductions in energy generating capacity of knee

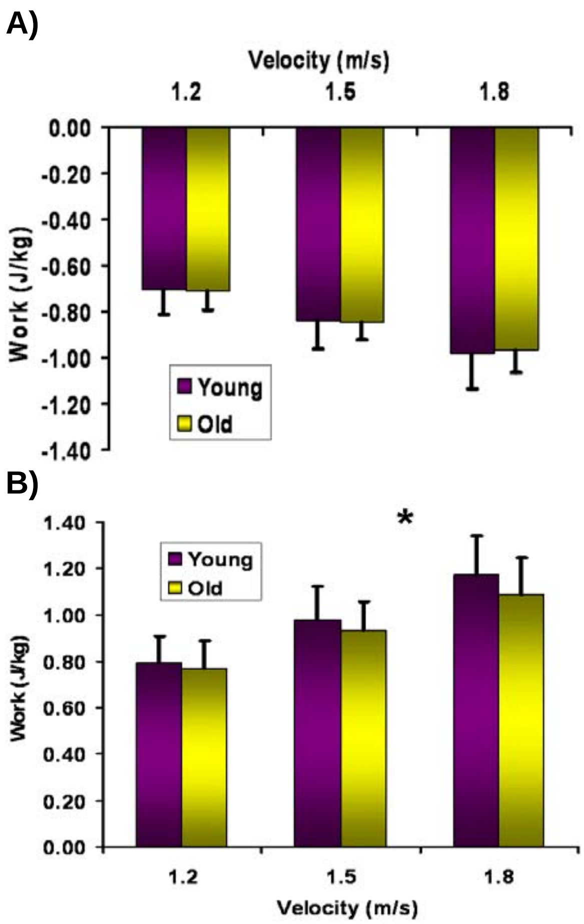

Figure 1, Total negative (A) and total positive (B) work. No significant interaction or age effect was seen in negative work. * significant age by speed interaction was seen in positive work ($p<0.05$).

extensors and ankle plantarflexors but not in their energy dissipating capacity. The retention of hip muscle function and loss of knee and ankle muscle function during walking also agrees with observations that distal vs. proximal muscles undergo larger reductions in physiological properties (3). These data show the retention of eccentric strength with age as seen isokinetically is manifested functionally during walking.

SUMMARY/CONCLUSIONS

The hypothesis was supported and showed healthy, mobile old vs. young adults retain their ability to dissipate energy during walking through lengthening contractions but have reduced capacity to generate energy through shortening contractions.

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Table 1: Mean (sd) negative & positive work at each joint

		Negative Work			Positive Work		
		1.2 m/s	1.5 m/s	1.8 m/s	1.2 m/s	1.5 m/s	1.8 m/s
Hip	**Young**	-0.14*(0.05)	-0.20 (0.07)	-0.28 (0.10)	0.42 (0.09)	0.51 (0.11)	0.62 (0.12)
	Old	-0.17 (0.04)	-0.23 (0.06)	-0.29 (0.07)	0.45 (0.09)	0.56 (0.10)	0.67 (0.13)
Knee	**Young**	-0.31 (0.06)	-0.40 (0.07)	-0.50 (0.09)	0.14 (0.05)	0.18 (0.05)	0.23 (0.06)
***, #**	**Old**	-0.31 (0.05)	-0.40 (0.05)	-0.50 (0.07)	0.10 (0.04)	0.13 (0.05)	0.16 (0.05)
Ankle	**Young**	-0.26 (0.05)	-0.24 (0.05)	-0.20 (0.05)	0.24 (0.06)	0.28 (0.09)	0.33 (0.12)
*****	**Old**	-0.24 (0.06)	-0.22 (0.04)	-0.22 (0.04)	0.22 (0.04)	0.24 (0.05)	0.26 (0.06)

* Significant interaction effect for positive work ($p<0.05$); # Significant age effect for positive work ($p<0.05$)