

The Application of Spring Balancer for Hand Risk Reduction among Grinding Workers in a Thai Automobile Industry

Journal of Bioscience & Biomedical Engineering

Research Article

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Submitted : 3 Aug 2020 ; Published : 25 Aug 2020

Abstract

The purpose of this study was to evaluate the effect of a spring balancer to reduce the risk of hand injury among the automobile industry workers who used the vibration tools. The study used a quasi-experimental research designs in which a single group of 20 participants who used the vibrating machines regularly were tested, given a spring balancer and then re-tested. The results showed that the occurrence of potentially harmful levels of vibration decreased significantly (p -value <0.05) after using the spring balancer; vibration on Z-axis with the frequencies of 100, 315, 800, and 1,000 Hz significantly decreased. In addition, it was found that the strength of hand muscles after using the spring balancer also increased significantly (p -value <0.05). In conclusion, this study suggests and recommends that the spring balancer should be universally implemented across the Thai automobile industries in order to reduce the risk of hand injury and increase the strength of a worker's hands.

Keywords: Hand Risk, Spring Balancer, Vibration Tool

Introduction

Working with tools that cause heavy vibration has potential health effects on the worker's hand. Grasping vibrating tools can, for example, result in an inadequate blood flow to the hands and fingers. Morbidity of hands, for example Raynaud's phenomenon, neurosensory injury and carpal tunnel syndrome, has been widely reported in association with vibrating machine usage. A systematic review covering the scientific literature up to January 2016 showed that workers who are exposed to hand arm vibration (HAV) have an increased risk of vascular and neurological diseases compared to non-vibration exposed groups. The crude estimate of the increase in risk for such disease while using vibration tools is approximately 4–5 fold higher. The estimated effect size (odds ratio) is 6.9 for the studies of Raynaud's phenomenon when including only the studies judged to have a low risk of bias. The corresponding risk of neurosensory injury is 7.4 and the equivalent of carpal tunnel syndrome is 2.9 [1].

This study focuses on employees working in a motor vehicle assembly plant. They use machines with a speed of 6,300 and

22,000 revolutions per minute and a pressure of 90 PSI. The working period starts from 08:00 to 20:00, with the 10-minute breaks during the morning and afternoon. When assessing health complaints among the workers, it was found that 100% of workers reported numbness and pain symptom in their hands, and 20% reported a so-called trigger finger. The key work related factor causing these problems was the fact that these workers were holding a portable grinder machine throughout their working shift.

Tool selection is a critical important issue for user safety, comfort and health. The use of tool balancers can reduce the effort of holding and operating the vibrating tools. The lighter tool can get the job done properly [2]. A study about the transmission of vibration in the hand-arm system with special reference to changes in compression force and acceleration found that when the grip strength was increased fourfold, i.e., 12 dB, vibration increased only 3 to 5 dB in the hand-arm system. Thus, changing the weight of a vibrating tool does not sufficiently reduce the vibration. The attempt to reduce the

vibration should emphasize++ on the mechanical parts of the engines [3].

Therefore, the researchers considered the characteristics of the spring suspension, which can help to decrease the weight of the device and also the load on the gripping handles. It was expected that the risk to hand injury would be reduced by the application of springer balancer because of reduced exposure to vibration through the hand. In addition, workers will experience decreased fatigue and more comfort during working hours. The application of springer balancer could also improve the efficiency of the entire production process in the long run.

Method

Construction Site and Participants

The site of the study was located in an auto parts factory in Chonburi province, Thailand. Twenty workers who used the portable grinder machines and did not exhibit the symptoms or diagnosis of hands or arm injuries were selected in the study. Ten workers used the grinder machine with the model that supplied speed of 6,300 RPM while the remaining ten workers used the machines with the model that supplied speed of up to 22,000 RPM.

Data Collection

There were two major components of this study: the first phase of the study involved the acceleration of HAV and hand grip strengthening before the application of a spring balancer, while the second phase focused on data collection after the application of the spring balancer.

The acceleration of HAV was measured by the vibration meter modeled VI-410 DYTRAN 3023A2 S/N 8692. The evaluation of vibration exposure was based on the measurements of the acceleration on all three axes; x-, y- and z-axes. The vibration measurement was made with the force which are the representative of the coupling force at the interface between the hand and the grinder, handle or work piece in typical operation of the tool [4].

The handgrip strength test was evaluated using the handgrip dynamometer Lafaye modeled 78010 S/N 72120277. The subject held the dynamometer in the hand to be tested. The handle of the dynamometer was adjusted -the base should rest on the first metacarpal, while the handle should rest at the middle of the fourth fingers. The subject squeezed the dynamometer with maximum isometric effort and maintained this posture for about 5 seconds. No other body movement was allowed during this test. The value of best result was recorded and listed (in kg) and compared to a guide with expected scores for Thai adults [5]. The observation time was at the end of the working shift.

Results

A total of 20 grinding workers from Trimming Section

were participated in the study. The workers were 11 males and 9 females with the majority age between 18-28 years. Approximately 85% of the participants were right-handed.

The tool balancer modeled TIGON-TW-1R which has the capacity to lift 0.5 to 1.5 kg was hung up a hook about 2 meters high. Then the vertical distance of the hanging point where the grinding part was placed on the table was adjusted.



Figure 1: The installation of spring balancer

The comparative study of the average acceleration on the handle of grinders at the speeds of 6,300 RPM and 22,000 RPM showed a significant difference (p-value <0.05) only for the workers using the grinder with a speed of 6,300 RPM.

There was a significant difference of the acceleration on the Z axis of the grinder grip with a speed of 6,300 RPM (p-value < 0.05). The average vibration acceleration was reduced to 100, 315, 800, and 1,000 Hz. The comparison of the average of hand strength between before (34.40 kg. +11.56) and after (38.12 kg. +11.78) using the spring balancer was found to increase significantly (p-value <0.05).

Type of Grinders	(S.D.)		Paired t test	P – value
	Before using a tool balancer	After using a tool balancer		
Speed 6,300 RPM	0.10 (0.15)	0.09 (0.14)	-1.887	0.040*
Speed 22,000 RPM	0.08 (0.13)	0.07 (0.11)	-0.919	0.187

Table 1: The comparative average of acceleration between before and after using the tool balance

Discussion

After the installation of the spring balancer tool, the vibration was reduced only for the grinder tool with a speed of 6,300 RPM. The vibration was reduced only on the Z axis. The frequency of vibration reduction is 100, 315, 800 and 1000 Hz of grinding machines with a speed of 6,300 RPM. The reason for this vibration reduction of the grinder with a speed of 6,300 might come from the physical shape of the grinder which has a pointed handle tip. Due to the sophisticated work piece grinding, the direction of work piece grinding is not stable. Thus, the installation of spring balancer causes the worker to change the amount of force or direction of force resulting in a change in the acceleration on the Z-axis.

The study has shown that after the application of the spring balancer tool, hand strength has become higher than before the installation. This is because of the change in the way the worker handles the grinding machines after installing the spring balancer, which helps to support the weight of the machine. Employees who use the grip on the grinder to reduce the contact time to the grinder have the opportunity to relax their hand muscles as well [4].

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