

Development of the Palpation Domain for Muscle and Skin in the Global Body Examination

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ABSTRACT

Objectives: To develop new scales within palpation of muscle and skin domains based on 16 items from the Global Physiotherapy Examination and 46 items from the Comprehensive Body Examination [CBE], and investigate how well these new scales would discriminate between healthy individuals and different groups of patients, compared to the original methods.

Methods: Two physiotherapists independently examined 132 persons [34 healthy, 32 with localized pain, 32 with widespread pain, and 34 with psychoses]. Muscle and Skin domains were studied separately. The number of items was reduced by omitting items with too high correlation and by exploratory factor analysis. Internal consistency was examined with Cronbach's alpha. Discriminative validity was examined with Mann-Whitney U-test and area under the curve.

Results: Only items from the left body half was included in the exploratory factor analysis, as very high correlation [mean $r = 0.90$] was found in the 23 bilateral palpation pairs in CBE. The initial 62 items were reduced to 11 for palpation of muscle and five for palpation of skin. Cronbach's alpha was 0.88 for the subscales for Muscle and Skin. The new Palpation domain in the Global Body Examination showed excellent discriminative ability between healthy persons and the different patient groups [$P < 0.001$; area under the curve 0.81-0.94]. Patients with localized pain had significantly less muscular and skin aberration than patients with widespread pain.

Conclusions: A new Global Body Examination Palpation domain with acceptable psychometric properties was developed. It had fewer items than Global Physiotherapy Examination and CBE, but with almost the same discriminating ability.

KEY WORDS: Body examination, palpation, normative data, musculoskeletal pain, psychotic disorders

INTRODUCTION

Musculoskeletal complaints manifest themselves in physical changes that can be examined in a valid and reliable way. Recent studies have shown that bodily changes related to posture, respiration, movement, muscle, and skin can be examined in an objective way, i.e. with high degree of reliability, discriminative validity, and reproducibility (1,2). There are no universal criteria for how to examine the presence or absence of symptoms, neither the importance of specific findings, but the summation of identifiable aberrations can form scales that can assist in planning and evaluation of treatment (3).

The body reacts to both physical and emotional strain, and respiration, posture, flexibility, ability to relax, and muscular tension will be affected. All these elements should therefore be included in the examination and treatment of a patient with long-lasting problems. Two fairly similar examination methods have developed with the principle about examining and treating the whole person (4,5). The methods are known as the Global Physiotherapeutic Muscle Examination [GPM] and the Resource Oriented Body Examination (5-9). Both methods include examination of posture, respiration, movement, and muscle. In GPM skin is also examined. In the last few years, these body examinations have undergone an extensive development in order to meet the increasing demand for scientific reliability and validity, and the methods are today named the Global Physiotherapy Examination [GPE-52] (2) and the Comprehensive Body Examination [CBE] (1). Both methods can be used in examination of patients with long-lasting physical and/or psychological complaints.

The focus of this article is on palpation of muscles and skin. In order to have flexible and appropriate movements, one needs elastic and good muscles (9,10). Measurable characteristics of muscle include viscoelastic tone, physiological contracture, and voluntary as well as involuntary muscle contraction (11). Simons and Mense (11) defined muscle tension as stiffness that is measured in terms of elastic and viscoelastic properties of the muscle,

examined with slow passive movement of the muscles fibers across the longitudinal direction. Furthermore, in order to assess the compliance [compressability] and quality of a muscle, the therapist presses the fingers or squeezes the muscle bulk to determine how easily it is indented and if it is hard with taut bands, getting another impression of the muscle stiffness and its consistency. Unintentional muscle tension is not associated with EMG activity, but with pain, distress and inefficient use of muscles (11).

A body dominated by too hard or too slack muscles does not function well neither physically nor emotionally (1,9,12,13). Sick-listed patients with long-lasting musculoskeletal disorders proved to have considerably more tense and painful muscles than healthy persons (14). In depressed and despaired individuals, muscle and skin can react and also turn limp and flabby (15,16). Both ways of reaction can sustain an evil circle of dysfunction. To be able to experience degrees of disturbed muscle tensions is considered the first step in changing restrained movements and improve respiration (17). Palpation is an important aspect of the physiotherapy examination. One needs, however, to palpate several muscles and use subscales and sumscores to get a reliable and objective picture of the degree of bodily changes in patients with long-lasting complaints (15,18).

In both the GPE-52 and CBE, muscles are palpated in the extremities and trunk [Table 1]. In GPE-52 only the left side is examined and the left leg, thigh, trunk, neck/shoulder, and arm are palpated. In the CBE one palpates bilaterally and also muscles in the foot, hand, and forearm are examined. The GPE-52 has three subscales in the Muscle domain and two in the Skin domain, each with four items: Stretch palpation of muscle, Reaction to stretch palpation, Pressure palpation of Muscle; Pressure palpation of skin, and Stretch palpation of skin in the same areas as palpation of muscles. The CBE has a total of 46 items [23 bilateral pairs] located in four domains: Peripheral slackness with 14 items, Central hardness with 12,

Peripheral hardness with 10, and Central dorsal slackness with 10. “Peripheral” means examination of the extremities, while ”central” includes tests on the trunk.

As the methods have considerable similarities (19,20), one should examine if they could be merged to one new Global Body Examination. A new body examination should be clinically meaningful and with good psychometric properties. This can hopefully contribute so that more therapists will choose a systematic evaluation tool and document degree and extent of bodily complaints before and after treatment.

The purpose of this study was therefore to compare and examine the measurement properties of the palpation items found in GPE-52 and CBE, and integrate them into a new and feasible evaluation tool called Global Body Examination [GBE]. To investigate the validity of the new scale, we wanted to examine how the new model would discriminate between healthy individuals and different groups of patients compared to the original methods. Furthermore, as muscle and skin qualities can be either too slack or too tense, we wanted to examine how common such palpation qualities are in different groups.

Insert Table 1 about here

MATERIALS AND METHODS

Participants

A cross-sectional design was used in the present study. Two experienced physiotherapists independently examined 132 persons [Table 2], one used GPE-52 and the other CBE. The two examiners were not very familiar with the other method, and they did not discuss scoring of items before or during the examination period.

All individuals were examined in random order on the same or on the following day. In both methods the palpation of extremities and trunk took place with the individual in a rested position, either in supine, prone, or side lying position. Altogether 34 were healthy individuals [Group A; not sick-listed the last year, and with no pain for the last few weeks].

Patients were recruited from different pain and spine clinics, from physiotherapy clinics, and from several psychiatric institutions through a third person. The patients could be categorized into three subgroups: 32 had long-lasting [longer than six weeks] localized pain [Group B], 32 had long-lasting widespread pain [Group C], and 34 were hospitalized and had been diagnosed with psychoses by at least two independent psychiatrists [Group D]. The examining physiotherapists did not have access to medical diagnoses for the patients with musculoskeletal pain. As former studies have shown significant differences in patients with localized versus widespread pain, a pain drawing was filled in on the first visit and used to categorize patients into either Group B or C before the data analyses started (14,21). Patients with localized pain had pain either above *or* below a horizontal line at Th10, while patients with widespread pain had pain both above *and* below this line. The diagnoses for patients in Group D were known to the examiners, as these patients were examined while hospitalized.

The study was approved by the Regional Committee for Medical and Health Research Ethics, Western-Norway, and was performed according to the Helsinki Declaration. Each participant was given oral and written information about the study and signed an informed consent form.

Insert Table 2 about here

Scoring

As for musicians, a therapist's main instrument is often the hand, and through experience he/she learns to interpret and rely on the information obtained through palpation (22). The muscle to be examined is in a relaxed position. As muscles have thixotropic properties (11), palpation must be slow and repeated a maximum three times in the same area. Degree of muscle tension is in the GPE-52 measured as resistance to a slow stretching movement across the longitudinal direction in the middle of the muscle bulk, also called a measure of elasticity (9,11). The consistency is measured by the compressibility of four

muscles in GPE-52 and of 23 pairs of muscles in CBE; how easy can the fingers be pressed into the tissue of a flat muscle with a force of 2 to 4 kilogram. Is it a springy feeling, or too soft and slack, or too thin and hard (8,23)?

Each test in the GPE-52 and CBE is well-defined in their respective manuals and performed in standardized manners (8,23). The items are rated on a scale, where a score of 0 indicates ideal findings, and deviation away from 0 indicates aberration [Table 3]. The GPE-52 has a 15-step scale; a muscle or skin quality that is not ideal/good can either be too slack and gets a negative value, *or* be too hard and tense and gets a positive value. In GPE-52 one has to decide whether the muscle is ideal, too hard and tense or too slack, and in muscles with mixed consistency the dominating impression is scored. The palpation items of the GPE-52 data were in this study transformed to a new 15-step scale ranging from -7 to +7. Absolute scores can be added to a sumscore for each subscale or main domain.

The CBE has 13 steps, ranging from -6 over 0 to +6. In the Muscle domain, however, one rates degree of slackness and degree of hardness in the same muscle in separate subscales, each ranging from 0 to +6. Muscles with a mixed consistency, e.g. a slack muscle with taught bands, will get a score greater than zero both for slackness and for hardness (15).

Insert Table 3 about here

Data Analysis

Data were analyzed with PASW Statistics 18. The 23 pairs of muscles in CBE that were palpated both on the right and left side of the body were first examined with Spearman's correlation analyses. Mean correlation between the bilateral items in CBE was $r = 0.90$ [0.69-1.00]. As only the left side is examined in GPE-52, we chose to omit all CBE items from the right side. Of the remaining 23 items, 18 items had both slack and hard scores in the same muscles, and these were recoded to nine new items [Table 1].

To allow for comparison of the two methods, the scores for both methods were recoded to one deviation score for each muscle. For GPE-52 negative scores were recoded to positive ones, and for CBE we merged the scores of the positive and negative subscales, registering the most deviant score for that muscle [in CBE these variables are marked A in the result section]. All items with correlation $r > 0.70$ were considered too similar and redundant, and one was kept and the other omitted from further analyses. High correlations [>0.70] were present between the three items palpating m. erector spinae in CBE and two items were omitted [A110, A122]. High correlations were found between some of the extremity muscles in CBE, and two items were omitted from the lower and one from the upper extremities [V159, V165, A182]. High correlation was found in palpation of the gastrocnemius in GPE, and pressure palpation was omitted [v89c], while stretch was kept. As palpation of the m. trapezius was performed in the same manner in both methods, one was included and one omitted in the analyses [V224].

An exploratory factor analysis [EFA] was performed separately for the muscle and skin items to further reduce number of items and to examine construct validity (24). As not all the data were normally distributed, we chose principal axis factoring. We expected the factors to correlate and the direct oblimin method was used to allow for a rotated and more accurate solution (25). There are different guidelines for cut-off point in factor extraction. Each factor has an associated eigenvalue, which is related to the percentage of variability within the data set that can be accounted for by the factor. Some factors will account for very little variance and are therefore eliminated from the analysis (24,26). To decide the number of factors to retain, we used a scree test involving examination of the graph of eigenvalues to find the break point in the data where the curve flattens out (25). A one-factor solution was chosen as the optimal solution for both muscle and skin items.

Based on the EFA we made new subscales, separate for muscle and skin, by including the scores of items that loaded >0.50 . Cronbach's alpha was used to measure the internal consistency of the scales, first separately for the muscle and skin subscales, and then for the whole Palpation domain (24,26).

The final version of the new Palpation domain in the Global Body Examination [GBE] was applied on the data from the 132 individuals, and compared to the former palpation scales from GPE-52 and CBE. Mann-Whitney U-test was used for group wise comparison. P values <0.05 were considered statistically significant. In addition to descriptive data, the Receiver Operating Characteristics Curve was used to get an impression of the subscales' ability to discriminate between healthy persons and the patient groups. Area under the curve [AUC] [0.0-1.0] expresses the discriminative ability. As a general rule, $0.7 \geq \text{AUC} < 0.8$ can be considered acceptable, $\geq 0.8 \text{AUC} < 0.9$ is excellent, and $\text{AUC} \geq 0.9$ is outstanding discrimination (27).

In GPE-52 the patient's verbal reaction to Stretch palpation of muscle is also scored. Data from the reaction subscale was included in the comparison of methods, but the items were not included in analyses for the new scales.

In order to examine how common slack versus hard palpation findings were in our groups, we calculated from the raw data separate sumscores for slack and hard qualities for Muscle and Skin.

RESULTS

Muscle

The EFA started with 15 muscle items [i.e. 8.8 participants per item] and resulted in a factor which explained a total variance of 38.8 percent and an eigenvalue of 5.5. This factor had six items from GPE-52 and five from CBE, and included both stretch and compression of

muscles in the trunk and the extremities [Table 4]. This factor was named Muscle and Cronbach's alpha was 0.88.

Insert Table 4 about here

The next step was to examine the discriminative validity of the new Muscle subscale and compare it to the original methods. As shown in Table 5, the new GBE Muscle scale showed excellent to outstanding discriminative validity with significant differences [$P < 0.001$] between healthy persons and all patient groups. Patients with localized pain had significantly less muscular aberration compared to patients with either widespread pain or psychoses. The results were similar to the results found in the original methods, especially as seen in the original GPE-52. Furthermore, the CBE subscale Peripheral hardness detected more muscle hardness in patients with psychoses compared to patients with widespread pain.

Our study indicates that with an AUC of 0.80, the probability is 80 percent that patients will have a higher score compared to healthy persons (28). For healthy persons the mean sumscore for 11 items in the Muscle subscale was 23.5 ± 6.2 , whereas mean for all patients was 31.7 ± 9.0 . A GBE sumscore for Muscle of about 28.5 points had best cut-off value for specificity [0.79] and sensitivity [0.76].

The slack sumscore for muscles revealed that 60 percent of the total sample had some slack palpation findings. In the healthy sample, 44 percent had some slack findings, compared to 69 percent in patients with localized pain, 63 percent with widespread pain, and 65 percent with psychoses. Most of them had only a few negative scores. We applied a cut-off of 11 for the slack sum score [i.e. a mean of 1 for each of the 11 items], and found that none had this high sumscore among the healthy or among those with localized pain, whereas 3 percent among those with widespread pain, and 12 percent among those with psychoses had a sumscore ≥ 11 . Only two patients [one with widespread pain and one with psychoses] had an overweight of slack scores.

Insert Table 5 about here

Skin

Of the eight items included in the Skin domain in GPE-52, a high correlation [>0.70] was found between the items that had both stretch and pressure palpation in the same region and two could be omitted [v91d, v96e] [Table 1]. Of the six remaining items included in EFA, five items constituted one factor with loadings above 0.50, and this factor was named Skin. It had an eigenvalue of 3.1, an explained variance of 51.3 percent, and Cronbach's alpha was 0.88 [Table 4]. The included items were stretch palpation of skin in the leg, thigh and arm, and pressure palpation in trapezius and erector spinae.

The discriminative ability of the new Skin scale in GBE was acceptable to excellent [Table 5]. Patients with widespread pain had significantly more skin aberrations compared to patients with localized pain. The mean Skin sumscore for healthy persons was 8.2 ± 3.6 , whereas mean for all patients was 13.7 ± 5.0 . A cut-off value of 10.5 gave good sensitivity [0.69] and sensitivity [1 minus 0.24].

Regarding slack palpation findings in the Skin subscale, 35 percent of the healthy had some negative scores, compared to 28 percent in those with localized pain, 22 percent in those with widespread pain, and 53 percent in those with psychoses. We applied a limit of slack sumscore ≥ 5 for five items. Fourteen percent of the total sample had a score above this cut-off: 3 percent of the healthy, 9 percent of those with localized pain, 12 percent of those with widespread pain, and 29 percent of those with psychoses. Fifteen percent of the sample had an overweight of slack skin scores: 15 percent of the healthy, 9 percent of the patients with localized pain, 9 percent of those with widespread pain and 27 percent of those with psychoses.

Cronbach's alpha for the 16 items in the Palpation domain was 0.92. Figure 1 illustrates the median and spread of scores for the new Palpation domain, with its two

subscales for Muscle and Skin. A reference line drawn at 38.5 indicates best cut-off value with a sensitivity of 0.80 and a specificity of 1 minus 0.24.

Insert Figure 1 about here

DISCUSSION

The main finding was that the new subscales and the Palpation domain have good psychometric properties and discriminated very well between healthy subjects and different patient groups, which is in accordance with former studies where the original methods were used (15,18). The original GPE-52 discriminated better between both pain patient groups and patients with psychoses compared to GBE and the CBE. Also, in the original CBE one scale demonstrated that patients with psychoses had significantly harder muscular consistency in the extremities compared to patients with widespread pain. However, it seems that the new scales are more sensitive to differences within the groups, especially among patients with widespread pain and among those with psychoses.

Examining the 16 items in the new Palpation domain of GBE will take five to 10 minutes with experienced investigators. The included items cover the whole body, and give information separately for muscle and skin quality as well as an overall impression of degree and type of aberration in the Palpation domain [Table 4]. As palpation is applicable for assessment of many different types of patients, it is important to distinguish between general tension and consistency, and score one thing at the time (23,29). This will also influence the reliability of palpation (18). Former reliability studies of the included items have, however, rendered high intraclass correlation coefficients values and low measurement errors (18,30).

In the CBE, slack and hard scores were scored on separate subscales, giving the opportunity to score both qualities in the same muscle. In the GPE-52 the rater has to rate the most dominant quality only. To be able to combine the two methods, we had to merge the CBE subscales by applying the GPE-52 selection principle. To make the factor analyses, both

CBE and GPE-52 scores were converted to deviation scores. The total muscular deviation score gives an indication of how deviating the muscles are. However, it gives no information about how much of the deviation is due to hard and to slack qualities. Therefore we calculated separate slack and hard sum scores. The deviation score is strongly correlated with the hard [positive] sumscore, indicating that usually the deviations are of the hard kind. However, a majority of the patients had some slack findings, and a few had a considerable number of such qualities. Although slack palpation qualities may be rare, they have important clinical implications in treatment of the individual (7,16).

Decreased tension and general slackness has been an indication of more serious psychopathology (15,16,18,21,31). In a former study where the GPE was used in examination of patients with long-lasting musculoskeletal complaints, the Skin domain was found to correlate significantly with the Minnesota Multiphasic Personality Inventory-2 scales for severe psychopathology, but only in men with widespread pain that had too slack and too stretchable skin (21). Such findings are a reminder that one must both look at the positive and negative sumscores, as well as have separate subscales for muscle and skin in order not to overlook clinical information that may make the basis for targeted treatment that promotes change where needed.

A previous factor analysis of CBE-data gave separate factors for items located in the extremities and the trunk (15). The factor analyses in the present study did not replicate this finding. New examination methods must have face validity and be tested on the entire range of the target population (33). The included items in the new GBE give information about muscle tension and consistence in the leg [planta pedis, gastrocnemius, rectus femoris], arm [triceps and pronator teres], neck [trapezius and sternocleidomastoid], and trunk [costal bow/diaphragm/abdominal muscles, intercostalis, latissimus, and erector spinae]. The five items in the Skin subscale also give information of the extremities and trunk and have good

psychometric properties [Table 4]. Examination of skin seems rarely to be included in the assessment of pain syndromes related to the musculoskeletal system, although altered skin physiology seems related to underlying problems (22,34,35). The items included in the new GBE Palpation domain seem meaningful for the experienced testers in this study. The patient sample in our study included a continuum from healthy persons to pain patients and patients with a severe psychiatric disorder. Our patient sample did not, however, include patients with chronic fatigue syndrome or patients with far too high or too low body mass index. **As we did not have access to the medical diagnosis in the pain patients we do not know if any of them had a known connective tissue disorder or not.**

Healthy persons in our study had significantly better scores compared to patients [Table 5], whether they were examined with GPE-52, CBE or GBE, patients having a much larger degree of muscle tension and taut bands with reduced springiness, in accordance with former studies (11, 15, 18, 32). As in former studies, changes were most prominent in patients with widespread pain, both regarding muscular and skin aberrations (14). Patients with psychoses had also higher muscular scores compared to patients with localized pain. Patients with psychoses had quite similar degree of aberrations generally as patients with widespread pain, although with a larger spread in scores [Figure 1], as well as a higher percentage having slack qualities, especially concerning the skin.

Strength of the present investigation is that all patients were examined by two physiotherapists who were experts in the examinations they used. The examiners were, however, not familiar with the other method, but similar results were found independent of which method that was used. The sampling of healthy controls and patients with different degrees and types of pathology increase the external validity of the results, although the sample size in each group was moderate. **It could be a bias that the therapists only knew the diagnosis of one of the four groups. All were recruited through a third person, and no**

diagnosis where provided, except for the hospitalized patients with psychosis where it was nearly impossible to conceal psychosis. Another limitation is that our examination is cross-sectional. A longitudinal investigation could have included an intra-tester reliability study. Furthermore, the categorization of the pain patients by means of the pain drawing is very rough, but this particular categorization to either localized or widespread pain groups have been found useful in former studies (18,21). Future studies must test the inter-tester reliability, as well as include examination of larger samples. Use of an algometer can in future studies examine the correlation between pain threshold and examination of muscle and skin quality, and possibly add to the objectivity of the palpation results.

CONCLUSION

Based on palpation data from a heterogeneous sample of 132 persons, this study has shown that the initial 62 items from GPE-52 and CBE could be reduced to 16 items and be integrated into meaningful subscales for muscle and skin, as well as into one main domain for Palpation in a new evaluation tool called the Global Body Examination. Good psychometric properties and acceptable to outstanding discriminative abilities were found in this new Palpation domain of the GBE. Healthy persons had significantly better muscle and skin qualities compared to three different patient groups. Patients with localized pain had significantly better scores both regarding muscle and skin qualities compared to patients with widespread pain. Patients with psychosis had slightly less skin aberrations than patients with widespread pain, but they had a much higher percentage with slack skin quality. The palpation tests appear to give useful and objective information and little information was lost when using the new GBE compared to the two original methods. However, as the deviation scores primarily reflect hard muscle and skin qualities, we strongly recommend that slack sumscores are also calculated, as these scores give important information for treatment planning. The new version can be recommended for future use whether it is for clinical or for

research purposes. The use of systematic evaluation tools as described here may help to document where and to what extent patients with musculoskeletal and psychiatric disorders have physical problems that can be addressed in therapy.

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