The Correlation between Energy Absorption Ratio and Pain Score of the Upper Extremity under Different Fall Heights

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INTRODUCTION

A fall onto the outstretched hand is the most common cause of upper extremity injury, including approximately 90% of fractures at the distal radius, humeral neck, and supracondylar region of the elbow. In the study by Chou et al. [1] found if the elbow flexed instead of outstretched after impact would decrease the ground reaction forces. They suggested the elbow-flexed motion represents the effects of damper and spring. In the whole, the total dissipation energy produced by shoulder moment is larger than dissipation energy produced by elbow moment; this means that the shock-absorption effect of shoulder is stronger than that of elbow. Since elbow joint and shoulder joint play important roles to absorb impact energy during falls . The purpose of this study is to find the best joint energy distribution between elbow joint and shoulder joint.

METHODS

The ExpertVison motion system (Motion Analysis Corp., Santa Rosa, CA, USA) with six 120 Hz cameras and two 1000 Hz Kistler force-plates (Type 9281B, Kistler Instrument Corp., Winterthur, Switzerland) was used to measure relative joint positions and ground reaction forces.

The subjects were dropped from a height of 10 cm and 20 cm (i.e. distance between the outstretched hand and the force plate) , and fell onto two hands. The angle between the trunk and the upper arm is maintained at 60° forward flexion of the shoulder.A questionnaire was also designed to record each subject's sensation of pain or uncomfortable index during the impact. The index ranged from 0 to 10, and higher score means more uncomfortable.

RESULTS AND DISCUSSION

Table 1. is the grouping result of all subjects when h=10 cm.

Table 1. energy absorption ratio (h=10 cm)

	comfortable	moderate	uncomfortable
1	1.45	1.50	1.62
2	1.41	1.57	1.60
3	1.69	2.00	2.29
4	1.28	1.38	1.57
5	1.84	1.85	2.08
6	1.53	1.79	2.13
7	1.51	1.55	1.73
8	2.02	2.18	2.45
9	1.66	1.69	1.79
10	1.61	1.69	1.71

Table 2. is the result of the subjects when h=20 cm.

Table 2. energy absorption ratio (h=20 cm)

	comfortable	moderate	uncomfortable
1	1.59	1.67	1.76
2	1.63	1.76	1.89
3	2.00	2.28	2.35
4	1.47	1.57	1.64
5	1.99	2.16	2.17
6	1.71	2.24	2.34
7	1.73	1.73	2.01
8	2.14	2.44	2.63
9	1.78	1.79	2.10
10	1.78	1.85	1.90

Different energy absorption distribution between shoulder joint and elbow joint makes different kind of feeling to the subject. The most comfortable group has the smallest energy absorption ratio since the most uncomfortable group has the highest ratio. In the other words, the most comfortable group has the best energy distribution. In this experiment, all the energy absorption ratios are bigger than 1. So shoulder joint plays the important role during the impact. But smaller ratio makes subjects feel better. If elbow joint can help to share the energy absorption, it is the better way to prevent subjects from injury. Otherwise, when the falling height is higher, the ratio is getting bigger and bigger. That means that we normal people used to use our shoulder to absorb the impact energy. It is not a good way during the impact.

CONCLUSIONS

In this study, different energy absorption ratio really makes subjects feel different. Smaller energy absorption ratio makes subjects feel better. If we can use our elbow joint to help absorbing more energy, it is the better way for us to prevent from injury.

REFERENCES

[1] Chou P.H., Chou Y.L., Lin C.J., Su F.C., Lou S.Z., Lin C.F., Huang G.F., Effect of elbow flexion on impact forces of upper extremity on a fall. Clinical Biomechanics 2001,16:888-894

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