

ABSTRACT

In Iraq, the production of the lower limb prosthesis represents 92% of the total amputation prosthesis, while the through and above knee amputation represent 22% of the total lower limb prosthesis production.

Above Knee Amputee (AKA) prosthesis is typically comprised of five components; socket, knee joint, pylon, foot and adapters, the most important part is the artificial knee joint. Presently, there are a large number of commercially available artificial knee joints and all of them attempt to return some of the lost gait function, but may use different principles to do so. Among the types ranging from simple single axis locked knee joint to the complex computerized C-Leg, the four bar artificial knee joint represents the intermediate and most commonly used in Iraq, especially 3R20 four bar knee joint.

The human lower limb is studied in detailed manner, the gait cycle of the sound person and AKA person are discussed. Also, the construction, design and controlling parameters of the knee joint behavior are examined carefully. Therefore, three lines are introduced; the modeling of the human lower limb, the variation of initial assistant spring setting of the knee joint and the variation of linkages lengths of artificial knee joint.

The anatomy of human lower limb, the behavior during the gait cycle and the anthropometric data are used with the help of Euler- Lagrange equation to construct the equation of motion of the human lower limb links in order to calculate the applied torque at the human lower limb joints. The obtained torque curves and the values of peaks and their points of action during the gait cycle are similar to a large extent with those experimentally or theoretically obtained from other researchers. The above results reveal that the applied torque can be obtained from the variation of the joints angles and GRFs during the gait cycle with the help of Euler-Lagrange equation.

The 3R20 knee joint has a number of controlling parameters, namely, the initial adjustment setting of the assistant spring and the linkages length. The adjustment of the initial assistant spring setting is studied, and a new external

adjustment system is introduced in order to show the effect of initial spring setting on the amputee person and on his gait characteristics with the variation of walking speed. The tests included the EMG activity of thigh muscles, the lower limb joints angles, the accumulated potential of the spring and the treadmill parameters during the gait cycle.

The results show that at each walking speed, there is a direct relationship between the minimum EMG activities of amputee person with the minimum accumulated potential of the assistant spring exerted on the amputee person estimated at each walking speed. The minimum values for EMG activity of the right limb coincide with the minimum accumulated potential for the speeds 0.4, 0.7, 1.1, 1.4 and 1.8 km/h with +2, zero, zero, +2 and +2 mm spring settings, respectively. At 2.0 km/h, the accumulated potential is minimum with +2 mm spring setting, while the minimum EMG activity shows minimum value with (-2, +2, +4 and +6 mm spring setting) and at 2.2 km/h, the results are different.

The EMG activity of the left limb muscles depict minimum values with +4, +5 and +6 mm spring setting, i.e., with maximum values of initial spring setting. The treadmill parameters show different useful points at each spring setting and walking speed.

The comparison between the sound person results and the results of the assistant spring setting variation shows the weakness of the amputee person due to the loss of muscles around ankle joint, muscles around knee joint and the part of thigh muscles. Also, the rate of increasing of EMG activity of the AKA person is higher than that of the sound person. Finally, the treadmill results manifest the same behavior and the lack of the right limb is compensated by the intact limb.

The 3R20 knee joint and the most four bar knee joints available at the markets have specified lengths. The present study tried to investigate the effect of linkages length variation on the gait cycle characteristics of the AKA person and on the load exerted by him during the gait cycle.

Three cases of lengths variation with the standard knee joint are experimentally tested, and the same tests introduced for spring setting are applied.

The results show that there is a direct relationship between the length of the linkages and the assistant spring and its compression during the knee joint flexion corresponding to each linkages length case. Also, it is possible to manufacture knee joint that has linkages length differs from that of the standard one with suitable spring characteristics and gives similar accumulated potential and EMG activity.

The K1 knee joint shows minimum accumulated potential values and after that the K knee joint, and K knee joint reveals minimum EMG activity and after that the K3 knee joint.

The treadmill results show useful points distributed between the four cases of knee joints, but the K knee joint (standard knee joint) exhibits higher points.