

Investigating the effect of medical gloves on grip strength and manual dexterity

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ABSTRACT

Background and Objectives: Hospital and medical staff use medical gloves to protect themselves and their patients from infectious agents. Wearing gloves may reduce manual dexterity and grip strength and interfere with work performance. The aim of this study was to investigate the effect of wearing medical gloves on grip strength, manual dexterity, and perceived comfort.

Methods: 20 people (10 women, 10 men) participated in this study. Participants were tested in three gloveless modes, with latex gloves and with nitrile gloves with two tests, a 9-hole pegboard and a modified pegboard. Perceived comfort in working with gloves, wearing and removing gloves was also assessed using a subjective scale.

Results: The age range of participants was 20 to 40 years with an average of 29.45 years. There was a significant difference in manual dexterity between gloveless hands and nitrile gloves in the 9-hole pegboard test. In the modified pegboard test, gloveless hand manual dexterity was significantly different from both latex and nitrile gloves. The results also showed that wearing any type of glove significantly reduced the grip strength of individuals. The worst comfort rating was given to wearing gloves.

Conclusion: The results of this study showed that wearing gloves reduces manual dexterity and grip strength. A modified pegboard test is also recommended to assess the manual dexterity of medical gloves. Latex and Nitrile gloves are difficult to wear and should be considered in designs.

Keywords: Manual Dexterity, Gloves, Grip Strength, Design



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Extended Abstract

Background and Objectives

The human hand, with its special physical and sensory capacities, is able to perform a wide range of movements, such as fine and fast movements, grasping power, applying a lot of force, and repetitive and careful movements. However, hand injury is one of the most common injuries in the workplace [1-3]. Gloves are one of the personal protective equipment, which is used in many jobs to protect the hands from possible dangers [7]. Hospital and medical staff such as doctors, surgeons, laboratory staff, and nurses use medical gloves to protect themselves and patients from contamination. The most common medical gloves are latex and nitrile. Latex gloves are most commonly used by healthcare staff [8, 9]. Nowadays, the use of nitrile gloves has increased to solve the sensitivity problems of latex gloves. However, several studies have reported adverse effects of nitrile gloves, such as weak elasticity and reduced dexterity [10, 11]. Wearing medical gloves may reduce hand dexterity, speed, and grip strength, as well as interference in the implementation of affairs [12, 13]. The most common tests to assess the dexterity of medical gloves are Purdue Pegboard and Crawford Small Parts Dexterity Test [12]. There have been many studies on the effect of wearing medical gloves on hand dexterity. Many of these studies have reported no significant effect of wearing medical gloves on dexterity [19, 20]. On the other hand, studies have reported a significant effect of wearing these gloves on hand dexterity [21, 22]. In a review study on the effect of medical gloves on hand dexterity, it was reported that medical gloves had no effect on hand dexterity, or the tests are not sensitive enough to show the effect of differences [12]. On the other hand, the effect of wearing medical gloves on the grip strength (balloon dynamometer) is not known. Therefore, this study aimed to investigate the effect of wearing medical gloves on the grip strength and dexterity of the hand using alternative dexterity tests and to evaluate the comfort when using, wearing, and removing medical gloves.

Methods

Participants

The study was carried out on 20 participants (10 men and 10 women) aged 20-42 voluntary. The participants were right-handed and healthy, with no musculoskeletal disorders. To eliminate the effect of experience, no work experience with medical gloves was considered as one of the inclusion criteria. The dimensions of the participants' hands were measured according to EN 420 standard and gloves were given to each person according to this standard.

Gloves

In this study, an evaluation was conducted on 2 common gloves in medical, surgical, and laboratory work (latex and nitrile). These gloves were some of the most common gloves on the market, which were selected after reviewing the opinions of sellers and experts in this field.

2.3. Test design

2.3.1 Dexterity Assessment Tests

Two types of dexterity tests focusing on finger dexterity (9-hole pegboard and modified pegboard) were used in order to investigate the effect of different gloves on hand dexterity [23, 24]. The tests were performed according to the following protocol.

Modified Pegboard Test

This test is used to assess the dexterity of the thumb and index fingers during wearing gloves and is also a standard test (ASTM).

9-Hole Pegboard Test

This test is commonly used by occupational therapists as a quick way to measure finger dexterity. Some studies have also used this test to evaluate the dexterity of working with gloves. This test consists of a square board with 9 holes with specified distance and depth and a container containing 9 pegs (Figure 1b).

2.3.2. Evaluation of grip strength

In order to investigate the effect of gloves on grip strength (Figure 1c), a dynamometer (Squeeze (bulb) Dynamometer) according to the instructions of the American Society of Hand Therapists (ASHT) was used [25].

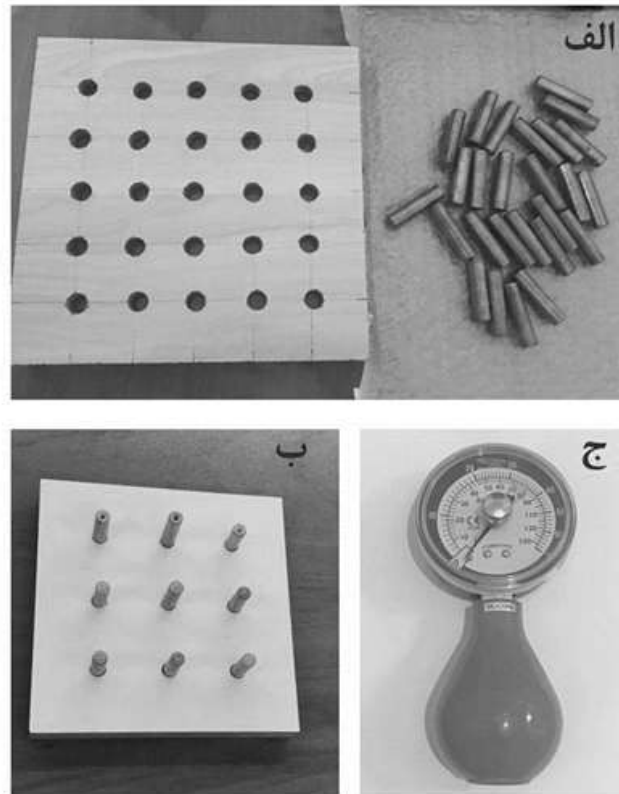


Figure 1. Dexterity and grip strength tests (A: modified Pegboard test; B: 9-hole Pegboard test; C: balloon dynamometer)

2.3.3. Subjective evaluation

A 9-point Likert scale (from extremely discomfort=1 to extremely comfortable=9) was used to assess participants' mental perception of the comfort of working with latex and nitrile gloves. The subjective evaluation of the participants was conducted using A 5-point Likert scale (1=very bad to 5=very good).

2.4. Methods

At first, the participants were given written instructions about the methods and objectives of the study, and they were taught the test practically performed by the examiner. Participants were allowed to leave the study at any stage of the experiment. All tests and gloves were presented to the participants randomly. At the beginning and end of the work with each glove, participants' viewpoints about wearing and removing gloves were evaluated using providing a 5-point scale wearing. At the end of each test of the gloves, a 9-points scale was provided to participants to assess their comfort understanding to record the discomfort level in their hands immediately after the test.

The experiments were performed from 8 to 12 a.m. in a room (22 ° C, 45% relative humidity). 2-minute intervals between tests and one-minute intervals between each repetition were considered to make a break for the subjects. The grip strength was assessed for each glove with a 1-minute interval between each attempt and a 2-minute interval between each glove-wearing.

2.5. Statistical analysis

The results were presented using descriptive statistics. Repeated measures ANOVA and Bonferroni post hoc tests were used to evaluate the effect of wearing gloves on grip strength and hand dexterity.

Findings

A total of 20 people (10 women and 10 men) participated in this study. The age range of participants was 20-40 years, with an average of 29.45. The results of the hand dexterity assessment with two 9-hole Pegboard and modified pegboard tests have been shown in [Figure 2](#).

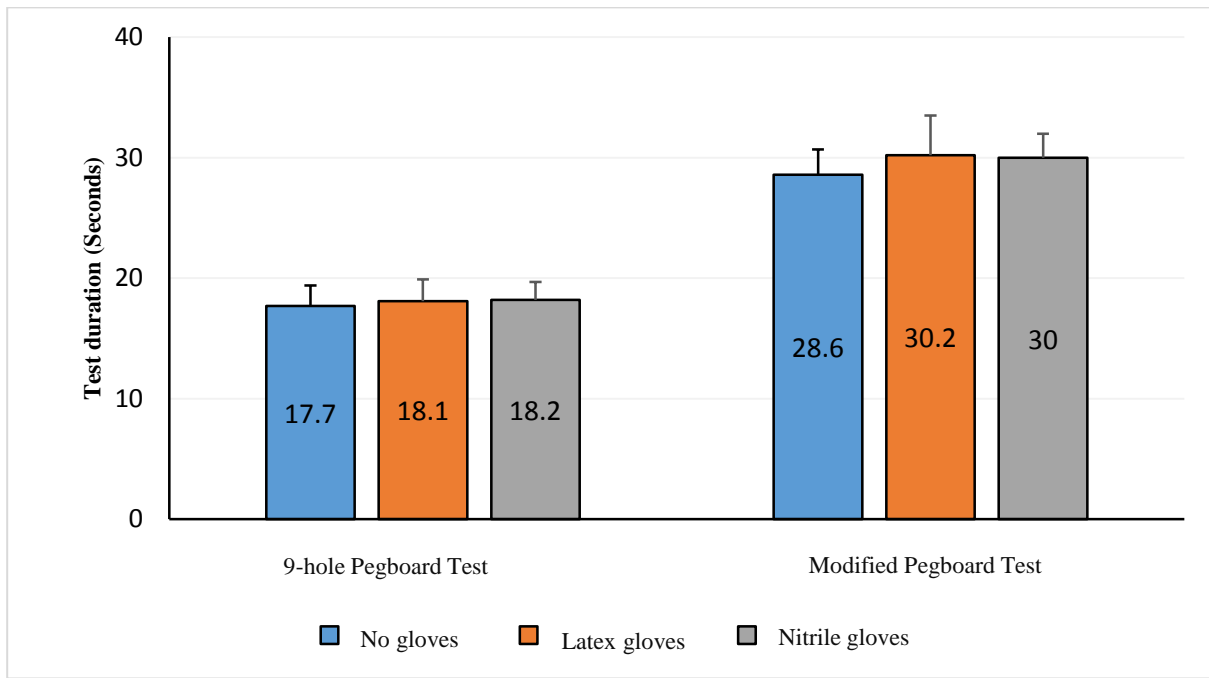


Figure 2. Results of hand dexterity test in different modes by two modified 9-hole Pegboard and dexterity tests.

The results for the grip strength in different modes have been shown in Figure 3. The mean grip strength in gloveless mode, latex, and nitrile gloves was 16.9 (3±0.9), 15.6 (6±0.6), and 15.5 (3±0.5) kg, respectively.

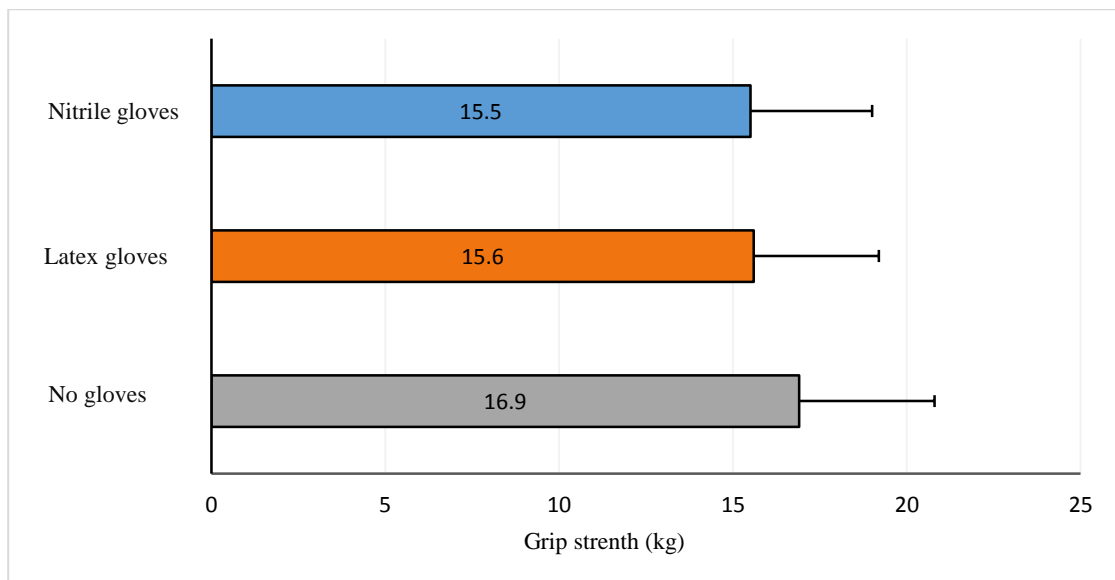


Figure 3. Grip strength of subjects with different gloves

The results of the repeated measures ANOVA test with correction of gender effect as well as Bonferroni post hoc test has been shown in Table 1. There was a significant difference in hand dexterity between gloveless hands and

nitrile gloves in the 9-hole pegboard test. The comfort of the gloves was evaluated in three general, taking off and wearing gloves modes. The results have been shown in Table 2.

Table 1. Pair comparison of grip strength and hand dexterity in different modes (Bonferroni test)

	9-hole Pegboard		Modified Pegboard		Grip strength	
	No gloves	Latex gloves	No gloves	Latex gloves	No gloves	Latex gloves
No gloves	-	-	-	-	-	-
Latex gloves	0.511	-	0.01	-	0.001	-
Nitrile gloves	0.036	1.00	0.001	1.00	0.001	1.00

Table 2. The comfort of gloves in different modes

Glove type	Comfortable during the test	Comfortable to wear	Easy to remove
Latex	7.8	2.7	4.3
Nitrile	7.3	2.2	4.3

Discussion

In this study, the effect of wearing two medical gloves on hand dexterity, grip strength, and comfort was measured using different tests. The findings of this study showed that hand dexterity using latex and nitrile gloves is reduced compared to gloveless hands. The results were consistent with the findings of Milon [21] and Zare *et al.* [13].

On the other hand, there was no significant difference between the dexterity score of latex and nitrile gloves in the 9-hole Pegboard and modified Pegboard tests. The results are in contradiction with the study of Sawyer *et al.* [26], and its reason is the different tests in the two studies. The effect of wearing medical gloves on dexterity is challenging because, in many studies, it has reduced hand dexterity [13, 22], and in some studies, it has been ineffective [19, 20]. This is addressed in a review study by Press *et al.* [12], which in addition to the type of gloves, the thickness of the gloves, whether the gloves are double-layered, or monolayer, and the type of task, one of the other important factors in assessing the dexterity of medical gloves is selecting the appropriate dexterity test with the necessary sensitivity.

In a study, the grip strength was measured using a balloon dynamometer. The results showed a significant reduction in grip strength with wearing nitrile and latex gloves compared to gloveless hands, which are inconsistent with some studies [27, 13]. Due to the discrimination power of the dynamometer, it can be used in future studies to show the difference between gloveless and gloved hands. The results of the study also showed that the comfort of wearing gloves is not appropriate and should be considered in

the design of gloves.

In general, the results of this study can be used to develop a standard for assessing the dexterity of medical gloves. Despite the study's strengths, such as the use of new hand dexterity tests and the balloon dynamometer, which was first used to evaluate medical gloves, there were some limitations.

Another limitation of the study was a limited number of gloves for evaluation. Also, a key point for future studies is the use of other dexterity tests to examine the effects of wearing gloves on dexterity, as well as the creation of simulated tests such as the time required for surgical suturing.

Conclusion

The findings of this study showed that gloves used in hospitals could significantly reduce hand function. Also, dexterity tests should be carefully selected and tests with maximum sensitivity should be selected according to the desired tasks. The use of a modified pegboard test is recommended to evaluate the dexterity of medical gloves. Wearing gloves reduces comfort during use. On the other hand, the comfort level of wearing gloves is not appropriate and it should be considered in the design of gloves. It is easier to take off the glove than to wear it.

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Conflict of interest

There is no conflict of interest.