age (29.95±3.28) years, their mean BMI (28.11±4.23) kg/m^2, and their mean of parity (3.15±1.46). All received MET with a home programme and phonophoresis, 3 times per week for 12 sessions.

Control group (B)

20 female patients were included in this group, their mean age (30.20±3.24) years, their mean BMI (28.88±3.22) kg/m^2, and their mean of parity (3.70±1.46). All received phonophoresis 3 times per week for 12 sessions.

Materials

Examination modalities

Pain Assessment (Numeric Rating Scale (NRS)

The NRS for pain is a one-dimensional measure of pain intensity in adults, including those with chronic pain .It is an instrument tool to measure the intensity of pain, it consists an 11-point numeric scale with 0 representing "no pain" and 10 representing extreme pain (Worst possible pain) [39] (**Figure 1**).

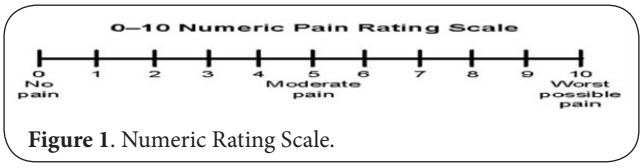

Figure 1. Numeric Rating Scale.

Functional ability assessment (The Oswestry Disability Index) (ODI)

The (ODI) has become one of the principal condition-specific outcome measures used in the management of spinal disorders. The ODI measures disability of the spine in a patient, using a 10-item scale and these are evaluated by 0–5 scores. The categories are pain severity, self-care, walking, sitting, standing, sexual function, travelling, and social life. The extreme score in ODI is 50, which means 100% disability. Every participant answered the ODI questionnaire before and after treatment to detect the level of functional disability. A higher score is usually associated with severe pain and debility. The ODI remains a valid and confident measure and has been a worthwhile outcome measure [33].

Blood analysis (plasma cortisol level)

The plasma cortisol concentration was significantly higher in pain patients as compared with healthy subjects free from pain at the time of the highest pain intensity. There is a positive correlation between the intensity of pain and increased plasma cortisol level (Damzal et al, 1983). Hence the assessment of plasma cortisol level was needed before and after the treatment to assess the decrease in the cortisol level as an indicator of improvement [38].

Treatment modalities

Ultrasound equipment

Ultrasound waves were applied with sodium diclofenac (Voltaren Emulgel, Novartis) phonophoresis onto the painful side by the ultrasound device.

Experimental procedures

The explanation of the treatment was brief and clearly demonstrated to all the subjects in order to gain consent.

Examination

All the following assessment were done as mentioned above in the examination modalities part to all the subjects in both groups (A) and (B) before and after the treatment program

1. Pain Assessment (*Numeric Rating Scale (NRS)*
2. Functional ability assessment
3. Blood analysis (plasma cortisol level)

Treatment

The participant was asked to lie in the half lying position, with the back and arms well supported. The anticubital area was cleaned with alcohol. Blood sample of about 5cm^3 was drawn from the anticubital vein from all subjects by disposable sterile syringe by vein puncture to determine the plasma cortisol level, which was done in the biochemistry department. This was done 2 times, the first time before starting treatment and second after the end of treatment session. All samples are collected early at the morning before breakfast for all cases.

Study group (A) were treated by MET and sodium diclofenac (Voltaren Emulgel, Novartis) phonophoresis therapy through ultrasound device to allow penetration over the coccyx while the patient assuming a prone position. The parameters of ultrasound were 1 MHz frequency for deep penetration, 1.5 W/cm^2 power, pulse ratio 50% for the greater mechanical compression and relaxation effects, duty-cycle continuous 1: 1 and, the treatment duration was for 5 minutes [34].

The MET was performed while the patient was lying supine on a treatment table, placing their buttocks just off the edge of the table with one leg placed on the therapist's shoulder and the other leg rested down under the therapist hand. The subject was asked to "push their leg into the therapist's shoulder" and "push up with the opposite leg into therapist's hand. A total of 5 contractions were resisted by a force equal to the subject's, held for 5 seconds with 5 seconds rest between each contraction [14].

Placement of subject during muscle energy technique**:** The leg of the anterior innominate was placed over the therapist shoulder and the leg of the posterior innominate was placed under the therapist hand. When an isometric contraction is produced, the anterior innominate will rotate posteriorly from the force of the hamstrings and the posterior innominate will rotate anteriorly from the force of the iliopsoas [14].

Home exercises programme

Following the MET procedure, the patient received a MET component to their home exercise program (HEP). This HEP is thought to assist the patient in maintaining spinal range

of motion, thus decreasing the need for further MET corrections. For example, if a patient was diagnosed with a flexion and side-bending left restriction, the patient was instructed to place the left foot on a stool or chair (both hip and knee angles of 90°) and slowly bend forward and rotate to the left . Patients were instructed to stretch as far as possible in a pain-free range and hold the stretch for 5 to 7 seconds. The patient was then instructed to place her hands upon the flexed knee to assist in returning to a standing position with the use of the upper extremities. Patients were to perform this stretch "as often as possible." [20]. Patients were asked to repeat the same steps for the right side. The patients were told to apply HEP for 3 repetitions on each side, 3 times every day, except the day of the clinical session. While the control group (B) was treated by phonophoresis only for 10 min {as described before with group (A)}.

Statistical analysis

Results are expressed as mean±standard deviation. Test of normality, Kolmogorov-Smirnov test, was used to measure the distribution of data measured pre-treatment. Accordingly, comparison between variables in the two groups was performed using either unpaired t-test (in normally distributed data) or Mann-Whitney test (in non-normally distributed data). Comparison between variables before and after treatment in the same group was performed using either paired t-test (in normally distributed data) or Wilcoxon Signed Ranks test (in non-normally distributed data). Statistical Package for Social Sciences (SPSS) computer program (version 21 windows) was used for data analysis. P value≤0.05 was considered significant.

Results

Participants' characteristics

The demographic data of the participants of both groups revealed no significant difference between the two groups in terms of mean age, parity, and BMI (P>0.05) (**Table 1**).

Pain Assessment

There was a significant decrease in pain intensity measured after treatment in both study (group A) (1.75±0.85) and control (group B) (6.10±1.52) when compared with their corresponding values measured before treatment (Z-values=-3.953 and -3.754, respectively; p=0.001). Also after treatment, there was a significant decrease in pain intensity in group A when compared with group B (Z-value= -5.438 and P-value=0.001) (**Table 2**).

Functional ability

There was a significant difference in the functional ability measured after treatment in both study (group A) (6.90±3.82) and control (group B) (19.65±4.64) when compared with their corresponding values measured before treatment (Z-values=-3.950 and -3.924, respectively; p=0.001). Also after treatment, there was a significant difference functional ability

Table 1. General characteristics of the participants in both groups A and B.

	Study group A (n= 20)	Control group B (n= 20)	t value#	P value	Significance
Age (yrs.)	29.95±3.28	30.20±3.24	0.242	0.810	NS
BMI (kg/m^2)	28.11±4.23	28.88±3.22	0.648	0.521	NS
No. of deliveries	3.15±1.46	3.70±1.46	1.193	0.240	NS

Data are expressed as mean±SD. #=unpaired t-test. NS=p>0.05=non-significant.

Table 2. Numeric Rating Scale in group A and B Pain Assessment.
Inter and intra-group comparison between mean values of pain in the two studied groups measured before and after treatment.

	Study group A (n=20)	Control group B (n=20)	Z value#	P value	Significance
Before treatment	7.65±0.99	8.15±0.93	-1.630	0.103	NS
After treatment	1.75±0.85	6.10±1.52	-5.438	0.001	S
Mean difference	5.90	2.05	--	--	--
% change	77.12 ↓↓	25.15 ↓↓	--	--	--
Z value ##	-3.953	-3.754	--	--	--
p value	0.001	0.001	--	--	--
Significance	S	S	--	--	--

Data are expressed as mean±SD. #=Mann-Whitney test. ##=Wilcoxon Sign Rank test. NS=p>0.05 =non-significant. S=p<0.05=significant.

in group A when compared with group B (Z-value=(-5.224) and P-value= 0.001) (**Table 3**).

Plasma cortisol level

There was a significant decrease in Plasma cortisol level measured after treatment in both study (group A) (5.09 ±1.12) and control (group B) (8.86±0.94) when compared with their corresponding values measured before treatment (t-values= 11.889 and 4.093, respectively; p=0.001). Also after treatment, there was a significant decrease in Plasma cortisol level for group A when compared with group B (t-value=11.507and P-value=0.001) (**Table 4**).

Discussion

Post-partum coccydynia is most commonly seen secondary to hormonal changes, which occur during the third trimester of pregnancy. These Changes induce a softening of the synchondrosis between the sacrum and coccyx, increases the mobility of the ligaments and surrounding muscles, causing inflammation [**22**].

This pain in the coccyx may radiate to hip and lumbar regions. The pain or tenderness may be aggravated by prolonged sitting, arising from seated position, leading back while seated, prolonged standing and walking, so the pain interferes with all the activity of the women, making it difficult for her even to sit to fed herself and her baby. Sometimes there is a pain with defecation or the patient feel a frequent need to defecate, the patient may feel pain during sexual intercourse or aggravated during menstruation and premenstrual period [**22**]. Unfortunately, the literature review was unable to identify any study addressing the effect of muscle energy technique in treating post-partum coccydynia. Consequently, the purpose of this study was to evaluate the effect of muscle energy technique in treating such cases.

The results of this study showed a significant improvement in pain level and functional ability in both groups A and B. There was a significant difference between the two groups for the benefit to group (A). The study group (A) received MET with phonophoresis (PP) and home programme based on MET for four weeks, 3 sessions per week. The control group (B) received PP only for the same period of treatment.

The improvement in pain and function in the present study have several explanations as follows:

Table 3. Functional ability in group A and B.
Inter and intra-group comparison between mean values of functional ability, in the two studied groups measured before and after treatment.

	Study group A (n= 20)	Control group B (n=20)	Z-value #	P-value	Significance
Before treatment	28.65±2.51	29.65±1.60	-1.332	0.183	NS
After treatment	6.90±3.82	19.65±4.64	-5.224	0.001	S
Mean difference	21.75	10.0	--	--	--
% change	75.92 ↓↓	33.73 ↓↓	--	--	--
Z value ##	-3.950	-3.924	--	--	--
p value	0.001	0.001	--	--	--
Significance	S	S	--	--	--

Data are expressed as mean ± SD. #=Mann-Whitney test. ##=Wilcoxon Sign Rank test. NS=p>0.05=non-significant, S=p<0.05= significant

Table 4. Plasma cortisol levels in group A and B.
Inter and intra-group comparison between mean values of plasma cortisol in the two studied groups measured before and after treatment.

	Study group A (n= 20)	Control group B (n=20)	t-value#	P-value	Significance
Before treatment	9.86±1.61	9.92±1.52	0.132	0.896	NS
After treatment	5.09±1.12	8.86±0.94	11.507	0.001	S
Mean difference	4.77	1.06	--	--	--
% change	48.38 ↓↓	10.69 ↓↓	--	--	--
t value ##	11.889	4.093	--	--	--
p value	0.001	0.001	--	--	--
Significance	S	S	--	--	--

Data are expressed as mean±SD. #=unpaired t-test. ##= paired t test. NS=p>0.05=non-significant. S=p<0.05= significant

Initially for MET

The physiological mechanisms underlying the therapeutic effects of MET were unclear and may involve a variety of neurological and biomechanical mechanisms, including hypoalgesia, altered proprioception, motor programming and control, and changes in tissue fluid [26]. Lasting biomechanical changes to muscle property following MET have not been demonstrated, and changes to muscle extensibility and spinal range of motion may be related to mechanisms promoting hypoalgesia and an increase in stretch tolerance. Clinical studies suggest MET and related post-isometric techniques reduce pain and discomfort when applied to the spine or muscles [27]. MET may have physiological effects, regardless of the presence or absence of dysfunction [28].

Varghese [18], has stated that function of any articulation of the body which can be moved by voluntary muscle action, either directly or indirectly can be influenced by MET procedure, so this may stretch tight muscles, strengthen weak muscles and mobilize a restricted articulation. Also, the change in muscle expansibility may be due to the mechanism of analgesia and increase in stretch tolerance. When MET was applied with therapeutic exercise for more than one session, this may have greater effect on outcome [20].

Similarly the touch of the clinician, along with stimulation of agonist and antagonist muscles, seems to alter perception of pain. This technique could be performed prior to other rehabilitation techniques, such as strengthening exercises, to decrease pain and allow more efficient exercises to be executed. This technique may be better than others in decreasing pain for several reasons. The time it takes to administer MET is very short (less than 1 minute). It also allows the clinician to have physical contact with the patient, helping the patient to trust the clinician. Lastly, MET is a low-force isometric contraction in a pain-free position. This technique can be accomplished without causing further pain or harm to the patient [25].

MET aims to normalize soft tissue structures, such as shortened or tight muscles with no direct implication to the joint associated with these soft tissues. MET can be used to improve joint mobility by influencing the dysfunctional soft tissues. MET can be used to relax tight, tense musculature, spasms, or fibrotic changes due to chronic soft tissue problems [31]. MET has several uses that can help increase muscle strength, increase range of motion (ROM), and decrease edema [32].

MET was used as a common conservative treatment and a gentle manual therapy for restricted motion of the spine and extremities for pathology around the spine, particularly lumbopelvic pain [19,20,23].

Next, Phonophoresis (PP) is the use of therapeutic ultrasound to increase percutaneous drug absorption [40]. This method allows suitable and fast concentration of drug in the tissues without side effects, the drug is applied direct at the site and massaged with a therapeutic ultrasound applicator. Ultrasound has two modes: continuous and pulsed output. The continuous mode has thermal effects, and the pulsed mode which is used in this study has mechanical effects such as cavitation (creation of tiny air bubbles by splitting molecules within keratinocytes through the use of ultrasound), microstreaming, acoustic streaming, increased skin pore size and intercellular space [41].

The small cavitation bubbles, which fluctuate in a steady manner, generate mechanical stress in the near blood vessels without causing any damage in tissue and increase penetration of vessels structurally and physiologically [42].

Thus, Phonophoresis (PP) Help in penetrating the gel inside the body because it increases cell permeability through the mechanical effect. In addition to the effect of sodium diclofenac gel which is used as anti-swelling, anti-inflammatory and pain- relieving [21].

Further researches are needed to compare the effects of MET to other treatment modalities, also more studies are needed to compare the long term effects of different treatment modalities on coccydenia cases for both the conservative and surgical treatment modalities.

Limitations

1. Lack of previous studies that used MET with coccydenia cases
2. We could not isolate the pure effect of MET alone in this study as it was used with phonophoresis.
3. Restrictions of the Saudi community to take any photos to female patients, as it was not allowed and refused also by participants, that is why we did not add any photos to the exercise procedures.

Conclusion

The MET was effective, more comfortable, and safe for the treatment of post-partum coccydynia. There was a statistically significant reduction in pain intensity and functional ability. Accordingly, it was found that MET in conjunction with phonophoresis to be an effective, noninvasive, cheap, and safe method of relieving post-partum coccydinia.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	HE	SE	MEH
Research concept and design	✓	--	--
Collection and/or assembly of data	✓	--	--
Data analysis and interpretation	✓	--	--
Writing the article	✓	✓	✓
Critical revision of the article	--	✓	✓
Final approval of article	✓	✓	✓
Statistical analysis	--	✓	✓