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Research Article

The Effect of Instrument-Assisted Manual Therapy Technique on Brachial Hemodynamics and Pain

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Abstract

Purpose: To investigate the effect of instrument-assisted manual technique versus standard manual soft tissue mobilization on heart rate, blood pressure, brachial artery blood flow, and subjective pain.

Subjects: Eleven males and nine females (age = 23.4 ± 2.7 years, height = 170.2 ± 8.2 cm, mass = 76.3 ± 18.1 kg) without pathology or cardiovascular impairment.

Methods: Participants received either instrument-assisted manual technique or manual soft tissue mobilization to anterior brachial region, medial forearm flexor wad, and distal bicep tendon on two testing sessions separated by 4-7 days. Brachial heart rate (bpm) and blood pressure (mm Hg) were measured using an automated blood pressure monitor and brachial artery blood flow velocity (cm/sec) was measured via spectral Doppler ultrasonography prior to therapy application, immediately post, and every 5 minutes for 30 minutes. Pain was measured post each testing session.

Data Analysis: A mixed design repeated measures multivariate analysis of variance compared heart rate, blood pressure, and blood velocity between the therapy applications across time. A mixed design repeated measures analysis of variance compared heart rate, blood pressure, and blood flow independently between therapy applications across time. Univariate analysis of variance compared pain between therapy applications.

Results: No significant multivariate difference was shown between therapy applications for heart rate, blood pressure, and blood flow ($p = 0.74$). No significant univariate difference was found between therapy applications in analysis over time for heart rate (Graston:65.5 to 64.5 bpm, manual:66.7 to 62.5 bpm; $p = 0.73$), systolic blood pressure (Graston:115.6 to 117.8 mm Hg, Manual:114.1 to 117.9 mm Hg; $p = 0.72$), diastolic blood pressure (Graston:71 to 74.2 mm Hg, Manual:69.6 to 73.8 mm Hg; $p = 0.98$), or blood flow (Graston:20.6 to 20.1 cm/sec, Manual:20.1 to 19.8 cm/sec; $p = 0.32$). There was a significant decrease in heart rate (66.1 to 63.72 bpm; $p = 0.001$) over time regardless of therapy application. Pairwise comparison revealed time significance between baseline to immediate post, ten minutes, twenty minutes, and twenty-five minutes post. No difference was found for pain between applications (Graston:3.3cm, Manual:3.9cm; $p = 0.32$).

Conclusion: Instrument-assisted manual techniques nor manual techniques differentially influence localized heart rate, blood pressure, or blood flow. Manual therapy, regardless of technique, does appear to reduce localized heart rate and stimulate equivalent subjective pain.

Keywords: Instrument-Assisted Manual Therapy; Doppler; Brachial; Blood Flow

Abbreviations

ANOVA: Analysis of Variance; BP: Blood Pressure; BPM: Beats Per Minute; cm/sec: Centimeters Per Second; HR: Heart Rate; MANOVA: Multivariate Analysis of Variance; mm Hg: Millimeters of Mercury; VAS: Visual Analog Scale

Introduction

Manual therapy techniques are employed in rehabilitation medicine to augment healing of various pathologies and musculoskeletal conditions. Manual therapy interventions are applied to promote relaxation and often used for acute management of delayed onset muscle soreness. Manual interventions may elicit a controlled microtrauma to assist normal phases of physiological healing that potentially influence connective tissue and scar tissue. Manual therapy techniques are engaged to also promote healing via the stimulation of increased the rate and flow of blood. However, there is inconclusive evidence for exact applications and techniques [1-3].

Recent trends have seen the increased use of instrument-assisted manual therapy applications. These use the underlying principles of manual therapy, allow for more specific and controlled applications, and potential ease of applying the techniques by the clinician. These techniques are often used to break down scar tissue and fascial restrictions. Instrument-assisted manual techniques are also purported to increase the rate and blood flow however, there is inconclusive investigations of the effect on hemodynamic measures.

The Graston Technique® is as an emerging manual technique that utilizes instrument-assisted soft tissue mobilization that enables clinicians to break down scar tissue and fascial restrictions areas exhibiting soft tissue fibrosis or chronic inflammation. These applications are designed to influence connective tissue, potential changes to scar tissue, and changes at the microvascular level. The technique utilizes uniquely designed stainless-steel instruments based on application and therapeutic goals. Instrument-assisted manual therapy applications theoretically work by allowing the clinician to more effectively introduce a specific and controlled amount of microtrauma into an area with excessive or poorly organized scar tissue [4]. The Graston Technique® has shown preliminary evidence for improving pain and function in plantar heel pain [5], patellofemoral pain syndrome [6], scar tissue [4], and costochondritis [7]. Animal models have shown increased ability of instrument-assisted cross friction massage to improve ligament stiffness in healing knee medial collateral ligaments [8]. The Graston Technique® has also shown improvement in nerve conduction latencies, strength, range of motion, and subjective pain in the conservative treatment of carpal tunnel syndrome over time [9].

The specific Graston Technique® has limited evidence with many studies being case designs, subjective outcome measures, or difficult to quantify different designs. The Graston Technique® is purported to increase the rate and amount of blood flow to and from the treatment area as well as reduce manual stress on the clinician. There is also anecdotal evidence of increased patient pain and discomfort with generalized instrument-assisted tool application techniques. The effectiveness of instrument-assisted manual therapy application needs further quantitative investigation using objective outcome measures in blinded randomized clinical trials.

Purpose

The purpose of this study was to investigate the effect of the Graston Technique® versus manual soft tissue mobilization techniques on 1) Heart rate (HR), 2) Blood pressure (BP), 3) Brachial artery blood flow, and 4) Subjective pain.

Materials and Methods

Study design

This was a randomized single-blind repeated-measures crossover design. Institutional Review Board for Human Subjects approval was obtained from the sponsoring institution and conformed to the ethical consideration of the Helsinki Code.

Subjects

Inclusion

Recreationally active healthy men and women between the ages of 18 to 45 were recruited for the study.

Exclusion

Subjects were excluded if they had a history of upper extremity surgery or injury, musculoskeletal impairment, vascular impairment, cardiovascular disease, neurologic disease, systemic disease or dysfunction, cancer, sensation deficits, impaired cognition, or are pregnant.

Procedures

Subjects were randomized to receive either Graston Technique® or manual cross friction/soft tissue mobilization. Each therapy procedure was applied to the extended dominant arm anterior brachial region, distal bicep and tendon, entire anteromedial elbow, and halfway down the forearm for a total of 10 minutes in a supine position with a standardized number of strokes.

For the instrument-assisted manual therapy session, the Graston Technique® soft tissue mobilization emollient was first applied to the brachial region. A fanning stroke with the GT-4 Grastech™ tool was administered per Graston Technique® protocol (Figure 1).

Figure 1: Instrument-assisted manual therapy session application.

For the manual soft tissue mobilization therapy session, the Graston Technique® soft tissue mobilization emollient was first applied to the brachial region. Manual cross friction/soft tissue mobilization perpendicular to the structures was administered using both thumbs (Figure 2).

Figure 2: Manual soft tissue mobilization manual therapy session application

Main Outcome Measures

Herat rate and blood pressure

Brachial HR beats per minute (bpm) and systolic/diastolic BP in millimeters of Mercury (mm Hg) were measured using an automated blood pressure monitor (Figure 3).

Figure 3: Automated blood pressure monitor (Arial BP 2400, Medquip, Bluffton, SC).

Blood Flow

Brachial artery blood flow velocity (cm/sec) was measured via spectral Doppler ultrasonography (SonoSite M-Turbo, SonoSite, Inc., Bothell, WA). A 13-6-MHz multifrequency and 25-mm linear array with a maximum depth of 6 cm in Duplex Power Doppler mode was utilized (Figure 4).

Figure 4: Spectral Doppler ultrasonography (SonoSite M-Turbo, SonoSite, Inc., Bothell, WA).

Pain assessment

Subjective pain was assessed using a 10cm visual analog scale (VAS) (Figure 5).

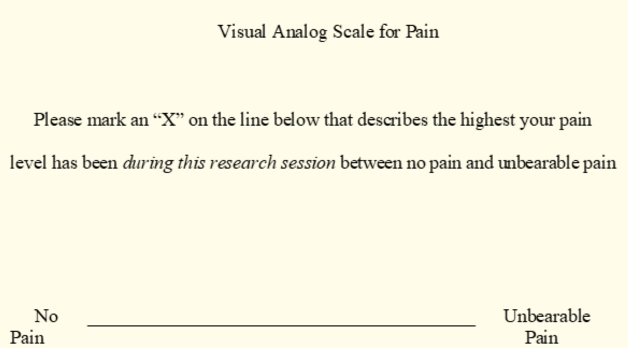

Figure 5: 10cm visual analog scale.

HR, BP, and blood flow were measured prior to therapy application, immediately post, and every 5 minutes for 30 minutes. VAS was measured post each testing session. One investigator performed all the treatment applications while the other completed all the outcome measures and each was blinded to each other's procedures and assessments. Subjects were instructed not to exercise their upper extremity at least 48 hours prior to the testing dates and to abstain from caffeine, any medication that may affect hemodynamics, and exercise or strenuous activity on the day of the testing. Subjects were schedule for two sperate sessions and returned 4-7 days later after the initial session to receive the other therapy application utilizing the exact procedures.

Statistical analysis

A mixed design repeated measures multivariate analysis of variance (MANOVA) analyzed HR, BP, and blood velocity between the therapy applications across time. A mixed design repeated measures analysis of variance (ANOVA) assessed HR, BP, and blood flow independently between the therapy applications across time. A Univariate ANOVA analyzed VAS between the therapy applications. Any significant pairwise comparisons utilized a Bonferonni adjustment.

Results

Demographics

Twenty subjects (age = 23.4 ± 2.7 years, height = 170.2 ± 8.2 cm, mass = 76.3 ± 18.1 kg) completed the study (Table 1). Three subjects were disqualified for not meeting inclusion and exclusion criteria.

Mean (± SD) for description of participants (n = 20)	
Characteristic	
Age (year)	23.4 ± 2.7
Body weight (kg)	76.3 ± 18.1
Height (cm)	170.2 ± 8.2
Gender	
Male	11
Female	9
Limb	
Right	20

Table 1: Subject Demographics and Characteristics.

Multivariate heart rate, blood pressure and blood flow

No significant difference was shown between therapy applications in multivariate analysis of HR, BP, and blood flow (p = 0.74).

Heart rate

Instrument-assisted therapy application slightly decreased (65.5 to 64.5 bpm) and manual therapy application decreased (66.7 to 62.5 bpm) over time but repeated measures ANOVA revealed no significant difference between the two manual therapy applications (p = 0.73) (Figure 6).

Heart rate displayed a significant decrease in bpm relative to time (66.1 to 63.72 bpm) regardless of therapy application ($p = 0.001$). Pairwise comparison revealed significant ($p < 0.05$) difference in pre-test to immediate post (66.1 to 62.3 bpm), pre to 10 min post (66.1 to 61.3 bpm), pre-test to 20 min post (66.1 to 62 bpm), and pre-test to 25 min post (66.1 to 62.5 bpm) (Figure 6).

Figure 6: Heart rate per time interval by manual therapy and instrument-assisted therapy application.
Abbreviations: bpm: Beats Per Minute.

Systolic BP

Both instrument-assisted therapy application (115.6 to 117.8 mm Hg) and manual therapy application (114.1 to 117.9 mm Hg) systolic BP slightly increased over time but revealed no significant difference between the two manual therapy applications ($p = 0.72$) (Figure 7).

Diastolic BP

Both instrument-assisted therapy application (71 to 74.2 mm Hg) and manual therapy application (69.6 to 73.8 mm Hg) diastolic BP increased over time but revealed no significant difference between the two manual therapy applications ($p = 0.98$) (Figure 8).

Figure 7: Systolic blood pressure per time interval by manual therapy and instrument-assisted therapy application.
Abbreviations: mm Hg: Millimeters of Mercury

Figure 8: Diastolic blood pressure per time interval by manual therapy and instrument-assisted therapy application.
Abbreviations: mm Hg: Millimeters of Mercury

Blood flow

Instrument-assisted therapy application blood flow slightly decreased (20.6 to 20.1 cm/sec) and manual therapy application blood flow also slightly decreased (20.1 to 19.8 cm/sec) over time but repeated measures ANOVA revealed no significant difference between the two manual therapy applications (p = 0.32) (Figure 9).

Figure 9: Blood flow per time interval by manual therapy and instrument-assisted therapy application.
Abbreviations: cm/sec: Centimeters Per Second

Visual analog scale for pain

Instrument-assisted therapy application subjective pain scale (3.3cm) and manual therapy application subjective pain scale (3.9cm) after treatment showed no significant difference between the two manual therapy applications (p = 0.32) (Figure 10).

Figure 10: Visual analog scale for pain by manual therapy and instrument-assisted therapy application.
Abbreviations: VAS: Visual Analog Scale.

Discussion

Vascular hemodynamics at the brachial region do not appear to be influenced by instrument-assisted application versus manual soft tissue mobilization therapy techniques. The decreased heart rate found, regardless of intervention, was potentially due to local mechanical compression that stays diminished up to at least the 25-minute time point in this research study. Both manual therapy techniques decreased local heart rate acutely near the area of treatment applications.

Instrument-assisted and manual soft tissue mobilization therapy did not impact blood pressure or blood flow velocity as has been demonstrated in other studies examining different populations and vascular structures [10-12]. While both therapy applications did diminish heart rate, the associated blood pressure and blood flow velocity were not altered by either application technique. This could be attributed to the large superficial brachial artery vessel and both treatment application techniques provided limited depth of penetration of the tissue for the specific measures.

The hemodynamics assessed in this study were limited to the brachial vessel. It is unclear whether changes in actual capillary flow, perfusion, and microvascular morphology occurred that might influence circulation and healing as has been preliminary demonstrated in other studies [6,13]. This design only examined the acute effects of treatment applications which produced no vasodilation or vasoconstriction responses, and it is uncertain of the longer-term effects of repeated treatments over time and differing parameters.

While instrument-assisted therapy has anecdotal evidence for increasing pain during its application, our study revealed equal subject pain response between the therapy applications. Both the instrument-assisted and manual soft tissue mobilization therapy interventions elicited mild to moderate pain response. Associated subjective pain from both manual therapy interventions had an equivalent effect on the outcome measures and instrument-assisted therapy does not appear to promote additional discomfort.

Conclusions

Manual therapy application using instrument-assisted versus soft tissue mobilization techniques does not differentially influence localized heart rate, blood pressure, or blood flow. Manual therapy, regardless of technique, does appear to reduce localized heart rate. Both instrument-assisted and manual therapy techniques stimulate equivalent subjective pain during treatment. Future research studies should incorporate a true control group, other vascular structures of interest, microvascular assessments, and applications to specific pathological populations.

Acknowledgements

None.

Conflict of Interest

No conflict of Interest.

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