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Effects of a massage-like essential oil application procedure using Copaiba and Deep Blue oils in individuals with hand arthritis

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ABSTRACT

Background and Purpose: Existing research suggests that both massage and essential oils may have analgesic and anti-inflammatory benefits. We investigate the benefits of the AromaTouch Hand Technique® (ATHT), a procedure that combines a moderate pressure touch with the application of essential oils to the hand, in individuals with hand arthritis.

Methods and materials: Thirty-six participants with rheumatoid arthritis, osteoarthritis, and/or chronic inflammation received ATHTs with either a 50/50 preparation of Deep Blue® and Copaiba oil or a coconut oil placebo twice daily for 5 consecutive days. Changes in maximum flexion in finger and thumb joints, items from the Arthritis Hand Function Test, and hand pain scores were evaluated.

Results: Participants treated with the essential oil preparation required significantly less time to complete dexterity tasks and showed about 50% decrease in pain scores, increased finger strength, and significantly increased angle of maximum flexion compared to subjects treated with coconut oil.

Conclusion: The ATHT with Copaiba and Deep Blue may have ameliorative effects on hand arthritis.

1. Introduction

Arthritis is a general term describing a condition in which the joints become painful and inflamed. Rheumatoid arthritis (RA) is an autoimmune disorder characterized by chronic inflammatory vascularization and infiltration of the synovial membrane of diarthrodial joints, while osteoarthritis (OA) is caused by the erosion of joint cartilage, resulting in painful bone-against-bone rubbing. Humoral and cell-mediated immunity are both implicated in the pathogenesis of RA. Onset of RA is marked by the atypical presentation of self-antigen by immune cells, which is followed by activation of autoreactive T cells. T cells accumulate in the afflicted joints and secrete proinflammatory cytokines, attracting other cells and aggravating the immune response. B cells release autoantibodies and activate T cells, while both B cells and macrophages secrete proinflammatory cytokines (e.g. TNF-α, IL-6, IL-8) [1]. In RA, neutrophils are found in very high numbers in the joint synovium [2]. Elevated cytokine levels are thought to play a major role in the induction of neutrophil infiltration to the synovium [3]. Although neutrophils are absent in the synovial fluid in patients with OA, inflammatory cytokines, chemokines, and other inflammatory markers are found in pathogenic concentrations in the synovial fluids. While inflammation is a hallmark of OA, it is not its cause, unlike RA. Research suggests that age-related increases in the proinflammatory cytokine IL-6 contributes to frailty and physical impairment, as well as increased risk of knee OA progression [4]. Neighboring tissues could be another source of inflammatory mediators. Their levels in tissue steadily increase with age and contribute to the pathogenesis of OA [4]. Although not the underlying cause, the elevation of inflammatory signaling contributes, at least in part, to the pain and joint swelling experienced by individuals with OA.

Many essential oils possess anti-inflammatory and analgesic properties. One well-understood mechanism underlying their activity is their ability to inhibit cytokine production. For example, one pilot study in humans found that regular topical application of various essential oils, including the Deep Blue blend, significantly reduced salivary levels of IL-1β, IL-6, TNF-α, and IL-8 [5]. In addition, menthol and methyl salicylate, two prominent chemical constituents in Deep Blue, are known analgesics that function by inhibiting peripheral nociception [6]. The main constituent of Copaiba oil, beta-caryophyllene (BCP), is a known cannabinoid receptor 2 (CB_2) agonist [7]. CB_2 agonists have unique anti-inflammatory action [8].

Various essential oils have demonstrated promising activity in animal models of arthritis as well as other inflammatory conditions of the hands and fingers in humans [9,10]. However, Copaiba oil is especially

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promising because of its primary chemical constituent BCP. In mice with mycobacterium-induced inflammation, BCP reduced inflammation by impairing neutrophil migration. The effect was mediated by BCP's action on CB_2 [11]. In a different study employing a rat model of arthritis, BCP decreased arthritic index scores about two-fold [12]. Other animal studies have demonstrated the anti-arthritic properties of BCP [13,14].

There is also evidence that moderate pressure touch procedures can alleviate hand pain and improve hand function. In one clinical study, rheumatoid arthritis patients with affected upper limbs demonstrated increased grip strength, less pain, and greater range of motion in the wrists, elbows, and shoulders after moderate pressure massage daily [15]. Another study showed that the combination of topical analgesic and massage for individuals with hand arthritis pain was more effective than either the massage or the analgesic alone [16].

Using this information as the impetus for our study, we propose that a moderate pressure touch procedure used in conjunction with anti-inflammatory and analgesic essential oils (Copaiba and Deep Blue) might have positive effects on individuals with arthritis in the hands and fingers. In this study, we evaluate the dōTERRA AromaTouch Hand Technique® (ATHT), a moderate pressure massage-like technique. The technique was developed by dōTERRA, a private company that sells essential oils.

2. Materials and methods

2.1. Study design

This pilot study used a randomized, double-blind, placebo-controlled design. Approximately one-half of the participants (n = 20) were given the ATHT with essential oils while the others (n = 16) were given the ATHT with the fractionated coconut oil (FCO) placebo. Neither technique administrators nor study participants were informed about which treatment they received. Special measures were taken to ensure that neither administrators nor participants would be able to use their sense of smell to identify which treatment was received. These measures are explained in the section "Testing Procedures." A schematic diagram of the experimental design is given in Fig. 1. Note that because this was a pilot study, we could not determine an n value that might give the study a desired statistical power. The power calculation requires knowledge of the expected difference in the measured variables, which was previously unknown.

2.2. Participants

The study protocol was approved by an institutional review board prior to the recruitment process. Participants were recruited using a flyer advertisement which was posted in community centers and placed in product bags sold at the dōTERRA Product Center. Tentative participants were screened by an orthopedic doctor, who took radiographic images and characterized the type and progression of each patient's arthritic condition. At this appointment, a medical history was also established. Patients with rheumatoid arthritis, osteoarthritis, or chronic inflammation of the hands and fingers were selected to participate in the study. Participants were included in the study solely on the basis of formal diagnosis and recommendation by the orthopedic doctor. The type or severity of arthritis was not a criterion for selecting participants, and any arthritis-associated symptoms were not taken into account nor evaluated when recruiting for this study. Therefore, patients with RA/OA/chronic inflammation were not recruited in equal number. Prospective participants were not recruited for this study if they were not formally diagnosed with arthritis or chronic inflammation, or if they had allergies to any of the oils used in this study. There was no washout for medications in this study. Individuals taking prescription or over-the-counter drugs were not excluded from participation. Methyl salicylate, a major chemical component of the Deep Blue essential oil blend, can be toxic in high concentrations and is contraindicated in children and pregnant women [17]. These populations did not fall in the target demographic typically associated with arthritis diagnosis. Methyl salicylate has been shown to inhibit platelet aggregation, possibly potentiating the activity of blood thinners [18]. Due to the small volume of oil applied during each Hand Technique session, and its dilution in the Deep Blue blend and with Copaiba, the concentration of methyl salicylate was not high enough to cause concern, nor to exclude individuals taking blood thinners from participating. Therefore the contraindications associated with methyl salicylate bore no impact on recruitment in this study. All participants were instructed to continue taking their medications. Informed consent was obtained in writing from each participant. Participants abstained from using essential oils and related products for the entire duration of their participation in the study. Participants were randomly allocated to either the treatment or placebo group using simple randomization. This resulted in two homogenous groups, so stratification was not used. However, because of dropouts, the total number of rheumatic patients at the conclusion of the study displayed slight heterogeneity (Table 1). Average baseline measurements between groups for the angle of maximum flexion (AMF) test, the hand function test, and pain scores were highly similar. Baseline measurements showed that the control group began the study with an average pain score of 3.4, while the treatment group began with an average pain score of 3.0. The baseline average AMF in the control group was measured at 72.7, while the treatment

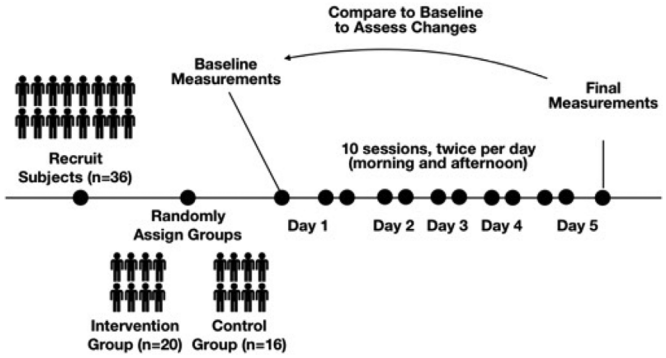

Fig. 1. Experimental Design.
After obtaining research approval from the institutional review board, 36 qualified subjects were recruited and screened for arthritis by an orthopedic doctor. Before the study began, subjects were randomly assigned to the intervention group or the control group. The intervention treatment consisted of the AromaTouch Hand Technique (ATHT) with a 50/50 preparation of Copaiba and Deep Blue oils, while the control treatment was the same except with coconut oil instead of the essential oils. Participants were instructed to continue taking their medications but to discontinue all use of essential oils or essential oil-containing products. Immediately before the first session on day 1, the baseline values of all outcome measures were recorded. Hand Techniques were administered twice per day for five days for a total of ten sessions. After the final session, the same values were measured and recorded again. Comparison of this data to baseline provided insights regarding the effects of the technique on different measures of arthritic severity and hand function.

Table 1
Final sample composition for intervention and placebo groups.

Group	OA	RA	HP/INF
EOs	13	4	3
FCO	12	2	2

Breakdown of arthritis/hand pain diagnoses between the treatment and placebo group. The groups were fairly homogenous. Abbreviations: EO, essential oil group; FCO, fractionated coconut oil group; OA, osteoarthritic patients; RA, rheumatoid arthritis patients; HP/INF, patients with hand pain and inflammation.

group had a total average of 70.3. The difference between the groups' average total score in the initial hand function test was within 3 seconds. Overall, the differences in baseline measurements across both groups were small enough to maintain homogeneity.

2.3. The AromaTouch hand technique

The AromaTouch Hand Technique (ATHT) is an essential oil application method involving physical touch similar to a hand massage. The individual administering the ATHT applies 2–3 drops (0.10–0.15 mL) of essential oil directly to the recipient's hand and spreads the oil throughout the palm. Following the application of the oil, the administrator delivers a moderate pressure touch procedure to the same hand. This process of essential oil application and moderate pressure touch is repeated again for the other hand. The ATHT takes about 10 min to complete, with about 5 min spent on each hand. Besides potential allergy to products used during aromatherapeutic massage, there are no known adverse effects of the various forms of aromatherapeutic massage, including the ATHT. The effects of the ATHT have never been evaluated in patients experiencing hand arthritis.

All ATHT administrators were trained following a standard protocol developed by dōTERRA, ensuring homogeneity of application. This protocol specified different motions for the various areas of the hands and fingers, as well as application pressure and motion repetition.

For individuals in the treatment group, ATHTs were performed using a 50/50 preparation of the following two oils, whose primary chemical constituents were determined by gas chromatography:

1. *50% v/v dōTERRA Deep Blue® blend*: methyl salicylate (32%), menthol (12%)
2. *50% v/v dōTERRA Copaiba oil*: beta-caryophyllene (55%)

For individuals in the control group, ATHTs were performed using fractionated coconut oil:

1. *100% v/v dōTERRA Fractionated Coconut oil*: caprylic (octanoic) triglyceride (37%), capric (decanoic) triglyceride (42%), lauric (dodecanoic) triglyceride (16%)

150 mL preparations of the Deep Blue/Copaiba essential oil combination and the placebo oil were formulated and stored in opaque 150 mL glass bottles. Smaller 15 mL opaque glass bottles fitted with orifice reducers were filled with their respective oil from the 150 mL bottles, and used for oil application during the ATHT. All bottles were stored at room temperature. No calculation was used to determine the 1:1 ratio. The ratio was arbitrary, but chosen for simplicity of formulation. No data currently exist to suggest that any given combination of Copaiba and Deep Blue oils is preferable over another combination.

2.4. Testing procedures

All measurements including angle of maximum flexion (AMF), Arthritis Hand Function Test (AHFT), and the Visual Analog Scale (VAS) were taken before the first ATHT for each participant. Each participant received 10 Hand Techniques, twice per day for five consecutive days. The two daily Hand Techniques were administered approximately five hours apart. The final round of measurements were taken after the completion of the final Hand Technique.

To prevent participants and ATHT administrators from using their sense of smell to determine which treatment group the participant was in, both the participant and administrator wore surgical masks to which 1 drop of lemon essential oil had been applied. Masks were worn by both the participant and the administrator for every Hand Technique session. These measures were implemented in order to maintain blinding by subduing the perception of the oil aroma. About 0.3% v/v blue food coloring was added to the FCO to mimic the light blue color of the preparation used in the treatment group. Additionally, 0.3% v/v spearmint essential oil was mixed with the coconut oil to mimic the minty scent of the oil used in the treatment group.

2.5. Visual analog scale

The Visual Analog Scale (VAS) was used to measure the severity of the participants' hand pain. Each participant was asked to rate their level of hand pain from 1 to 10. 0 on the scale was labeled with “no pain” and 10 was labeled with “worst imaginable pain.” The visual analog scale was administered via an electronic questionnaire on a laptop device. The query consisted of a sliding bar and a box where participants could type a number between 1 and 10 if they preferred not to use the slider.

2.6. Arthritis hand function test

The Arthritis Hand Function Test (AHFT) is an 11-item performance-based test designed to measure hand strength and dexterity in persons with arthritis, which has been validated in a number of trials and is described in greater detail elsewhere [19–21]. Previous evaluations of the AHFT have proven its reliability and validity as a hand function test. A 2000 study which assessed the AHFT showed that it had excellent interrater intraclass correlation coefficients (ICC = 0.99–1.00) [21]. The specific items in the test include measurement of grip and pinch strength, pegboard dexterity, lacing a shoe and tying a bow, fastening and unfastening 4 buttons, fastening and unfastening 2 safety pins, cutting putty with a knife and fork, manipulating coins into a slot, lifting a tray of tin cans, and pouring a glass of water from a pitcher. The grip and pinch strength tests as well as the pegboard dexterity test require each hand to be tested separately. The functional dexterity tests are all timed in seconds. The applied hand strength items are measured by the number of cans lifted and the volume of water lifted in the pitcher in mL. Administrators followed the prompts outlined in the AHFT manual when instructing participants through the items.

2.7. Angle of maximum flexion (AMF)

Joint mobility is an indicator of the degree of inflammation in an arthritic joint, with the degree of inflammation being inversely related to the angle of maximum flexion. To evaluate joint mobility in the hands, the interphalangeal joints of the 1st and 2nd digits of each hand were measured at full flexion using a goniometer. The angle θ between the two members on opposite sides of each joint was measured. Flexion angle from the resting state was then calculated using 180 - θ. Five joints were measured in total, including the distal interphalangeal (DIP) joint, the proximal interphalangeal (PIP) joint, and the metacarpophalangeal (MCP) joint of the 2nd digit (index finger), and the interphalangeal (IP) joint and metacarpophalangeal (MCP) joint of the 1st digit (thumb). The range of motion assessment was performed prior to the AHFT.

2.8. Statistical analysis

Differences between groups after treatment were analyzed using one-way ANCOVA, which bears the most statistical power in direct comparison to other clinically relevant statistical methods [22]. Adjusted means were obtained using baseline data as the concomitant (covariate) variable. Differences were calculated using the change from the pre-treatment combined group mean, and percent differences were calculated by dividing the difference by the pre-treatment combined group mean. Statistical significance of the differences between group means after treatment was determined using the F-test. Confidence intervals were computed using the mean-square error for dataset. P-

values were calculated using Fisher's exact test and quantify the probability that the EOs and FCO adjusted group means significantly differ from one another. P-values and 95% confidence intervals for the post-treatment means were calculated using an alpha value of 0.05. The analysis was performed using the computational tool "One-Way ANCOVA for 2 Independent Samples" provided by VassarStats, a free web-based statistical computation service. For outcome measures which were obtained for each of the participant's two hands independently, statistics were calculated with data for dominant and non-dominant hands both separately (n = 36) and together (n = 72, two hands per participant).

3. Results

3.1. Angle of maximum flexion

Perhaps the most compelling results of this study lie in the angle of maximum flexion assessment. There were several statistically significant differences between the treatment and placebo group in joint flexibility. Adjusted for baseline differences and averaged for both hands, the difference in joint flexibility between groups after the ATHT achieved statistical significance for all five joints measured (Table 2). The differences in joint angle of DIP 2, PIP 2, MCP 2, MCP 1, and IP 1 between groups achieved P-values of 0.044, 0.04, 0.021, < 0.00001, and 0.00016, respectively. Participants in the treatment group experienced increased angle of flexion (thus increased flexibility) in DIP 2, PIP 2, MCP 2, MCP 1, and IP 1 joints, with increases of 4.7° ± 1.92°, 4.2° ± 1.69°, 3.1° ± 1.75°, 6.5° ± 1.58°, and 6.0° ± 1.53°, respectively. Participants in the coconut oil group did not experience consistent increases in angle of flexion except for modest changes in the IP 1 and MCP 1 joints. Participants in the coconut oil group showed changes of 0.6° ± 1.92°, 0.6° ± 1.69°, −1.1° ± 1.75°, −3.2° ± 1.58, −0.3° ± 1.53° in the DIP 2, PIP 2, MCP 2, MCP 1, and IP 1 joints, respectively (Table 2). When analyzed separately, the dominant and non-dominant hands exhibited differing instances of statistical significance due to sample size reduction. However, when both hands were analyzed separately, the differences in IP 1 and MCP 1 flexion between groups still achieved statistical significance.

3.2. Arthritis hand function test

Although only one of the eleven test items achieved a statistically significant difference between groups, the Arthritis Hand Function test still produced some clinically relevant results (Table 3). After statistically adjusting for baseline differences, the treatment group exhibited a decrease of −6.6 ± 3.0 seconds for the thumb-intensive shoe-lacing task, while the placebo group actually showed an increase of 1.9 ± 3.0 seconds to complete the task. The time difference to complete the task between groups was statistically significant, reaching a P-value of 0.0105. Several other 2-hand functional tests almost achieved statistical significance; given a larger sample size, these test items would likely reach significance. The safety pin, cutting putty, and coin box tasks neared statistical significance in the time differences between groups. For the safety pin task, participants in the treatment group showed −3.4 ± 1.1 seconds decrease in time to complete the task, while participants in the placebo group only showed −1.7 ± 1.1 seconds time reduction (Table 3). Though this difference is not statistically significant with a P-value of 0.15, the treatment group completed this task, on average, twice as quickly as the placebo group. Similarly, the cutting putty task did not reach statistical significance, but proved marked improvement in the treatment group, as they completed the task 7.4 seconds faster than the placebo group. Finally, the coin box test approached a statistically significant difference between groups, with the treatment group completing the task 1.0 s faster than the placebo group (Table 3). Though the difference may seem marginal, the coin box test was on average the fastest task to complete, thus accounting for the near statistically significant time difference between groups. Whether the dominant/non-dominant hands were assessed together or separately, the strength and dexterity tasks involved in the Arthritis Hand Function test (including 2- and 3-point pinch strength, grip strength, and pegboard dexterity tasks) did not show a statistically significant difference between groups, however all measurements of strength were indeed greater in the group which received the essential oil treatment. Lastly, the two applied strength tasks (lifting cans and pouring water) did not yield any meaningful results, since every participant tested was able to lift the maximum number of cans and pour the maximum volume of water.

4. Discussion

The endocannabinoid system is a frequent target in strategies of pain management. Research has repeatedly demonstrated the analgesic effects of CB_2 activation, particularly by phytocannabinoids. Prevalent phytocannabinoid compounds, namely those contained in *Cannabis* plants, are noted for their analgesic and psychoactive effects via activation of CB_1 and CB_2. Indeed, recent findings indicate that a number of CB_2 agonists can modulate various types of pain, including acute, cancer-related, neuropathic, and inflammatory pain, hence the frequent prescription of cannabinoids in treatment strategies for these pain classifications [23]. Dual activation of CB receptors induces analgesia, but can be accompanied by psychoactive effects. Theoretically, CB_2 activation only by selective CB_2 agonists could result in pain relief without psychoactivity.

Synovial tissues in RA joints reportedly express CB_2 at higher levels than synovial tissues in OA joints, suggesting greater efficacy and potency of CB_2 activation in RA patients [24]. CB_2 activation by an experimental CB_2 agonist significantly suppressed the production of autoantibodies and proinflammatory cytokines IL-6 and TNF-α in a murine model of RA, with no inhibitory effect of LPS-stimulated macrophages in CB_2 knockout mice. This indicates potent anti-inflammatory activity by CB_2 activation [25]. BCP, the primary chemical constituent of Copaiba essential oil, is a known selective CB_2 agonist, with demonstrated suppression of LPS-induced proinflammatory cytokine expression [7]. Because of its selective action toward CB_2, BCP is a potentially favorable approach in pain and inflammation management for symptoms of arthritis.

The results of the present study indicate significant increase in joint flexibility in participants that received the ATHT with the essential oils. This is likely mediated by the high BCP content of Copaiba oil through its activation of CB_2, reducing inflammation in the joints of the fingers and therefore increasing flexibility [24]. Averaged for both hands, participants in the treatment group experienced increased flexibility in all five joints measured, while those in the placebo group experienced a slight increase in flexibility of IP 1 and MCP 1 joints only. Participants which received the ATHT with essential oils would have most likely experienced increased joint flexibility due to the attenuation of inflammation through the high BCP content of Copaiba oil and its action on CB_2 [24]. This is especially evident compared to the modest changes of flexibility in the control group, which only received the ATHT with coconut oil.

Although the difference in pain reduction between groups did not achieve statistical significance, the pain score changes were clinically relevant. Participants that received the ATHT with essential oils reported nearly 50% reduction in their pain scores. This may attest to the analgesic properties of the essential oils used in this study. As previously noted, BCP, menthol, and methyl salicylate all have clear analgesic function, BCP through CB_2 activation and menthol/methyl salicylate through antinociceptive action [26]. Topical analgesics have been shown to have a pronounced effect on arthritic pain when paired with massage, especially in direct comparison of either individually [16]. The ATHT takes advantage of this principle, by combining multiple known analgesics with a moderate pressure Hand Technique,

Table 2
Effects of hand techniques using the essential oil preparation or inactive coconut oil on hand pain and finger angle of maximum flexion.

VAS Pain	Pre-Treatment combined group mean	Post-Treatment adjusted group mean		Difference from baseline				Difference Between Group Means		Significance and Spread		
	BL (n = 36)	EOs (n = 20)	FCO (n = 16)	EOs - BL	%	FCO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
Hand Pain Score (out of 10)	3.2	1.7	2.3	−1.5	−46.9	−0.9	−28.1	−0.6	−18.8	0.138	3.25	0.59
AMF (Both Hands)	BL (n = 72)	EOs (n = 40)	FCO (n = 32)	EOs - BL	%	FCO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
DIP 2 flexion (degrees)	62.6	67.3	63.2	4.7	7.5%	0.6	1.0%	4.1	6.5%	**0.044***	69.15	1.92
PIP 2 flexion (degrees)	93.6	97.8	94.2	4.2	4.5%	0.6	0.6%	3.6	3.8%	**0.04***	53.76	1.69
MCP 2 flexion (degrees)	81.9	85.0	80.8	3.1	3.8%	−1.1	−1.3%	4.2	5.1%	**0.021***	57.15	1.75
MCP 1 flexion (degrees)	52.6	59.1	49.4	6.5	12.4%	−3.2	−6.1%	**9.7**	18.4%	< **0.00001***	47.04	1.58
IP 1 flexion (degrees)	66.2	72.2	65.9	6.0	9.1%	−0.3	−0.5%	6.3	9.5%	**0.00016***	44.07	1.53
AMF (Dominant Hand)	BL (n = 36)	EOs (n = 20)	FCO (n = 16)	EOs - BL	%	FCO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
DIP 2 flexion (degrees)	61.4	65.1	63.2	3.7	6.0%	1.8	2.9%	1.9	3.1%	0.489	57.03	2.47
PIP 2 flexion (degrees)	94.0	98.8	95.8	4.8	5.1%	1.8	1.9%	3.0	3.2%	0.201	47.48	2.25
MCP 2 flexion (degrees)	81.3	85.5	80.2	4.2	5.2%	−1.1	−1.4%	**5.3**	6.5%	**0.063†**	67.5	2.68
MCP 1 flexion (degrees)	52.7	59.8	48.8	7.1	13.5%	−3.9	−7.4%	**11**	20.9%	**0.00002***	43.69	2.16
IP 1 flexion (degrees)	66.0	71.6	65.3	5.6	8.5%	−0.7	−1.1%	**6.3**	9.5%	**0.018***	48.85	2.28
AMF (Non-Dominant Hand)	BL (n = 36)	EOs (n = 20)	FCO (n = 16)	EOs - BL	%	FCO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
DIP 2 flexion (degrees)	63.7	69.3	63.2	5.6	8.8%	−0.5	−0.8%	**6.1**	9.6%	**0.054†**	83.69	2.99
PIP 2 flexion (degrees)	93.1	96.8	92.6	3.7	4.0%	−0.5	−0.5%	4.2	4.5%	0.114	61.08	2.55
MCP 2 flexion (degrees)	82.4	84.5	81.4	2.1	2.5%	−1	−1.2%	3.1	3.8%	0.200	49.96	2.31
MCP 1 flexion (degrees)	52.4	58.3	50	5.9	11.3%	−2.4	−4.6%	**8.3**	15.8%	**0.0023***	53.68	2.39
IP 1 flexion (degrees)	66.4	72.8	66.5	6.4	9.6%	0.1	0.2%	**6.3**	9.5%	**0.0068***	42.04	2.12

Adjusted group means post-treatment were calculated using one-way ANCOVA with the baseline data as the covariate to correct for baseline differences between groups. Mean changes in each variable are given with their respective 95% confidence intervals (95% CONF). Note that because ANCOVA assumes equal variances in both groups, the confidence interval for post-treatment data is the same for the Fractionated Coconut Oil (FCO) and Essential oil (EO) groups. Asterisks (*) emphasize p-values with statistical significance. Obelisks (†) indicate a p-value associated with a difference that would likely reach statistical significance given a larger sample size. Abbreviations: AMF, angle of maximum flexion; BL, baseline; MSE, mean square error; IP, interphalangeal joint; MCP, metacarpophalangeal joint; DIP, distal interphalangeal joint; EO, essential oil group; FCO, fractionated coconut oil group.

Table 3
Effects of Hand Techniques using either the essential oil preparation or inactive coconut oil on Arthritis Hand Function Test items.

Both Hands (combined data)	Pre-Treatment combined group mean	Post-Treatment adjusted group mean		Difference from baseline				Difference Between Group Means		Significance and Spread		
	BL (n = 72)	EOs (n = 40)	FCO (n = 32)	EOs - BL	%	FCO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
2-pinch (kg)	4.1	4.46	4.38	0.36	8.8	0.28	6.83	0.08	2.0	0.765	1.09	0.34
3-pinch (kg)	5.2	5.85	5.75	0.65	12.5	0.55	10.58	0.1	1.9	0.664	0.97	0.3
grip (mm Hg)	277.4	301.7	291.3	24.3	8.8	13.9	5.01	10.4	3.7	**0.194**†	1097.89	10.8
pegboard dexterity (s)	22.5	22.5	22.9	0	0.0	0.4	1.78	−0.4	−1.8	0.539	8.09	0.9
Dominant Hand	BL (n = 36)	EOs (n = 20)	FCO (n = 16)	EOs - BL	%	CO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
2-point pinch strength (kg)	4.2	4.54	4.37	0.34	8.1	0.17	4.05	0.17	4.0	0.92	1.14	0.35
3-point pinch strength (kg)	5.2	5.94	5.75	0.74	14.2	0.55	10.58	0.19	3.7	0.613	1.13	0.35
grip strength (mm Hg)	276.4	304.9	290.8	28.5	10.3	14.4	5.21	14.1	5.1	**0.19**†	987.87	10.3
pegboard dexterity (s)	21.6	21.7	22.0	0.1	0.5	0.4	1.85	−0.3	−1.4	0.658	5.31	0.8
Non-Dominant Hand	BL (n = 36)	EOs (n = 20)	FCO (n = 16)	EOs - BL	%	FCO - BL >	%	EOs - FCO	%	P-value	MSE	95% CONF
2-point pinch strength (kg)	4.0	4.46	4.27	0.46	11.50	0.27	6.75	0.19	4.8	0.600	1.11	0.3
3-point pinch strength (kg)	5.2	5.76	5.74	0.56	10.77	0.54	10.38	0.02	0.4	0.921	0.88	0.3
grip strength (mm Hg)	278.4	298.4	292.0	20	7.18	13.6	4.89	6.4	2.3	0.606	1286.97	11.7
pegboard dexterity (s)	23.3	23.44	23.74	0.14	0.60	0.44	1.89	−0.3	−1.3	0.793	10.87	1.1
2-Hand Functional Tests	BL (n = 36)	EOs (n = 20)	FCO (n = 16)	EOs - BL	%	FCO - BL	%	EOs - FCO	%	P-value	MSE	95% CONF
shoe lace time (s)	44.6	38.0	46.5	−6.6	−14.8	1.9	4.26	−8.5	−19.1	**0.0105***	86.56	3.0
button board time (s)	25.7	23.9	24.5	−1.8	−7.0	−1.2	−4.67	−0.6	−2.3	0.79	35.57	1.9
safety pins time (s)	23.8	20.4	22.1	−3.4	−14.3	−1.7	−7.14	−1.7	−7.1	**0.15**†	11.14	1.1
cut putty time (s)	49.5	39.9	47.3	−9.6	−19.4	−2.2	−4.44	−7.4	−14.9	**0.205**†	177.02	4.3
coin box time (s)	14.2	11.5	12.5	−2.7	−19.0	−1.7	−11.97	−1	−7.0	**0.149**†	4.44	0.7
total time (s)	157.7	137.9	149.6	−19.8	−12.6	−8.1	−5.14	−11.7	−7.4	**0.099**†	392.39	6.5
number of cans lifted	12	12	12	0	0.0	0	0.00	0	0.0	1	0	0.0
mL of water poured	2000	2000	2000	0	0.0	0	0.00	0	0.0	1	0	0.0

Adjusted group means post-treatment were calculated using one-way ANCOVA with the baseline data as the covariate to correct for baseline differences between groups. Mean changes in each variable are given with their respective 95% confidence intervals (95% CONF). Note that because ANCOVA assumes equal variances in both groups, the confidence interval for post-treatment data is the same for the FCO and EO groups. Asterisks (*) emphasize p-values with statistical significance. Obelisks (†) indicate a p-value associated with a difference that would likely reach statistical significance given a larger sample size. Abbreviations: BL, baseline; EOs, essential oil group; FCO, fractionated coconut oil group; MSE, mean square error.

potentially offering two routes of pain relief. Because of the potential pain relief the ATHT offers, and its simplicity and ease of administration, it may be an attractive complementary treatment option for arthritis patients.

There are limitations of this study worth mentioning here. Sample size, duration of the study, and self-reported data were all factors that limited the study. The metric used to measure hand pain was a self-reported pain scale which has limitations in quantitative research because of the subjective nature of the responses. The sample size was relatively small. Although statistically significant relationships were found in this study, further research is warranted using a larger sample size before the results of this trial can be considered representative of the general population. The intention of this pilot trial was to produce preliminary data that would indicate if further investigation on this subject is justified. The collection of data from the subject's final assessments were performed immediately after the final treatment was given, providing a measurement of the short-term benefit of this treatment. Further research should be done on the long-term effects of the treatment, including assessments of subject's hand function and pain weeks or months after the treatment has ended, as well as designing a long-term treatment period to evaluate the effect of time on the impact of the treatment.

5. Conclusions

Our results suggest that the active chemical constituents in Copaiba oil and the Deep Blue blend enhanced the benefits associated with the moderate pressure touch procedure. The active chemical constituents contained in these essential oils, namely methyl salicylate, menthol, and BCP, manifested their analgesic and anti-inflammatory properties even though participants continued using their prescribed medications. This evidence supports the conclusion that health providers should consider recommending the AromaTouch Hand Technique using Copaiba and Deep Blue as a complementary therapy in individuals with hand arthritis. Our data suggests that when used along with the standard care, the technique may relieve hand pain and inflammation to a greater extent and may also improve hand function in individuals with arthritis. We recommend that future research studies involving the ATHT with essential oils should include a larger sample size and assess a longer treatment period. Additional objective measures should be implemented, including measurements of proinflammatory cytokine levels in the synovium of the joints in the hands and fingers.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ctcp.2018.10.004.

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