Session 1 | Whitecloud Award Nominated Papers

92. Age-Adjusted Alignment Goals Inadequately Represent Asymptomatic Adults and are Prone to Undercorrection

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Hypothesis

Age-adjusted alignment formulas inadequately reflect alignment in asymptomatic adults.

Design

Retrospective cohort

Introduction

Recent literature emphasizes age-adjusted alignment objectives in deformity correction, advocating for less aggressive adjustments in older patients. However, applicability of these age-adjusted alignment formulas remains unverified in asymptomatic adults.

Methods

468 asymptomatic adult volunteers with biplanar spinal imaging were included in this multi-ethnic, multi-center cohort. The primary endpoint, mean absolute error(MAE), quantified the absolute discrepancy between observed and age-adjusted targets for Pelvic Incidence-Lumbar Lordosis(PI-LL) and T1 Pelvic Angle(T1PA). These targets were derived as follows: for PI-LL,[(Age-55)/2 +3]; for T1PA,[(Age-55)/2 +16]. Univariate and multivariable logistic regressions assessed the relationship between the actual-to-target alignment deviation and demographic/radiographic factors. The multivariable model adjusted for age, BMI, sex, and pelvic incidence(PI) and incorporated two-way interactions among these variables. Data are shown as[β Estimate(Std Error, P Value)].

Results

Figure 1A and 1B show comparative plots of observed and target values for PI-LL and T1PA, respectively. The MAE for PI-LL was 9.41°. Older age groups exhibited greater deviations: 55–65 years[4.11(1.1, 0.0002)], 65–75 years[5.9(1.42, <0.0001)], and >75 years[5.71(2.28, 0.0124)]. A significant correlation between PI and MAE was observed, with higher errors in PI ranges 60-70[6.3(1.2, <0.0001)] and >70[5.29(1.47, 0.0003)]. Multivariable analysis(Figure 1E) identified increased age[0.75(0.2, 0.0002)] and PI[0.42(0.19, 0.0323)] as independent predictors of larger discrepancies, alongside a significant age x PI interaction[-0.01(0.003, 0.0012)]. The greatest absolute error(>13°) was in participants >55 years with PI >60°(Figure 1C). For T1PA, the MAE was 6.77°, with similar predictors to PI-LL in both univariate and multivariable models. In the latter(Figure 1F), older age[0.86(0.14, <0.0001)] and higher PI[0.46(0.13, 0.0005)], with a significant age x PI interaction[-0.01(0.002, <0.0001)], significantly influenced the error magnitude.

Conclusion

Age-adjusted alignment formulas do not accurately represent asymptomatic adults. Age-adjusted targets, premised on symptomatic adults, risk under correction in older patients needing reconstructive surgery.

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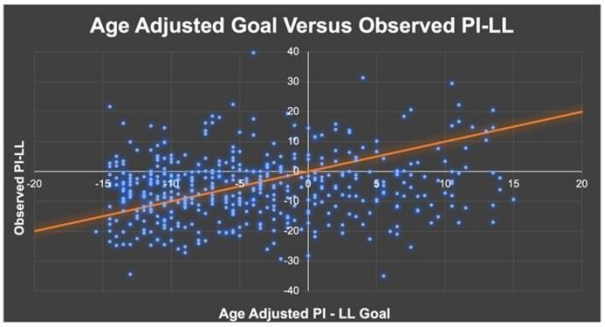
A



B

What is the magnitude difference between observed values in asymptomatic volunteers and age-adjusted spinal alignment benchmarks?

C

Pelvic Incidence Minus Lumbar Lordosis

Average | Observed - Age Adjusted Target | by Age and Pelvic Incidence

Age Cohort	Pelvic Incidence Cohorts 30°-40°	40°-50°	50°-60°	60°-70°	>70°
0-35 Years	8.39				
35-45 Years	8.28	7.68			
45-55 Years		9.73	9.34		
55-65 Years			10.68	14.32	
65-75 Years				15.36	13.36
>75 Years					14.11

D

T1 Pelvic Angle

Average | Observed - Age Adjusted Target | by Age and Pelvic Incidence

Age Cohort	Pelvic Incidence Cohorts 30°-40°	40°-50°	50°-60°	60°-70°	>70°
0-35 Years	5.86				
35-45 Years	5.52	5.66			
45-55 Years		6.65	6.74		
55-65 Years			7.81	11.43	
65-75 Years				11.74	9.18
>75 Years					13.18

E

Drivers of Increased Mismatch Between PI-LL Goals and Observations

	Univariate Regression β	SE	P value	Multivariable Regression β	SE	P value
Age [Per Year]	0.112	0.022	<0.0001	0.752	0.203	2E-04
Sex [Female]	*Reference*					
Male	-0.194	0.687	0.7775	3.040	5.799	0.6004
Body Mass Index [Normal, 18.5-25]	*Reference*			0.283	0.435	0.5163
Pelvic Incidence [PI°, Continuous]	0.062	0.031	0.05	0.418	0.195	0.032
Two Way Interactions						
Pelvic Incidence (PI°) : Age				-0.009	0.003	0.001

F

Drivers of Increased Mismatch Between T1PA Goals and Observations

	Univariate Regression β	SE	P value	Multivariable Regression β	SE	P value
Age [Per Year]	0.103	0.016	<0.0001	0.858	0.138	<0.0001
Sex [Female]	*Reference*					
Male	0.113	0.4975	0.8204	0.9075	3.932	0.8176
Body Mass Index [Normal, 18.5-25]	*Reference*			-0.185	0.2951	0.5311
Pelvic Incidence (°)	0.045	0.023	0.05	0.463	0.132	5E-04
Two Way Interactions						
Age : Pelvic Incidence (°)				-0.013	0.002	<0.0001

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