



ISB 2013
BRAZIL

XXIV CONGRESS OF THE INTERNATIONAL
SOCIETY OF BIOMECHANICS

XV BRAZILIAN CONGRESS
OF BIOMECHANICS

PAIN HAS A GREATER EFFECT ON SINGLE MOTOR UNIT DISCHARGE DURING FORCE-CONTROL THAN POSITION-CONTROL TASKS

Peter Poortvliet, Kylie Tucker, Paul Hodges

Centre of Clinical Research Excellence in Spinal Pain, Injury and Health, The University of Queensland, Australia

email: p.hodges@uq.edu.au

SUMMARY

Single motor unit (SMU) discharge rate reduces during pain in isometric force-controlled contractions, and force is maintained by recruitment of additional SMUs and/or increased discharge rate of some SMU activated before pain. This is thought to redistribute force in the muscle, potentially to reduce pain. When the objective is to maintain a joint's position rather than a unidirectional force, the control of SMU discharge is different and may not be affected in the same way by pain. This study compared changes in SMU discharge rate in position- and force-control tasks during experimental pain induced by injection of hypertonic saline into the infra-patellar fat pad. SMU discharge was recorded from the medial and lateral vastus muscles of the knee during isometric knee extension against resistance with force feedback, and during a task with an equivalent load applied to the free leg and feedback was provided of knee joint angle. SMU discharge rate was determined for 189 SMU that were identified both before and during pain in either or both the position and force control tasks in 14 participants. On average, SMU discharge rate reduced during pain in both tasks, and the reduction was larger during force-control. Discharge rate increased for a greater proportion of SMU during position-control (although the increase was small). Discharge rate variability reduced during pain for the force-control task. The findings imply different strategies of adaptation to pain for the two tasks, which may help explain inconsistencies in the clinical literature.

INTRODUCTION

Movement is changed in pain. The mechanisms that underpin these changes are beginning to be understood [2], but a major issue that continues to challenge the field is the explanation for the considerable variation in the observations reported in the literature [4]. Recent theories attempt to explain some of the differences between experimental paradigms and individuals on the basis of task-specific differences in adaptation to pain. This study addressed the issue of potential differences in the adaptation to pain between muscle contractions that target control of isometric force and those of a more postural nature that target control of a joint position.

Single motor unit (SMU) discharge rate reduces during pain in isometric force-controlled contractions. In this case force is maintained by recruitment of an additional population of SMUs and/or increased discharge rate of some SMU activated before pain [3]. This is thought to redistribute force in the muscle, potentially to reduce pain provocation. When the objective is to maintain a joint's position rather than a unidirectional force, the control of SMU discharge is different and adaptation of SMU discharge in the same manner as during force controlled contraction may not be an appropriate response to pain and other solutions, such as increased muscle activation and/or co-contraction may be favoured.

This study aimed to compare changes in SMU discharge between position- and force-controlled contractions of the knee extensor muscles with pain induced experimentally by injection of hypertonic saline into the infra-patellar fat pad to induce anterior knee pain [1].

METHODS

SMU discharge was recorded from the medial and lateral vastus muscles of the knee with fine wire electrodes in 13 participants. In separate trials, participants performed knee isometric knee extension against resistance with force feedback (force-control), and during a task with an equivalent load applied to the free leg and feedback provided of knee joint angle (position-control). Contractions were performed before and during knee pain induced by injection of hypertonic saline (0.25 ml 5% NaCl) into the infra-patellar fat pad. In 8 participants force- and position-controlled contractions were studied in separate sessions with replacement of the fine-wire electrodes, and therefore, recording of different SMUs in each task. In the remaining participants both tasks were performed on the same day and the same SMUs could be investigated in both tasks. SMU discharge rate and discharge rate variability were compared between tasks (position- vs. force-control) and between pain states (no pain vs. pain) with repeated measures analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Pain was similar during the pain condition in both tasks (means of 3.6 and 3.8/10 on a visual analogue scale). SMU data were extracted for 189 SMU. In the 5 participants with recordings made for both tasks in a single session, 35 were recorded from the same SMU before and during pain in both position- and force-control tasks. On average, SMU discharge rate reduced during pain in both tasks ($P < 0.05$). Analysis of the SMU that were recorded on the same day showed a larger reduction in discharge rate in the force-control task ($P < 0.05$).

The population of active SMU changed in both tasks and the discharge rate a subset of SMU increased during pain. Although the increase was small, this was apparent for a greater proportion of SMU during position-control task (Position-control – $n=28.6$; force control – $n=11.4\%$). Discharge rate variability reduced during pain only for the force-control task.

CONCLUSIONS

The findings of this study imply subtle differences in the strategy of adaptation to pain for position- and force-control tasks, despite the equivalent mechanical demand and nociceptive input. The data confirm that pain does not lead to generalized inhibition of drive to a muscle, but instead leads to a redistribution of input, and the manner in which this occurs differs between tasks. Differences in the effect of pain on SMU discharge variability could imply differences

in manner in which nociceptive input impacts on motoneuron excitability. Task differences in adaptation may account for some of the inconsistencies in the clinical and basic research literature.

ACKNOWLEDGEMENTS

This study was supported by funding from the National Health and Medical Research Council of Australia.

REFERENCES

1. Bennell K, Hodges PW, Mellor R, Bexander C, Souvlis T, *Journal of Orthopaedic Research* **22**:116-121, 2003
2. Hodges P, Tucker K, Moving differently in pain: A New theory to explain the adaptation to pain. *Pain* **152**:S90–S98, 2011.
3. Tucker K, Butler J, Graven-Nielsen T, Riek S, Hodges P, Motor unit recruitment strategies are altered during deep-tissue pain. *J Neurosci* **29**:10820-10826, 2009
4. van Dieen JH, Selen LP, Cholewicki J, *J Electromyogr Kinesiol* **13**:333-351, 2003