

The Box and Block Test Score is Dependent upon Block Surface

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INTRODUCTION

The ability to grip and manipulate objects is essential in performing various activities of daily living. Various clinical assessments of hand grip function have been developed and frequently used to identify individuals with sensorimotor impairment and to quantify their functional ability [1, 2]. One of the common clinical tests used to assess individuals' hand grip function is the Box and Block Test [1, 2]. First developed in 1957 [3], the Box and Block Test has been used to evaluate gross manual dexterity not only for healthy individuals [4], but also for individuals with disorders such as Cerebral Palsy [3].

An individual's ability to grip and manipulate objects is affected by many factors including hand strength [5], sensorimotor impairment [5], and frictional coupling between hand and object [6]. In particular, increases in the coefficient of friction (COF) between the fingers and an object reduce the minimum required grip force for individuals to successfully grip and lift the object [7]. An increase in finger-object COF also allows for greater deviation and variance of digit force direction from the direction perpendicular to the grip surface [8]. This study was performed to investigate if grip objects' frictional surfaces affect individuals' hand grip function. It was hypothesized that increasing hand-object COF improves hand grip function assessed using the Box and Block Test.

METHODS

Thirteen young healthy subjects (5 male, 8 female, 20-30 years of age) performed the Box and Block Test in a seated posture using their non-dominant hand for the following three sets of blocks: the commercially-available original blocks with the painted wood surface (COF 0.5 with skin [9]), blocks covered with a smooth sheet of rubber (COF

0.9 with skin [10]), and blocks with a paper surface (COF 0.3 with skin [11]) All three types of blocks had the same dimensions and weight (within ± 1 mm and 1 g). Subjects were instructed to move as many blocks as possible from one side of the container to the other for a period of 60 seconds [1]. The Box and Block Test score was determined by the total number of blocks that the individual moved in 60 seconds.

The Box and Block Test was repeated twice per block surface. The three block surface conditions were presented to subjects in a randomized order. Two minute rest breaks were allowed between tests to prevent muscle fatigue.

Analysis of variance was performed to determine if the within-subject variable of block surfaces (paper, painted wood, and rubber) significantly affected the Box and Block Test score. A post-hoc pair-wise comparison was performed to examine the Box and Block Test scores between the three block surfaces. The p -value of .05 was considered significant.

RESULTS AND DISCUSSION

The mean Box and Block Test scores for the three block surfaces are shown in Fig. 1. The effect of the block surface condition on the Box and Block Test score was found to be significant ($p < .01$). The Box and Block Test score was higher for the rubber-finished blocks than for both the paper- and painted wood-finished blocks ($p < .01$). The score was not significantly different between the painted wood blocks and the paper-finished blocks ($p > .05$).

Subjects were able to move 10% more blocks when gripping rubber-finished blocks compared to the painted wood- or paper-finished blocks. The results partially support the hypothesis that increasing hand-object frictional coupling improves hand grip function.

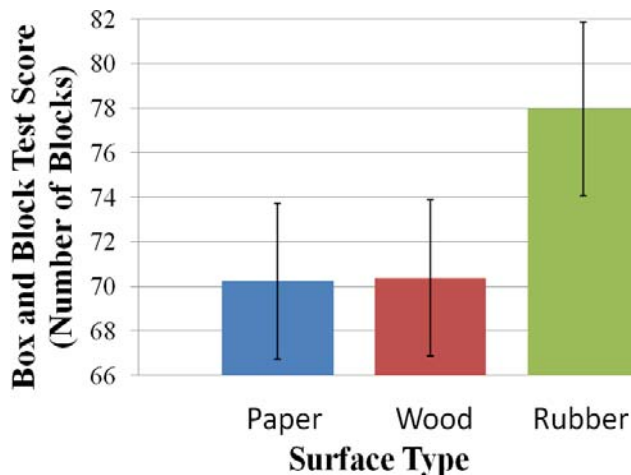


Figure 1: The mean \pm SE Box and Block Test scores (the number of blocks moved in 60 seconds) for the three block surfaces (the thirteen subjects' data pooled). The effect of the block surface was significant ($p < .01$).

Improvement in hand grip function for the rubber surface may first be due to reduction in the minimum required grip force. Increase in COF between the fingers and blocks allows individuals to successfully grip and lift the blocks with less grip force [7]. Secondly, high finger-object COF allows individuals to generate digit force in a wider direction but may prevent the finger from slipping from the object surface, compared with low finger-object COF [8]. This increase in finger-object COF may lessen the requirement for digit force direction control and thus may reduce the need for individuals to precisely control hand muscles [12]. The contribution of these two mechanisms may be more pronounced for a high COF condition such as between rubber and skin than for medium and low COF conditions (Fig. 1).

In addition, the blocks sometimes slid across the container floor when the finger came in contact with the block, which could also have contributed to the Box and Block score. Specifically, sliding occurred more for the painted wooden blocks compared to the other block surfaces. This sliding may have reduced the Box and Block Test score particularly for the painted wooden blocks.

CONCLUSIONS

Higher coefficients of friction can increase hand-object frictional coupling [6]. The present study demonstrates that increasing the frictional coupling between the hand and grip objects can improve

individuals' performance in the Box and Block Test. This finding has significant implications in rehabilitation as well as in ergonomics. A simple intervention of modifying grip object surfaces may be beneficial in improving hand grip function for people with weakness and for people with sensory and motor impairments. In addition, future investigations and clinical testing should recognize that the measurement of hand grip function is affected by grip objects' frictional surfaces.

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