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EFFECT OF SEAT TUBE ANGLE ON THE WORK EFFICIENCY OF LOWER LIMB MUSCLES DURING CYCLING

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The effect of seat tube angle (STA) on work efficiency at lower limb muscle was evaluated during a pedal rotation using inverse dynamic model. Since the target is not professional cyclist, the various seat tube angles of 78, 68, 58 and 48 degrees was investigated. Cycling simulation was performed at 250W and 60rpm. The works of individual muscle of lower limb and the total work was estimated. The result shows that the total work of single leg at seat tube angles of 78, 68, 58 and 48 degrees were 168.1(J), 167.9(J), 168.9(J) and 170.8(J) respectively. In conclusion, the exertion of lower limb for delivering same amount of work to the crank is the smallest at around 72 degree of seat tube angle which mean work efficiency of lower limb is the greatest

KEY WORDS: Cycling Simulation, Non professional cyclist**,** Net Muscle work.

INTRODUCTION: The effect of seat tube angle (STA) on the cycling performance was investigated many times in terms of metabolic cost (Price et al., 1997; Heil et al., 1995; Jackson, et al., 2008). The STA is measured at the position of the seat relative to the crank axis of the bicycle. Road racing cyclists prefer a STA between 72 and 76 degrees, whereas tri thletes prefer a STA between 70 and 78 degrees (Erik et al., 2005). Since cycling test results regarding the effect of STA on metabolic parameters are conflicting in the literature, further investigation was required. In this study the effect of STA on the cycling performance was investigated in terms of muscle mechanical work using human model simulation.

METHODS: Cycling simulation was performed at seat tube angles of 78, 68, 58 and 48 degrees using commercial human model simulation software ADAMS LifeMOD [figure 1]. A male human model (178cm of height, 79kg of weight) with lower limb muscle and bicycle model was built. Cycling intensity was set to 250W and pedalling rate was 60 rpm. For the work intensity, resistive torque which has sine wave characteristics was applied to the crank axle [figure 2].

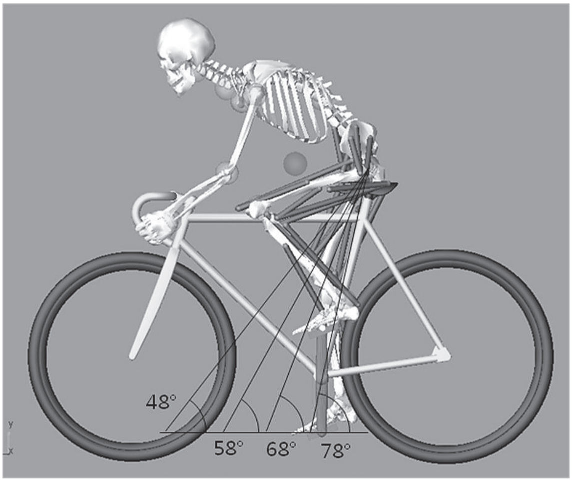

Figure 1: Various seat tube angle of cycling.

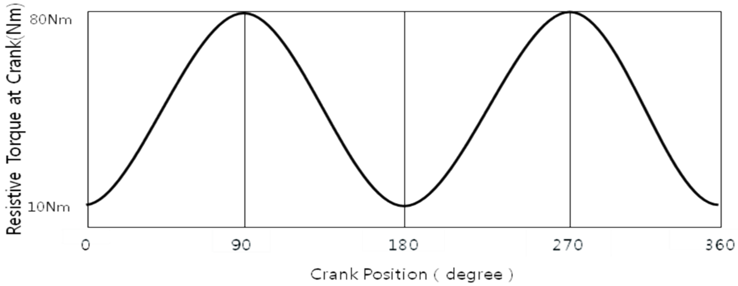

Figure 2: resistive torque at crank axle.
(Zero degree of crank position is Top Dead Centre)

The work (J) of individual muscles during one revolution of crank are simulated for Rectus femoris, Vastus, Biceps Femoris, Iliacus, Gluteus Maximus, Soleus. And total work of lower limb muscles was calculated

RESULTS: The powers of individual muscles during a revolution of right leg are showed at Figure 3. And the work is calculated for each muscle.

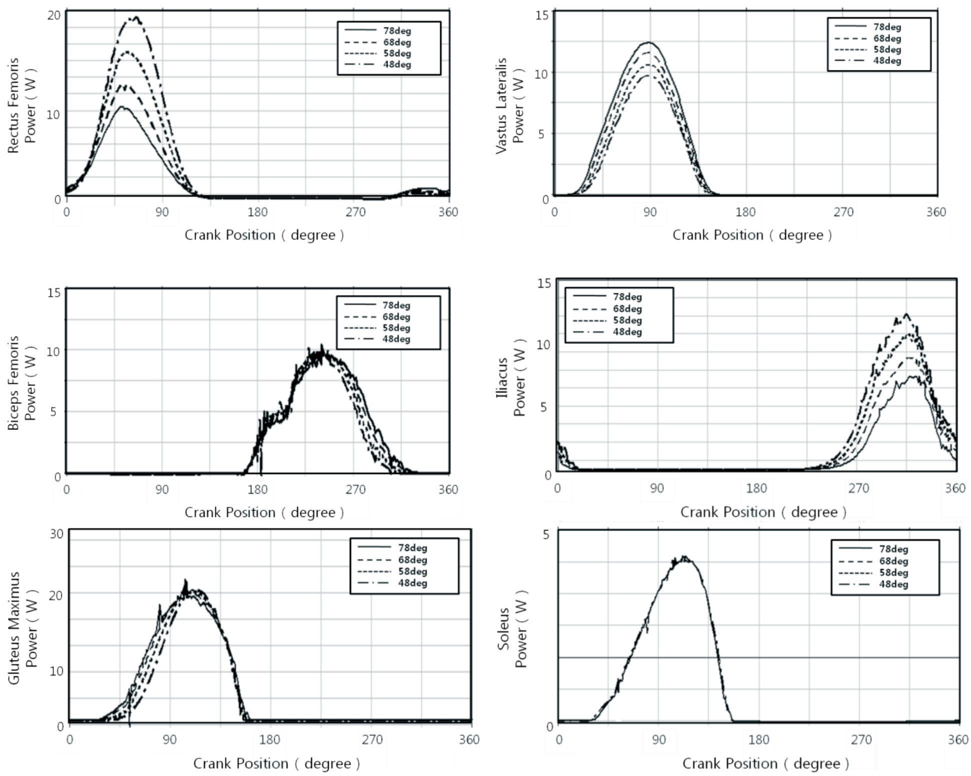

Figure 3: Power of individual muscle at right leg.

Maximal work was showed by Vastus (47.9J) at STA 78 degree, whereas during cycling at STA 48 degree, Gluteus Maximus, Rectus Femoris, Vastus are showed same works level. Total amount of work of right leg is 168.1(J), 167.9(J), 168.9(J) and 170.8(J) at STA 78, 68, 58 and 48 degrees respectively.

Table 1
Amount of work of individual muscles(J)

	STA 78	STA 68	STA 58	STA 48
Gluteus Maximus	41.9	41.0	38.2	35.3
Rectus Femoris	17.2	21.1	26.9	33.0
Vastus	47.9	43.1	37.8	33.6
Biceps Femoris	29.7	28.9	28.6	30.2
Iliacus	16.5	19.0	22.6	23.9
Gastrocnemius	6.9	6.9	6.9	6.9
Soleus	7.4	7.4	7.4	7.4
Tibialis	0.5	0.5	0.5	0.5
Total	168.1	167.9	168.9	170.8

DISCUSSION: The total amount of work of right leg during a rotation of crank was the lowest between 78 and 68 degree of seat tube angle. So we can conclude that cycling at 72 degree of seat tube angle is most work efficiency because work cost of a lower limb muscle was the lowest where 250 Joule of work output at crank was achieved identically. It is same result to previous study that low seat tube angle between 72~76 degree is more preferable when road racing cycling (Heil et al., 1995). Work efficiency (74.7%) during transmission from muscle to crank can be deduced from equation described as flowing:

$$250(J) / 167.9(J) \times 2 \times 100(\%) \quad (1)$$

Where, 250(J): work output achieved from the crank,
167.9(J): total work of single leg muscle

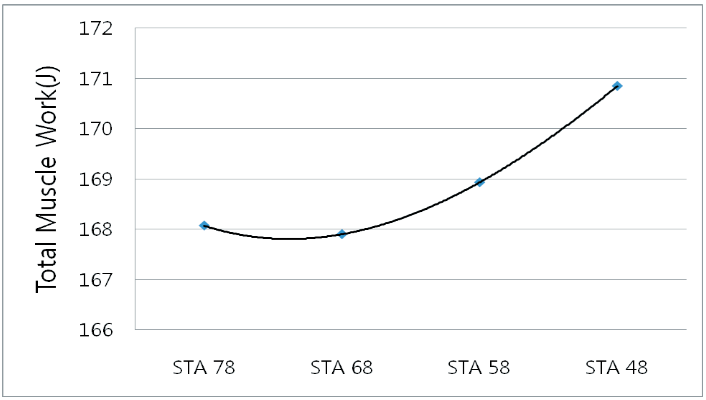

Figure 4: Total amount of work of right leg at various seat tube angles.

CONCLUSION: In this study the effect of seat tube angle on the cycling performance was investigated in terms of net muscle works using human model simulation. A comparison between the net muscle works of lower limb muscle and the works achieved from crank during a crank revolution was made. In conclusion, at around 72 degree of seat tube angle is most efficiency at lower limb kinematics point of view.

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