Effects of knife handle types, blade lengths and grip postures on forearm muscle activities and wrist movements

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It is widely known that highly repetitive movement involving forceful exertion and awkward postures of hand activities could lead to musculoskeletal injuries of finger, wrist, forearm, upper arm and shoulder [1, 2, 3]. Poultry processing operators especially who are using knives, also work in risks of the injuries. Several factors for knife design such as handle shape, handle size, and sharpness, related to knife user injuries have been considered to give recommendations for knife design criterions [4, 5, 6]. But some points of interesting factors and their interactions as found in real condition use have not been studied.

Blade length is one of those factors. In the poultry processing, the operators are using different lengths of knife blade after they performed cutting task for a period of time. The blade length is shortened after sharpening knife repeatedly.

The purpose of this research was to study the effects of knife handle types (Figure 1), blade lengths (100 mm and 180 mm), grip postures (thump control and index finger control) and their interactions on operators performing shear cutting task.

![Figure 1 Three different types of handle using in the study](image)

Eight females, without musculoskeletal problems, were selected to voluntarily perform the experiments of shear cutting in the laboratory with two different grip postures, three different types of handle shape and two sizes of blade length. Three indicators (1) electrical signal of muscle measured by Electromyography (EMG) (2) wrist movement measured by Electrogoniometer and (3) subjective rating of body comfort and discomfort evaluated by the comfort for the questionnaire for hand tool (CQH), were recorded during the experiments.

The result indicated that using the knife with soft surface handle (hardness of 70 ShA) with ergonomics shape (Type III handle) lead to the lower EMG signal of the forearm muscles, flexor carpi radialis (FCR), flexor digitorum superficialis (FDS), extensor carpi ulnaris (ECU) and the extensor digitorum (ED), significantly when compared with Type I and Type II handles. It was also found that the level of perceived comfort on using the knife with Type III handle was significantly higher than the comfort level from using
Type I and Type II handles. For the blade lengths and grip postures, they had influences on wrist angle and forearm muscle activities. Using the knife with the blade length of 180 millimeter was likely to cause wrist extend more than using the knife of blade length 100 millimeter. On the other hand using the knife with blade length 180 millimeter was possible to affect wrist deviation less than using the knife with blade length 100 millimeter. The result also showed the interaction effects between blade lengths and handle types on wrist movements both in extension and ulnar deviation significantly. Regarding two different grip postures, it was found that the grip posture with index finger control had an effect on wrist extension more than the grip posture with thumb control significantly (P<0.01) while the grip posture with thumb control caused a higher effect on ulnar-deviation than using the index control.

Keywords: Ergonomics, Shear Cutting, Knife, Grip Posture

References