PREFERRED POSITION AND ASSOCIATED FORCES FOR LOWER BACK SUPPORT IN VEHICLE AND OFFICE SEATING ENVIRONMENTS

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INTRODUCTION

The contour of a seat can influence the posture achieved by an individual. For example, an excessive forward contour at the shoulder region could prevent some individuals from achieving an erect posture, influencing the amount of support needed in the lower back or lumbar regions. Thus, the goal of our work was to measure the preferred locations and forces on lower back supports independent of a seat contour in vehicle and office seating environments.

METHODS AND PROCEDURES

For this study, an experimental laboratory seat was designed and built. Using two small motors activated by a subject-controlled switch, the seatback allowed the lower back support pads to move in vertical as well as fore-aft directions.

Two multi-channel force transducers were used along with the experimental seat, one was behind the fixed thoracic support while the other was behind the lower back support pad and moved with the pad. These force transducers measured support forces in the three axial directions F_x, F_y and F_z. The two force transducers together helped record forces exerted by the subject in the upper as well as lower back regions. Each of the two force transducers had a capacity of 250lb (1112 N).

Three dimensional positions of retro-reflective targets secured to both the experimental seat and bony landmarks of the subject were captured using a five camera 60 hertz Qualisys motion measurement system. Using these three-dimensional coordinates, the location of each force transducer could be computed relative to subjects' anthropometry. Eight subjects were placed in four different seating configurations marked by variation in seatback recline angle – 10º and 15º for office, 20º and 24º for vehicle seating environments. The footrest was allowed vertical as well as fore-aft adjustment in the office environment, but only fore-aft movement in the vehicle seating tests. The seat pan for vehicle testing was inclined at 14˚ with respect to the horizontal unlike the zero inclination for the office test seat pan.

RESULTS

Table 1 shows the preferred location of the support pads (average distance along the seat back). This distance was also converted to a percentage of each subject's seated height. Table 2 shows the average forces exerted by each subject on the thoracic and lower back supports as measured by the force transducers.

DISCUSSION AND CONCLUSIONS

The average vertical locations of all the support pads in the office and vehicle seating environments were measured and calculated to be 167.2mm, 173.5mm, 166.9mm and 161.8mm above the seat pan at each of the four recline angles respectively. All these values fall between the averages of the third lumbar vertebra (L3 = 195.1mm) and the posterior superior iliac spine (PSIS = 93.7mm). Hence, it appears that

Subject ID	Pad apex location along seat back at each recline angle (mm)				Seated Height (erect) (mm)	Pad apex height as percentage of Seated Height (%)			
	10˚	15˚	20˚	24˚		10˚	15˚	20˚	24˚
P2A	199.0	207.5	195.2	197.7	863.6	23	24	23	23
P2B	116.0	99.5	105.3	91.2	952.5	12	10	11	10
P2C	126.8	161.0	153.5	116.0	895.3	14	18	17	13
P2D	164.2	170.5	155.7	168.2	876.3	19	19	18	19
P2E	188.2	189.0	199.7	205.7	889.0	21	21	22	23
P2F	202.3	229.7	174.5	178.7	901.7	22	25	19	20
P2G	184.5	179.8	189.0	187.7	914.4	20	20	21	21
P2H	156.2	150.7	162.0	149.3	914.4	17	16	18	16
Averages	**167.2**	**173.5**	**166.9**	**161.8**	**900.9**	**19**	**19**	**19**	**18**
Std. Dev.	**32.4**	**39.2**	**30.6**	**40.4**	**27.2**	**3.9**	**4.7**	**3.7**	**4.7**

Table 1. Distance from seat pan to support pad apex (averages of all three pads) along the seat back. This distance is also reflected as a percent of seated height. All distances are in millimeters.

Recline Angle	Normal forces (N)		Vertical Shear forces (N)		Lateral Shear forces (N)	
	Thoracic	Lower Back	Thoracic	Lower Back	Thoracic	Lower Back
10˚	-58.2	-54.2	-9.2	-12.8	-2.1	-2.5
15˚	-71.3	-53.7	-7.2	-12.3	-2.1	-2.5
20˚	-121.5	-89.9	-15.3	-14.7	-2.2	-1.3
24˚	-132.7	-91.2	-13.6	-12.5	-2.2	-1.7

Table 2. Average forces exerted by subjects on lower back and thoracic supports at different recline angles. All forces are in Newtons. Negative sign indicates direction of force – into the pads for normal forces, downward for vertical shear forces and leftward for lateral shear forces.

subjects prefer to position the lower back support pads between L3 and the PSIS when a seat contour is not present.

Greater normal forces were exerted on both the lower back and thoracic supports in the vehicle seating as compared to the office seating indicating the correlation between recline angles and support forces. This is expected because with an increase in recline angle, the distribution of body forces on the seat shifts relatively more towards the subject's back (Bush and Hubbard, 2007). Also, the inclination of the vehicle seat pan with respect to the horizontal causes an increase in normal forces on the seat back.

SUMMARY

Since all lower back support movements were subject controlled, the data recorded were the preferred positions of the supports with the associated forces. These data have the potential to be used as an input for seat future design.

REFERENCES

Bush TR and Hubbard RP (2007), *ASME Journal of Biomechanical Engineering.*