A multi-use, self-adhesive sEMG electrode, designed for clinical applications

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Summary

Despite its high potential, surface electromyography (sEMG) has not found its way into clinical routine up to now. The underlying factors are various. However, the complexity of the sEMG procedure, the low tolerance of the method to incorrect positioning of the electrodes and the resulting high time expenditure and high costs for the application lead to low acceptance by the users in the medical sector. This paper presents a newly developed, multi-use, self-adhesive sEMG electrode, which overcomes some of the barriers preventing dissemination of sEMG in clinical applications.

Introduction

For more than 50 years, surface-electromyography (sEMG) has demonstrated its high potential for clinical decision-making. SEMG provides relevant information about muscular activation and neuromuscular control relevant for diagnostics, therapy and training. However, despite its high potential sEMG has not taken the step from the bench into (clinical) practice. According to a survey by the European Society for Movement Analysis in Adults and Children (ESMAC), sEMG is only routinely used in around 10% of clinical gait laboratories in Germany. The underlying factors are manifold and have been discussed in detail in various papers. Not meeting the user expectations regarding ease of use, tolerance of user errors and application costs has been repeatedly identified as a major barrier preventing widespread dissemination of sEMG in clinical applications.

Methods

The demand for sEMG systems that are simple and fast to use and at the same time cost-effective has led to the consideration that a suitable sEMG electrode should be self-adhesive and reusable. To fulfill these requirements, silicone rubber was chosen as the carrier material. To achieve the adhesive properties of the carrier material, the mixed silicone components were poured into a rectangular mold with the underside coated with a porous material. In this way, the silicone adheres to the small pores, enabling the carrier material to adapt to irregularities of the human skin. This results in an adhesion effect. Additionally, a curved shape of the silicone carrier leads to a better adaptation to the shape of the human body and, thus, to even better adhesion (Figure 1).

Since the quality of the derived signals should not be impaired by inaccurate positioning nor by time, the electrode should allow the derivation of at least two bipolar sEMG leads and include the ground electrode. A total of 7 gold contacts were integrated into the carrier material to form regions with high conductivity (Figure 1). The gold contacts used have a hemi spherically curved surface, a diameter of 8 mm, and a spacing of 10 mm. By differential amplification, two sEMG leads were created from 3 gold contacts (lead electrodes) arranged in line. The required ground electrode was formed from the remaining 4 gold contacts, arranged symmetrically around the center lead electrode and short-circuited to each other.

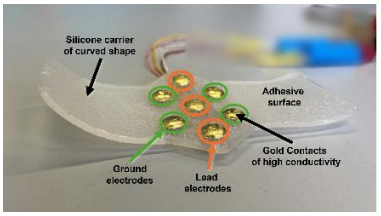

Figure 1: Multi-use, self-adhesive sEMG electrode;

Results and Discussion

The newly developed sEMG electrode was tested for adhesion strength, adhesion duration, and reusability on 7 subjects (Figure 2). The adhesive sEMG electrode could be reused up to 5 times without any problems and was worn by the test subjects for an average of 14 hours daily. In addition, the signal quality was analysed in terms of the signal-to-noise ratio, long-term stability, and interference from movement artifacts. The signal quality achieved was comparable to conventional wet electrodes and stable over several hours. Only minor movement artifacts occurred even with strong movements.

Figure 2: Application of the self-adhesive reusable electrode for the detection of muscular activation of different muscles.

Conclusions

The carrier material with integrated gold contacts represents an adhesive electrode material with which an sEMG electrode can be realised that adheres to the skin surface like a plaster and is reusable. Two integrated active sEMG channels reduce the risk of errors due to inaccurate positioning by the user. With this properties the newly developed sEMG electrode overcomes some of the barriers preventing dissemination of sEMG in clinical applications.

Acknowledgments

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