

ZeroTape vs. Standard Tape Roller

Comparison of the Ergonomic Quality of Different Packaging Tape Systems

The Department of Work Science and Ergonomics at the University of Siegen was commissioned as an external and neutral research facility to examine the ZeroTape packaging tape system in terms of its ergonomic quality and possible associated assistance with work in comparison with conventional/classic models.

Work Science at the University of Siegen has a long tradition which dates back to the 1970s. Research focuses are orientated towards analysing, assessing and designing as well as evaluating the technical, organizational, economic, ecological and social conditions of the operating processes on the one hand and products and consumer goods on the other, taking into account legal framework. According to the motto, 'man is the measure of all things', the primary concern, and not otherwise, is particularly geared towards the ergonomics of the product which make labour easier for human beings. In recent years, national and international studies have been carried out on the ergonomics of various PC-input systems (mice and keyboards), on muscular strain during extinguishing processes (fire brigade), and on the ergonomic quality of hand-tools. In the case of the latter, the department was also involved in the optimization and further development of grip design. Due to the scientific quality of both these and previous studies, the Department of Work Science and Ergonomics has become one of the leading institutes in the area of product ergonomics.

This long-term expertise and knowledge in examining and comparing the ergonomics of manual work equipment is now to be transferred to packaging systems. During the course of this study, working trials lasting several hours were carried out with 15 test subjects to analyse the ergonomic quality of the tape dispenser. The main focus was placed on the handling aspect of the work equipment as well as on the muscular strain of the hand-arm-shoulder system or the following muscles affected by tape dispensers:

Muscle	m. biceps brachii	m. deltoid pars spinalis	m. triceps brachii	m. flexor carpi radialis	m. extensor digitorum	m. flexor digitorum	m. extensor carpi ulnaris	m. flexor carpi ulnaris
Function	Holding and guiding the dispenser	Pulling the dispenser over the package	Support when cutting	Guiding over package edges	Hand stability	Gripping, guiding and holding	Attachment and cutting	Attachment and cutting

During the investigation three packaging tape dispensers were used:

- ZeroTape-packaging tape dispenser with safety knife
- Standard-packaging tape dispenser
- Standard-packaging tape dispenser with faulty knife

To be able to quantify the different muscle strains during the use of various dispensers, continuous electromyographic derivations were provided through many methods. As shown in Figure 1, during the work trials the electrical voltages of the test subjects' muscles were recorded (see Fig. 2) via bipolar leads (i.e. via two electrodes attached).

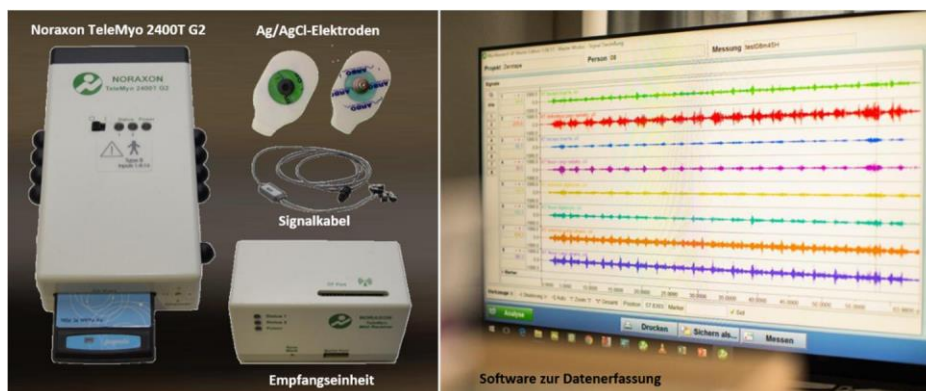


Figure 1: The measuring system for recording the electromyographic activity with transmitter and receiver unit, surface electrodes and signal cables with preamplifier unit (left) and screenshot of software display (right)

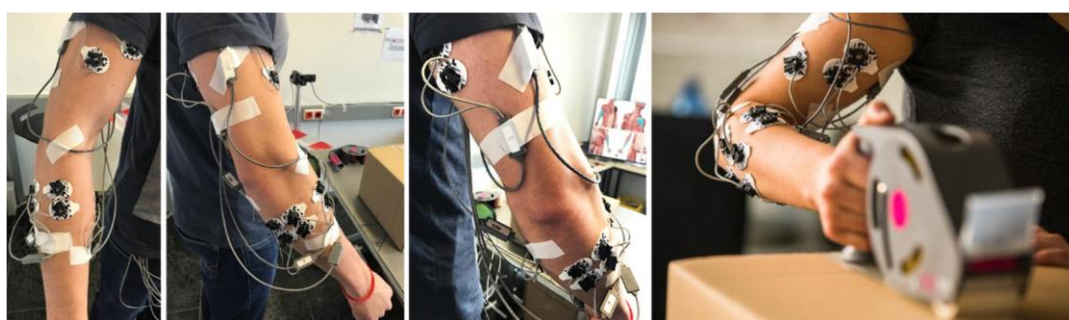


Figure 2: The recording of muscle activity with surface electrodes on the right-hand shoulder-arm-shoulder system.

The results of the study are shown below in Figure 3. The muscular strain during the use of the ZeroTape was set as a reference and the additional or reduced activity of the other dispensers were calculated accordingly.

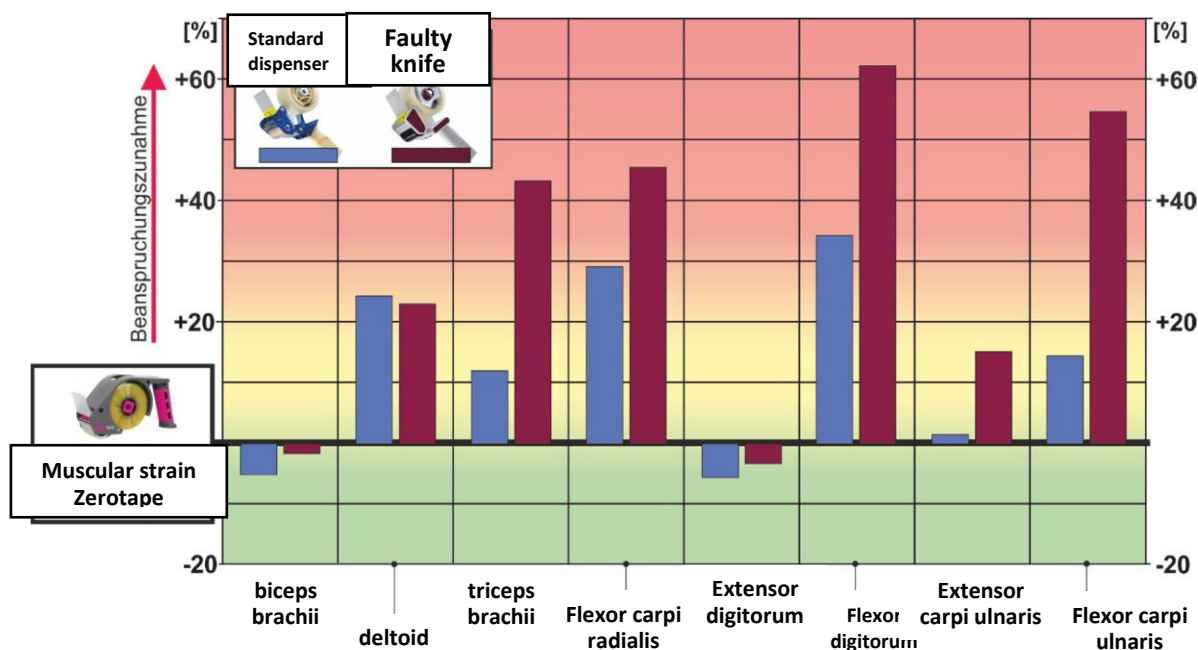


Figure 3: Added or reduced muscular strain in % when using a standard dispenser with and without a fault knife in comparison to the reference ZeroTape dispenser (mean value calculated over 15 test subjects)

From the investigation results it can be seen that the ZeroTape dispenser presents a valuable ergonomic development. For example, the use of a standard dispenser leads to significantly higher strain in 5 out of the 8 muscles considered.

Due to the novel design, physiologically unfavourable deflections of the wrist during the sticking process are not completely avoided, but at least significantly reduced. This is particularly visible with the heavy wrist-straining attachment and detachment processes (see Fig. 4). In comparison to the standard dispenser, the muscular strain of the flexor carpi radialis muscle (about -15%) and flexor carpi ulnaris muscle (about -30%) is thus minimised.

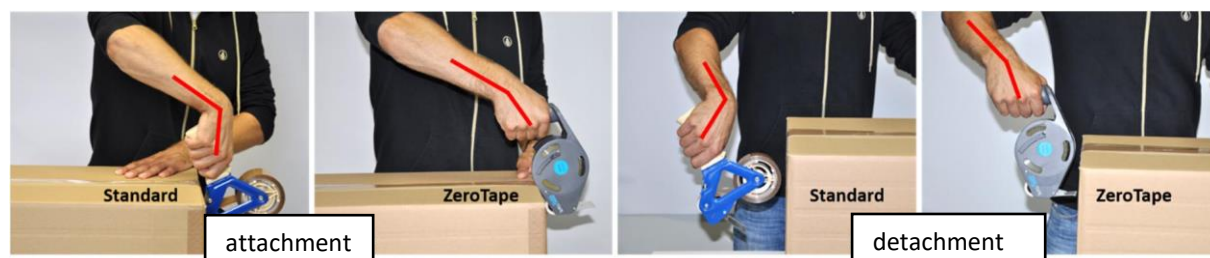


Figure 4: Deflections of the wrist during the attachment and after detachment with use of the standard dispenser and ZeroTape

The greatest savings in muscle strength – again compared to the standard dispenser – can be attained in the flexor digitorum (-35%) compared to the standard dispenser, which is due to holding the ZeroTape dispenser in a positive-locking connection between the handle and the hand (see Fig. 5). Here the new design shows its greatest advantages over the classic design.



Figure 5: Representation of different coupling methods when using the standard dispenser. Red arrows indicate the corresponding directions of force.

The reduced deflections of the wrist, coupled with the significantly lower gripping force, bring further advantages. Therefore, the possible limitations of the wrist (tendon insufficiency) as well as the occurrence of discomfort (epicondylitis – a.k.a. tennis arm and compression syndrome) are reduced.

The ZeroTape dispensing resistance, which is measurable in conjunction with corresponding adhesive tape, also relieves the shoulder muscles, especially the deltoideus pars spinalis (-25%).

The effects of the faulty knife are also visible (see Fig. 3). Through the difficult detachment process, the muscular strain of the wrist muscles (partly > 60%) and the triceps brachii increases enormously. Therefore, in practice, dispensers with retractable safety knives (such as ZeroTape) are preferable without restriction.

On the whole, the bottle-neck muscle structure in the shoulder and lower arm is relieved by an average of almost 25% with the use of ZeroTape. Since in many logistics areas packaging tape systems are also often used continuously, this does not only present a great assistance. In addition, more natural handling can reduce the occurrence of possible muscle and joint discomfort, especially during critical attachment and detachment procedures.

Based on these findings, the ZeroTape packaging tape system can be fully recommended from an ergonomic point of view.

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