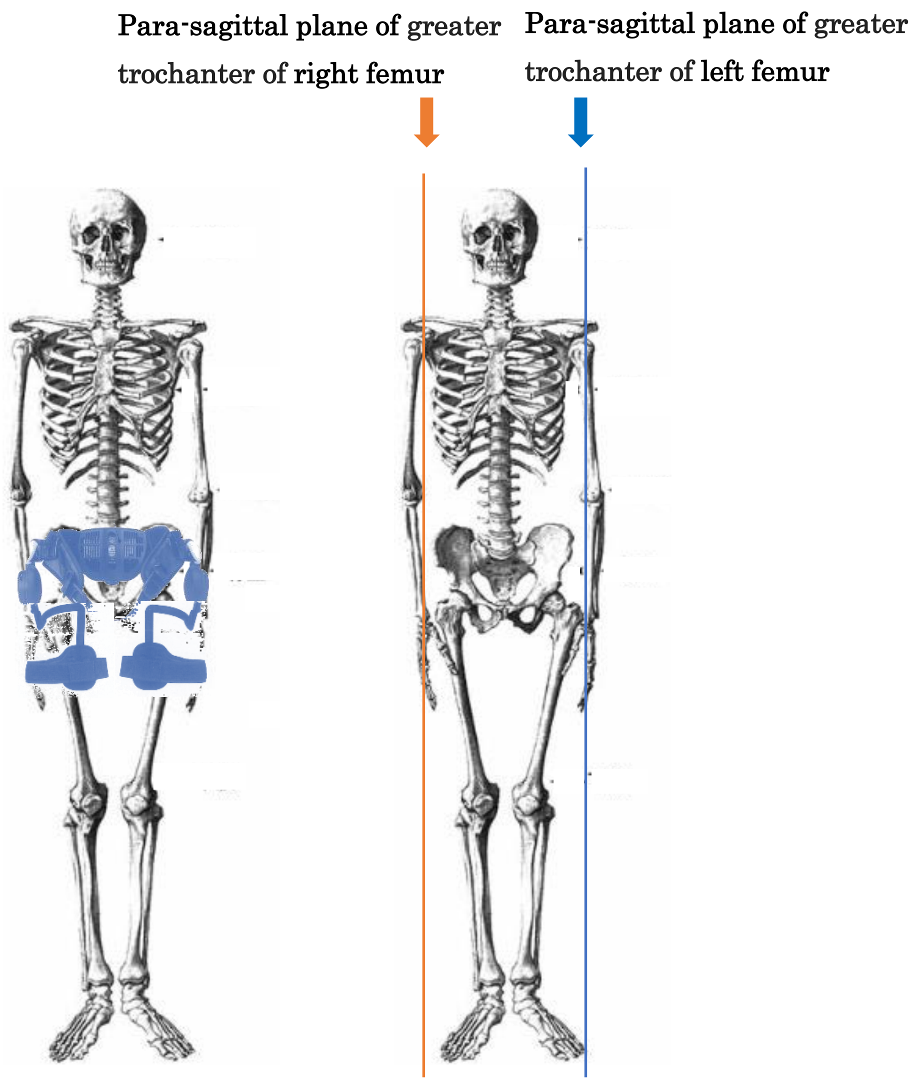
Figure 12. Whereabouts of Right and Left para-sagittal planes when a walker is viewed from his front (orange and blue lines) and an illustration to show HONDA ASSIST's wearing position in relation to a skeletal



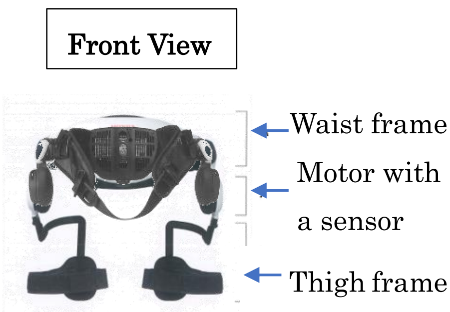
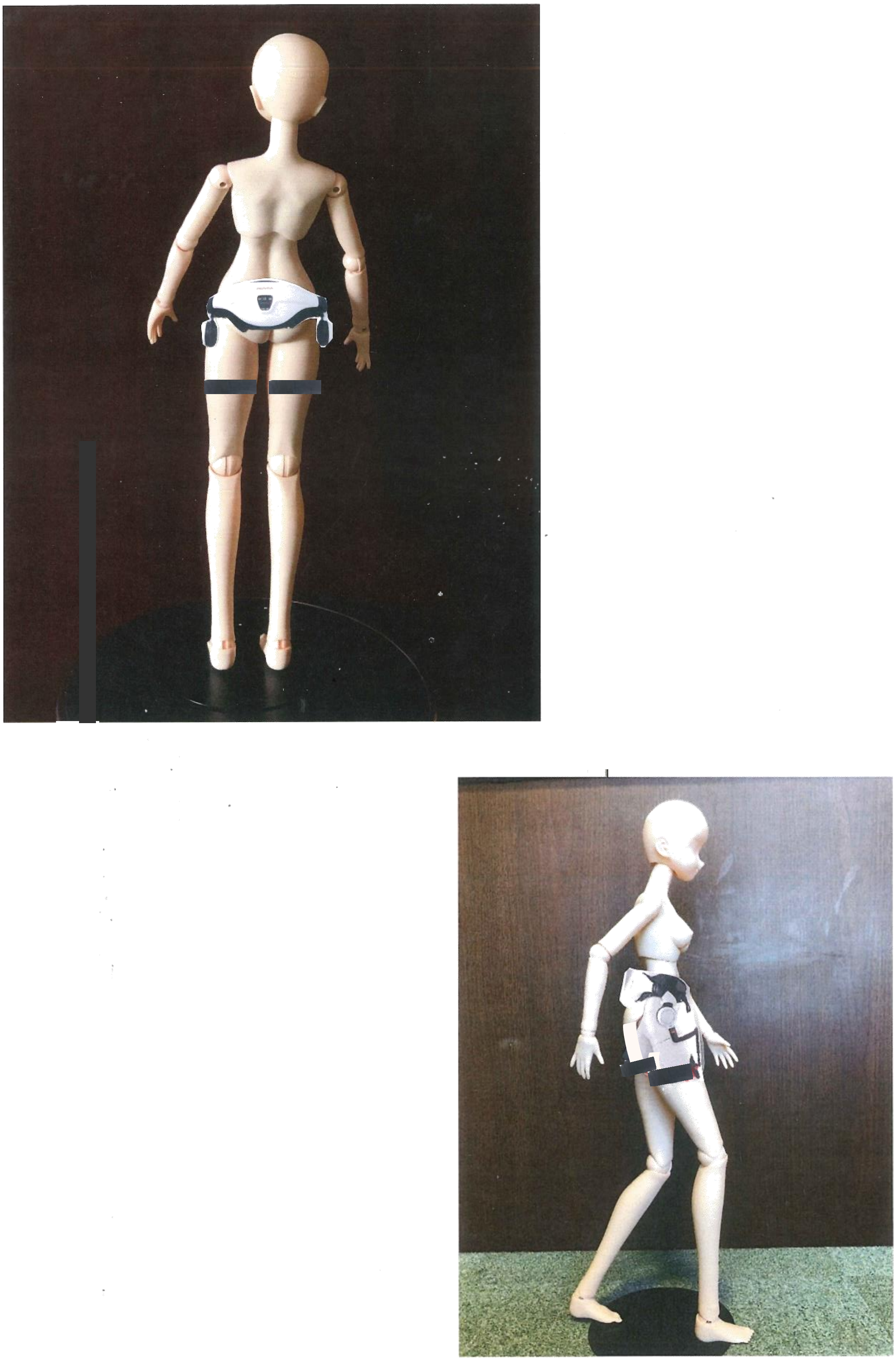


Figure 13. Back and Side view of a doll wearing HONDA ASSIST



When a human being walks on the basis of his bipedalism, both the measures of angles formed by his right femur and the perpendicular drawn from his right greater trochanter to the ground and the measures of angles formed by his left femur and the perpendicular drawn from his left greater trochanter toward the ground undergo a series of changes with the passage of time.

Observers can detect the acceleration and deceleration in the changes of the measures of angles and in the changes in the speeds of the pendulum movements of his right and left femurs, a phenomenon which has a similarity to the up-and-down movements of waves of a sea.

Figure 14 shows the graph representing the gate cycle of a person with a healthy walking ability and high levels of left-and-right symmetry degree who was subjected to our study. The figure also shows typical sine & cosine curves. Let us call readers' attention to the similarity of the person's sequential line graph and the sine curb.

Figure 14-(2) attests that her right leg's gait cycle curb resembles a sine curve (in this study, her right leg showed up as the front leg closer to observers when viewed from the standpoint of observers), while Figure 14-(3) attests that the graph drawn by her opposite (left) leg's gait cycle resembles another sine curve.

These observational findings are connected with the fact that a healthy human's bipedalism gait cycle consists of a series of pendulum-like or inverted pendulum-like trajectory movements that are made either by the human's legs or his or her greater trochanters.

It is noteworthy that a human's bipedalism walking is characterized by an inverted pendulum movement in which the center of gravity vaults over a stiff leg with each step. In humans, walking consists of several separate processes, including vaulting over a stiff stance leg, the passive ballistic movement of the swing leg and a short push from the ankle prior to a toe-of, which propels the swing leg.

These processes appear to contribute to the fact that both the measures of angles formed by his right femur and the perpendicular drawn from his right greater trochanter to the ground and the measures of angles formed by his left femur and the perpendicular drawn from his left greater trochanter toward the ground respectively produce a sine curb when they are represented by a sequential line graph.

Figure 16 shows a kangaroo's manner of locomotion. We present the figure for comparison purposes to communicate a clear understanding of the characteristics of a human's erect bipedalism manner of walking. Both a kangaroo and a human being engage in bipedal locomotion.

But among various species, only a human being engages in erect bipedalism at which he walks upright on two legs. In the case of a human's erect bipedalism, the human's vertebral column, legs and femurs stand vertically in relation to the ground as if the column, legs and femurs formed a single straight line in cases where the human is at a standstill. A kangaroo cannot line up its vertebral column and femurs in a straight column. In the case of a penguin, its vertebral column and femurs even form an almost right angle.

Kangaroos are the only large animals to use hopping as a means of locomotion. During a hop, the animal's powerful gastrocnemius muscles lifts the body off the ground, while the smaller plantaris muscle, which attached near the large fourth toe, is used for push-off. When it is moving at slow speeds, it employs pentapedal locomotion, using its tail to form a tripod with its two forelimbs while bringing its hind feet forward.

During a hop, a kangaroo leaps with two legs with both legs' movements synchronized. Therefore, a kangaroo's both legs looks as if they were connected together. Both legs move without laterality to enable it to move speedily. Both legs' flexion angles need to be large and the two legs' extension angles also need to be large to enable a speedy locomotion.

Figure 17 shows the muscles of a human's lower legs.

For each of the legs to stand alone during a stance phase, the muscles of this side leg need to be robust enough. Among the muscles described above, having strong and voluminous muscles are very important to support the weight of a human's whole body.

Conclusion

We have concluded that quantifying, measuring and analyzing post-stroke hemiplegic patients' gait cycles and comparing the measures of right and left scissors angles they produce with their legs with the aid of the Honda Walking Assist are quite useful in evaluating the walking ability of the post-stroke hemiplegic patients.

We also concluded that the HWA can be used to rehabilitate efficiently the walking ability of post-poststroke hemiplegic patients.

It is appropriate to conclude that "Right & Left Scissors Angles" measured by this instrument can work as accurate indicators of humans' walking ability by helping observers of post-stroke hemiplegic patients understand, record, print out and analyze the characteristics of gait cycles at the observed.

The author and co-authors do not have any conflict of interest to disclose regarding this academic paper.