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FEATURE ARTICLE

Surface Electromyography-Assisted Ergonomic Analysis in a Newspaper Printing Plant: A Case Study

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This case study reports on the use of surface electromyography (SEMG) evaluation in a work environment, including production, to show a relationship between muscle dysfunction and specific job tasks and their injury potential. The results show that SEMG can help identify discordant muscle activity as part of an ergonomic evaluation. Such an evaluation leads to improvement in muscle function through SEMG-guided worker/workplace retraining.

Introduction

Surface electromyography (SEMG) has been used in the workplace for many years. Hedge and Shaw (1996), Andersen et al. (2008), Donaldson, Nelson, Skubick, and Clasby (1998); Donaldson, Donaldson, and Snelling (2004); Veiersted, Westgaard, and Andersen (1993); and Peper, Gibney, and Wilson (2005) have published data that support SEMG's being the only method whereby muscle function and its relationship to job tasks can be objectively and reproducibly assessed. SEMG assessment includes data collection at rest, as well as with static and dynamic postures. The data gathered from this technology can help evaluators analyze whether muscles are being used correctly. This assessment of muscle function can be combined with observation of the worker's techniques, enabling the assessment to determine whether the major contributing factor to the muscle dysfunction is volitional behavior or postures and movements that are required by the workstation's design and/or layout. In either case, remediation can occur by either improving the workstation or changing the worker's behavior. As muscle function improves by whichever means, the occurrence of injury should be reduced.

Company Information

This case study reports on a major U.S.-based news publishing and media concern with multiple print facilities throughout the United States. Its largest facility has peak print output of more than 300,000/day. The plant is approximately 120,000 square feet, and the Environmental & Safety Department has implemented various programs that have improved the overall safety record. The press is a Goss Metro doublewide, semicylindrical with headliner offset and Global Newsliner Towers added to provide color capability.

A preliminary review of worksite injuries in the plant determined that there were excessive shoulder (rotator cuff) injuries (significantly more injuries to the right shoulder) and neck injuries to the pressmen, and subsequent analysis indicated that these were associated with one or more of the following tasks: blanket washing, newsprint roll handling, and predrive belt positioning wheel adjustments.

Our objective was primarily to assess muscle function during these tasks and compare these data with the data collected during muscle monitoring, both before the tasks began and after they were completed. The goal was to determine whether most of the problem was due to the workstation or to worker technique and then to offer recommendations to improve either or both in an effort to lower the injury risk.

Muscle activity data of two muscle groups was collected using computer-assisted SEMG before and after tasks and sometimes during the tasks done by the pressmen during their shift.

Results showed that muscle activity in all three tasks indicated dysfunction because of either asymmetrical patterns for a symmetrical task or because of posttask

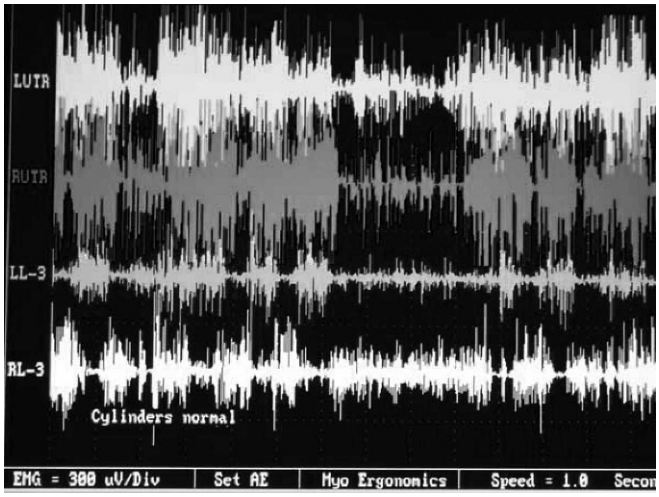

Figure 1. Worker cleaning as usual, with one arm and hand controlling the cleaning rag and the other arm and hand simultaneously controlling the inch-safe buttons in the control panel. For the arm to control the inch-safe buttons, it needed to be abducted to 90° or more and externally rotated beyond the coronal plane of the body.

muscle activity remaining higher than pretask activity. We recommended body mechanics training and exercises aimed at releasing tight muscles and restoring symmetry, along with workstation modifications. Administrative changes were recommended, which included a review of safety guidelines related to cleaning technique and observing OSHA's inch-safe service rule for presses.

We conclude that SEMG is a valuable tool that allows objective and reproducible assessment of muscle during ergonomic assessment. It is thought that making the aforementioned changes will result in fewer injuries.

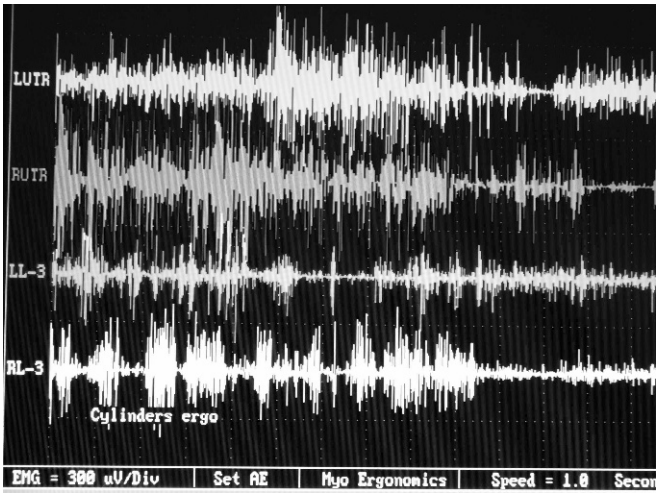

Figure 2. Worker cleaning after ergonomic intervention with body mechanics training, in which the worker was instructed to lean one arm on the lower cylinder (in front of the worker) while the other arm cleaned. The inch-safe buttons would be controlled after each cleaning, not during the cleaning.

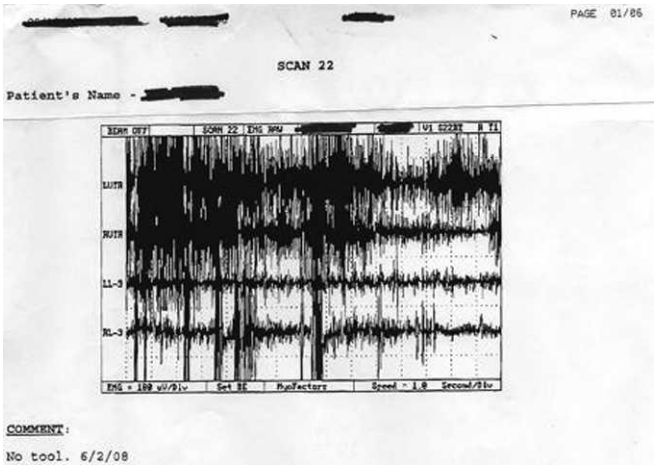

Figure 3. Worker using a rag soaked in solution to clean the cylinders. He sometimes stabilized himself by placing the noncleaning hand on the lower cylinder, whereas at other times, he used that hand to press the inch-safe buttons on the control panel.

SEMG Findings

This SEMG study was started and completed on August 10, 2006. All data were collected on the four-channel Noromed 8000 with a sampling rate of 1,200 per second with a bandpass filter of 20 to 400 Hz. Throughout the study, two silver/silver chloride electrodes (interelectrode distance of 2 mm) were placed parallel to the belly of the targeted muscles with the skin prepared following standard procedures (i.e., abraded with tissue containing rubbing alcohol).

The muscles studied were the left upper trapezius, right upper trapezius, left lumbar paraspinals, and right lumbar paraspinals at the L4/L5 disk levels of the lumbar spine.

The study was based in part on the work of Stuart Donaldson (Donaldson et al., 2004), which compares muscles from side to side during tasks. Donaldson's work on chronic muscular pain states that a bilateral difference greater than 20% is clinically significant, meaning that the employee/patient is at risk for developing or aggravating a musculoskeletal disorder. The bilateral difference in absolute terms is derived by subtracting the low side from the high side, and the relative (%) difference is then derived by dividing this by the high side. We also looked at resting muscle patterns before and after movement.

Blanket Washing

SEMG data were collected during the blanket cylinder washing using three different methods.

Method 1. The operator was told to perform his task as he normally would, so that one hand would be manipulating the inch-safe buttons on the control panel and the other would be simultaneously washing the blanket (see Figure 1).

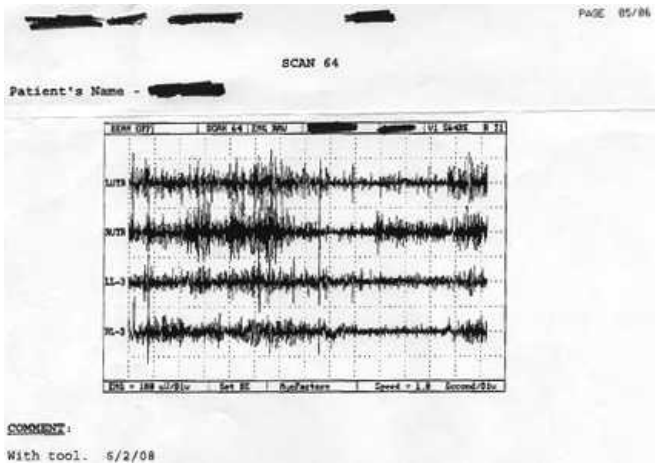

Figure 4. Worker using tool after brief instructions in proper mechanics. The employee was instructed to start cleaning the cylinder at one end and then move the tool the entire length of the cylinder. He was to avoid quick back-and-forth motions covering only small sections of the cylinder each time. He was then to go fully in the other direction, stopping to clean the tool head and to reapply the solution.

Method 2. The operator performed the same task but this time was trained to clean the blankets without simultaneously pushing the inch-safe buttons on the control panel. Instead, the noncleaning arm was to either rest at the worker's side or help maintain a three-point stance by resting the noncleaning arm or hand on the lower cylinder (see Figure 2).

Method 3. The operator was trained to use a cleaning tool that had a pole measuring approximately 4 feet in length and having two ergonomic handles (one near the midway point of the pole and the other near the end closest to the worker) and a flexible, rectangular cleaning head (see Figures 3 and 4).

Discussion

The SEMG data repeatedly showed patterns reflective of discordant muscle activity when the various job tasks were done as usual, either in the form of asymmetrical patterns for symmetrical tasks, failure to recover to pretask resting values, or generally excessive values before ergonomic intervention. Some of the postures typically seen are related to volitional behavior and technique. For example, the employees will simultaneously reach for both the cylinder and the control panel because they can complete their task more quickly. This behavior makes the muscles and related anatomy work harder than if the noncleaning arm were resting. This particular task requires very awkward and strenuous body mechanics because of the construction of the presses. When we introduced a supplemental cleaning tool as described above, there was a marked reduction in muscle activity while the worker completed the same task. Subjective reports were that the activity was less strenuous with the supplemental tool than cleaning with the usual method. These studies show the SEMG to be an effective tool to help objectively and reproducibly identify skeletal muscle function and to guide ergonomic intervention.

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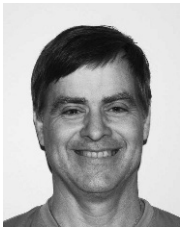

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