# INFLUENCE OF HIP ANGLE ON MUSCLE ACTIVITY AND LUMBAR POSTURE IN DENTISTS DURING A DENTAL SCREENING TASK

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## INTRODUCTION

To avoid potentially painful end-range positions and to facilitate activation of trunk muscles, adopting neutral lumbar spine postures has been emphasized. Such a neutral posture is obtained through positioning the lower lumbar spine into slight anterior tilt and slight lumbar lordosis while relaxation of the thoracic spine is maintained. Maintaining this neutral posture was found to be easier while sitting with an open hip angle.

Whereas in the past dental stools facilitated a 90° hip angle, recently different stools have been developed to allow a greater hip angle. Next to saddle stools, also the Ghopec has been developed. The latter comprises a seat pan consisting of a horizontal rear part for the pelvis and an inclinable sloping down front part for the upper legs, with a vertically and horizontally adjustable back rest.

The purpose of the present study is to evaluate the influence of different sitting modes on muscle activity and lumbar posture in dentists during work.


Fig. 1a: Ghopec Junior b: Salli MultiAdjuster c: A-dec Doctor's stool

## MATERIALS AND METHODS

A one-session repeated measures within-subjects study was performed. Twenty-five participants were recruited on a voluntary basis. Participants were pain-free, aged > 18 years and not pregnant.

Data were collected for 3 different stools: Ghopec Junior (Fig. 1a), Salli MultiAdjuster (Fig. 1b) and A-dec standard Doctor's stool, type 1601 without tilt feature (Fig. 1c)

The activation of 7 muscles was analysed by means of sEMG. The muscles studied were latissimus dorsi (LD), iliocostalis lumborum thoracic part (ICLT), multifidus (MF), gluteus maximus (GM), rectus femoris (RF), internal abdominal oblique (IO) and external abdominal oblique (EO)(Fig. 2).

To evaluate the lumbar spinal posture in the sagittal plane the BodyGuard™ was used.

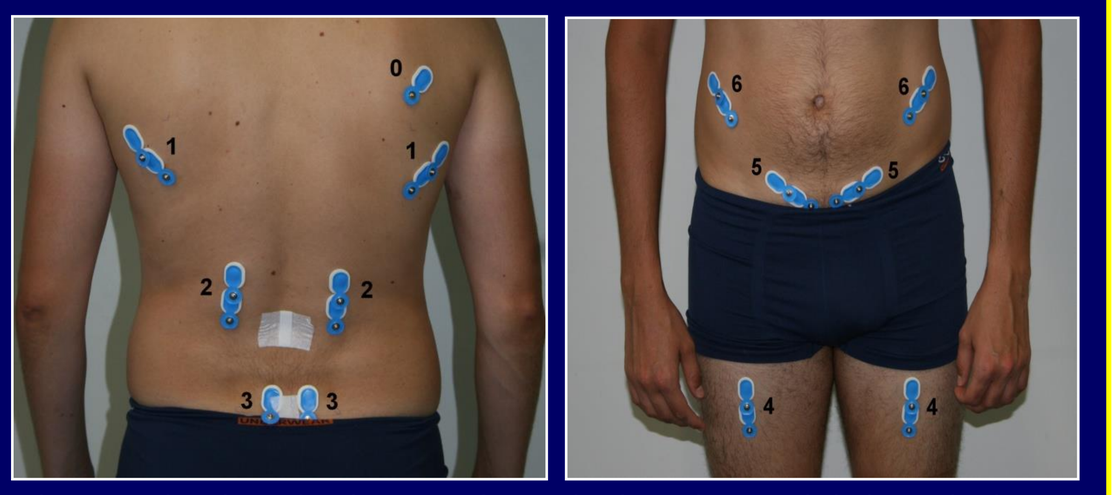


Fig. 2a & b: Electrode placement for earth electrode = 0; latissimus dorsi = 1; iliocostalis lumborum thoracic part = 2; multifidus = 3; rectus femoris = 4; internal abdominal oblique = 5; external abdominal oblique = 6.

### *PROCEDURE*

Participants were positioned at a simulated workstation and the ideal working distance was defined. The standard stool was adjusted until the hip and knee joints reached an angle of 90° and the lumbar spine was in a neutral position. Both other stools were adjusted to 125°. Next the back rests and the height of the phantom head were adjusted to each stool. Participants completed a standardized dental screening task of 15.5 minutes on each stool with a break of 5 minutes between stools.

Electromyography data were recorded at 0, 5, 10 and 15 minutes for 30 seconds and posture monitoring was performed throughout the complete 15.5 minutes.

### *STATISTICAL ANALYSIS*

Level of significance was set at α = 0.05. Normality was analyzed using Shapiro-Wilk tests. Non-parametric Friedman and Wilcoxon signed rank tests with Bonferroni correction were used to analyze sEMG results and parametric one-way repeated measures ANOVA to evaluate the BodyGuard™ results (post hoc pairwise comparisons with Bonferroni correction).

| | LD right | | ICLT right | | MF right | | GM right | | RF right | | IO right | | EO right | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Median | Range | Median | Range | Median | Range | Median | Range | Median | Range | Median | Range | Median | Range |
| Ghopec | 6.0 | 3.2-21.0 | 13.2 | 4.9-35.7 | 6.7 | 3.2-55.4 | 1.9 | 1.5-3.2 | 2.9 | 1.4-10.9 | 4.0 | 1.9-9.4 | 4.3 | 2.6-7.3 |
| Saddle | 6.2 | 3.4-15.4 | 10.5 | 2.4-35.8 | 5.5 | 2.3-21.3 | 1.9 | 1.5-4.2 | 2.5 | 1.5-7.3 | 5.7 | 1.8-20.0 | 4.0 | 2.1-9.9 |
| Standard | 7.4 | 4.1-14.7 | 18.6 | 8.6-48.7 | 7.9 | 3.0-32.0 | 1.9 | 1.4-5.0 | 2.0 | 1.3-27.4 | 3.3 | 2.0-11.8 | 4.0 | 1.9-8.9 |
| p-value | 0.075 | | <0.001 | | 0.094 | | 0.956 | | 0.344 | | <0.001 | | 0.422 | |

| | LD left | | ICLT left | | MF left | | GM left | | RF left | | IO left | | EO left | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Median | Range | Median | Range | Median | Range | Median | Range | Median | Range | Median | Range | Median | Range |
| Ghopec | 4.0 | 2.8-12.2 | 13.8 | 4.7-32.8 | 6.3 | 3.1-22.2 | 1.7 | 1.3-5.7 | 3.8 | 1.5-9.9 | 4.5 | 1.8-9.6 | 3.6 | 2.2-8.0 |
| Saddle | 4.7 | 2.9-10.4 | 10.2 | 2.7-32.3 | 6.5 | 2.1-26.5 | 1.9 | 1.3-5.2 | 3.0 | 1.6-8.3 | 6.5 | 1.7-18.8 | 5.1 | 2.3-13.4 |
| Standard | 4.2 | 2.9-11.2 | 14.6 | 5.8-35.3 | 7.0 | 2.7-33.7 | 1.9 | 1.3-4.0 | 2.8 | 1.6-18.8 | 3.8 | 1.8-7.7 | 3.9 | 2.2-6.6 |
| p-value | 0.422 | | 0.012 | | 0.113 | | 0.405 | | 0.444 | | <0.001 | | 0.012 | |

LD = latissimus dorsi; ICLT = iliocostalis lumborum thoracic part; MF = multifidus; GM = gluteus maximus; RF = rectus femoris; IO = internal abdominal oblique; EO = external abdominal oblique

Table 1: Median muscle activity and range (in µV) of the different muscles during a periodontal screening task on the Ghopec, saddle and standard stool.

## RESULTS

### *MUSCLE ACTIVATION*

Significant differences were found for right ICLT (p<0.001) and left ICLT (p=0.012), right IO (p<0.001) and left IO (p<0.001) and for left EO (p=0.012) (Table 1). The p-values of pairwise comparisons are illustrated in Table 2.

### *LUMBAR POSTURE*

A significant difference in lumbar flexion between the three stools was found (p=0.003)(Table 3). Flexion on the saddle stool was significantly lower than on the Ghopec (p=0.022). Posture on the standard stool was more flexed than on the other 2 stools, but only significantly higher than on the saddle stool (p=0.014).

| Muscle | Side | Significant difference | p-value |
|---|---|---|---|
| ICLT | Right | Standard > Ghopec | 0.009 |
| | | Standard > Saddle | <0.001 |
| | Left | Standard > Saddle | 0.015 |
| IO | Right | Saddle > Ghopec | 0.003 |
| | | Ghopec > Standard | 0.024 |
| | | Saddle > Standard | <0.001 |
| | Left | Saddle > Ghopec | 0.021 |
| | | Ghopec > Standard | 0.003 |
| | | Saddle > Standard | <0.001 |
| EO | Left | Saddle > Standard | 0.012 |

ICLT = iliocostalis lumborum thoracic part; IO = internal abdominal oblique; EO = external abdominal oblique

Table 2: P-values of pairwise muscle activation comparisons with significant difference.

## CONCLUSION

The use of the Ghopec stool, compared to a standard stool, facilitates a less flexed lumbar position while performing a dental screening task whereas the use of a saddle stool results in a somewhat hyperlordotic posture. Sitting with a larger trunk-to-thigh angle results in less activation of the lower paraspinal muscles, especially ICLT, and more activation of abdominal muscles, especially IO. The presence of a backrest decreases the activation of the abdominal muscles (IO).

Based on these findings, to maintain neutral posture and simultaneously reduce spinal loading, the Ghopec is considered the most suitable of the 3 stools investigated.

| | Ghopec | Saddle | Standard |
|---|---|---|---|
| Mean | 1.03 | -5.74 | 4.37 |
| (SD) | 10.00 | 16.43 | 8.12 |
| Minimum | -21.07 | -38.35 | -12.87 |
| Maximum | 13.41 | 35.89 | 19.56 |
| Range | 34.48 | 74.24 | 32.43 |

Table 3: Mean lumbar posture and standard deviation, minimum, maximum and range (° flexion) during a periodontal screening task on the Ghopec, saddle and standard stool.

Ethical approval was obtained from the independent Commission for Medical Ethics of the University Hospital Ghent (B670201317498) and the University of Derby.

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