The Audible Pop Is Not Necessary for Successful Spinal High-Velocity Thrust Manipulation in Individuals With Low Back Pain

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ABSTRACT. Flynn TW, Fritz JM, Wainner RS, Whitman JM. The audible pop is not necessary for successful spinal high-velocity thrust manipulation in individuals with low back pain. Arch Phys Med Rehabil 2003;84:1057-60.

Objective To determine the relationship between an audible pop and symptomatic improvement with spinal manipulation in patients with low back pain (LBP).

Design: A prospective cohort study.

Setting: Two outpatient physical therapy clinics located in military medical centers.

Participants: A cohort of 71 patients with nonradicular LBP referred to physical therapy.

Interventions: Participants underwent a standardized examination and standardized spinal manipulation treatment program. All patients were treated with a sacroiliac (SI) region manipulative technique and the presence or absence of an audible pop was noted.

Main Outcome Measures: Subjects were reassessed 48 hours after the manipulation for changes in range of motion (ROM), numeric pain rating scale (PRS) scores, and modified Oswestry Disability Questionnaire (ODQ) scores.

Results: An audible pop occurred in 50 of the 71 subjects during the manipulative procedure. Both groups—those who had an audible pop and those who did not—improved over time in flexion ROM, PRS scores, and modified ODQ scores; however, there were no differences between groups ($P>.05$). Nineteen of the 71 (27%) patients improved dramatically (mean drop in modified ODQ, 67.6%). In 14 of the 19 dramatic responders, an audible pop occurred. However, the odds ratio (1.2; 95% confidence interval, 0.38–4.04) suggested that the occurrence of a manipulative pop would not improve the odds of achieving a dramatic reduction in symptoms after the manipulation.

Conclusion: There is no relationship between an audible pop during SI region manipulation and improvement in ROM, pain, or disability in individuals with nonradicular LBP. Additionally, the occurrence of a pop did not improve the odds of a dramatic improvement with manipulation treatment.

Key Words: Low back pain; Manipulation therapy; Physical therapy techniques; Rehabilitation.

SPINAL MANIPULATION IS an intervention commonly used to treat individuals with low back pain (LBP) and is reported to be more effective than placebo[1–3] and other interventions.[4-7] In particular, spinal manipulation is proposed to be effective in individuals with sacroiliac (SI) region dysfunction.[3-5,8] High-velocity, low-amplitude thrust manipulation technique (HVT) is among the oldest and most frequently used forms of spinal manipulation.[9] A cracking sound or audible "pop" often accompanies HVT manipulation of the lumbopelvic spine. A practitioner's perception of the occurrence of an audible pop during spinal manipulation is reportedly very accurate,[10] and many clinicians and patients consider an audible pop necessary for the manipulation to be successful.

It is generally believed that the audible pop that occurs with manipulation is caused by a cavitation mechanism that happens with separation of the facet surfaces within the spinal zygapophyseal joint.[11] Cavitation is a well-documented engineering phenomenon that describes the generation and collapse of gas or vapor bubbles in a liquid.[12] Roston and Haines[13] were the first to investigate the cavitation phenomenon in a synovial joint. After an HVT manipulation of the metacarpophalangeal (MCP) joint, the authors reported the presence of a radiolucent cavity and change in the mechanical behavior of the MCP joint.[13] Subsequent cineradiographic studies[14,15] have reported increased joint space and increased carbon dioxide gas within the MCP joint after an HVT manipulation. Carbon dioxide is reportedly the gas with the highest miscibility in synovial fluid, and this increase in carbon dioxide has been suggested as a mechanism that would improve range of motion (ROM) of a joint after HVT manipulation.[12] Furthermore, it has been hypothesized that the cavitation phenomenon may be the mechanism responsible for initiating certain reflex relaxation of the periarticular musculature, which purportedly occurs with HVT manipulation.[12] Although it is accepted that the audible pop is the outward manifestation of the occurrence of the cavitation phenomenon within a joint, this relationship has not previously been studied. It is currently assumed, but unproven, that the audible popping noise is necessary to achieve the benefits of manipulation.

To our knowledge, only 2 reports[10,16] have investigated the audible pop during HVT manipulation in the spinal region. However, these authors reported only on the forces required and the presence of an audible sound. The relationship between the presence of a pop and changes in symptoms was not reported. Despite the paucity of evidence describing the relationship between an audible pop and symptomatic improve-

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ment with manipulation, many practitioners continue to gauge the success or failure of the procedure based primarily on the presence or absence of a pop.[16] Therefore, the purpose of this study was to investigate whether the occurrence of a manipulative pop during SI region manipulation is related to the outcome of the intervention.

METHODS

A cohort study of patients with LBP was conducted at 2 outpatient facilities—Brooke Army Medical Center and Wilford Hall Air Force Medical Center. Patients were 18 to 60 years old, referred to physical therapy with a diagnosis related to the lumbosacral spine, and had a chief complaint of LBP with or without radiation or tingling into the buttock and/or lower extremity. The baseline modified Oswestry Disability Questionnaire (ODQ) score had to be at least 30%. Exclusion criteria were current pregnancy, signs consistent with nerve root compression (positive straight-leg raise at less than 45°, or diminished lower-extremity strength, sensation, or reflexes), prior lumbar spine surgery, or a history of osteoporosis or spinal fracture. All patients were briefed on the purpose of the study and signed an informed consent approved by the Brooke Army Medical Center and Wilford Hall Air Force Medical Center institutional review boards.

Eight licensed physical therapists participated. Four were residents in the US Army-Baylor Post-Professional Doctoral Program in Orthopaedic and Manual Physical Therapy and 4 were instructors in the program. This program is designed to provide physical therapists serving in the US military with advanced training in orthopedic and manual physical therapy. A 1-day training session was conducted for participating therapists to standardize examination and treatment techniques.

Patients completed a baseline examination including demographic information and an 11-point numeric pain rating scale (PRS).[17] The modified ODQ assessed disability related to LBP.[18] Patients underwent a standardized history and physical examination. ROM and status change[19] in symptoms with single lumbar movements were recorded. Lumbopelvic ROM was measured with an inclinometer while standing. The inclinometer was centered over the T12 spinous process and zeroed. The patient was instructed to bend forward as far as possible without bending the knees, and the inclinometer value was recorded. This method has been shown to have excellent reliability (intraclass correlation coefficient=.94).[20]

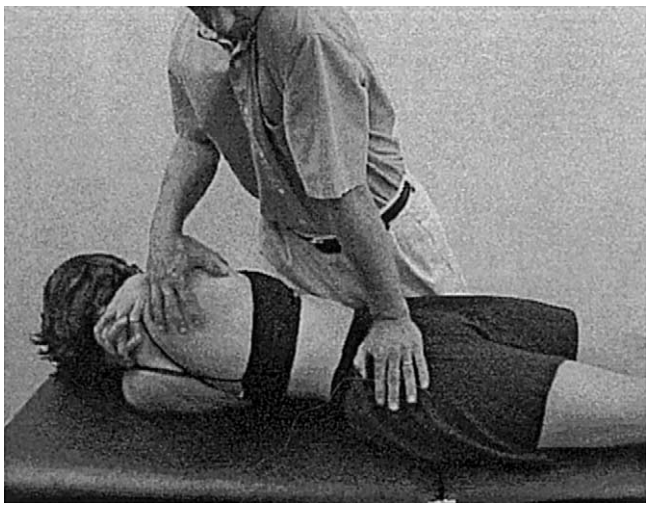

Fig 1. Manipulation technique used in this study.

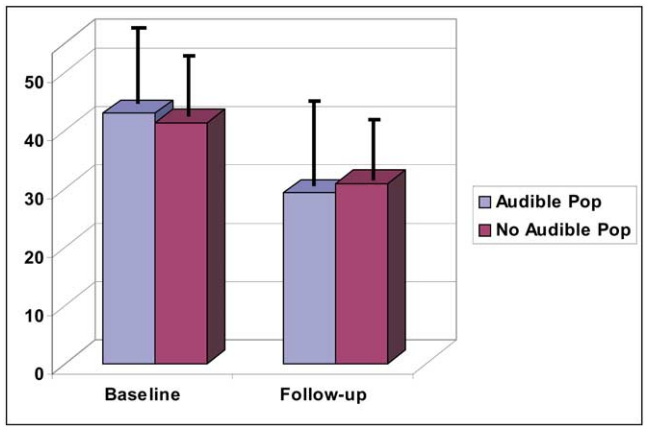

Fig 2. Initial and follow-up modified ODQ scores for the group in which an audible pop occurred and those where no audible pop was noted. The mean percentage change in the audible pop group was 31.9%±29.3%. For the nonpop group, the mean percentage change was 25.1%±26.2%.

Treatment

All patients were treated with the same manipulation technique with the patient supine. The therapist stood opposite the side to be manipulated. The patient was passively side-bent away from the therapist. The therapist passively rotated the patient, and then delivered a quick posterior and inferior thrust through the anterior superior iliac spine (fig 1).

The side to be manipulated was determined by an algorithm[21] based on movement, tenderness, or patient-reported symptoms. After the manipulation, the therapist noted whether the therapist or patient heard an audible pop. If no audible pop was produced, the patient was repositioned and the manipulation was attempted again. If no audible pop was experienced on this attempt, the therapist manipulated the opposite side. A maximum of 2 attempts per side was permitted.

If no audible pop was produced after the fourth attempt, the therapist proceeded to the other treatment components. Two additional treatment components were included: (1) instruction in a supine pelvic tilt ROM exercise (the patient was instructed to perform 10 repetitions, 3–4 times daily), and (2) instruction to maintain usual activity level within the limits of pain.[5] The follow-up session occurred 2 to 4 days after the first, at which time each patient completed the modified ODQ and PRS. The lumbar spine ROM measures were also repeated.

Data Analysis

Descriptive statistics were calculated for the modified ODQ, PRS, and total lumbopelvic flexion at baseline and follow-up. An analysis of covariance with the baseline score as the covariate was used to compare the change scores in these variables between the group of subjects in which an audible pop occurred and the group in which the audible pop was absent. In addition, the subjects were divided into 2 groups by whether a 50% or greater improvement in the modified ODQ score occurred. Chi-square test and an odds ratio were calculated to determine if the manipulative pop was associated with a substantial improvement (achievement of a $\geq$50% reduction in the modified ODQ score).

Table 1: Baseline Demographic Characteristics

Variable	All Subjects (N=71)	Audible Pop (n=50)	No Audible Pop (n=21)	*P*
Age (y)	37.6±10.6	36.9±11.5	39.3±8.2	.34
Gender	41% female			.81
Male (%)		69.2	30.8	
Female (%)		71.9	29.1	
Duration of symptoms (d)	41.7±54.7	39.8±54.1	46.2±57.4	.66
Prior history of LBP (%)	83	88	79	.37
Episodes of LBP becoming more frequent (%)	35	25	44	.10

NOTE. Values are mean ± standard deviation (SD) or as otherwise indicated.

RESULTS

Seventy-five patients entered the study. Four subjects (5%) did not return after the first session and were not included in the analysis. (Two subjects left the study because of personal or work-related circumstances. One subject dropped out because of complications from an ongoing episode of gastrointestinal distress, and 1 subject failed to return for his follow-up visit.) Demographic characteristics of the subjects are presented in table 1. Of the 71 patients included in the analysis, 29 (41%) were women, and 59 (83%) subjects had a history of LBP. The mean age was 37.6±10.6 years, and the subjects had experienced 41.7±54.7 days of LBP symptoms during this current episode.

At baseline, the mean flexion ROM was 75.7°±30.0° (range, 15°–140°), the mean modified ODQ score was 42.4±11.7 (range, 30–86), and the mean PRS score was 5.3±2.0 (range, 1–10) for all subjects. At follow-up examination approximately 48 hours later, the mean flexion ROM was 92.1°±22.5° (range, 40°–140°), the mean modified ODQ score was 29.7±13.5 (range, 0–64), and the mean PRS score was 3.8±2.0 (range, 0–9) for all subjects. A pop occurred in 50 of the 71 (70%) subjects during the manipulative procedure. Descriptive statistics by group are presented in table 2.

Both groups improved over time in flexion ROM, modified ODQ scores, and PRS scores; however, there were no significant differences between groups ($P>.05$). The improvement in mean flexion ROM in the group in which a pop occurred was 15.2°±19.7° compared with 10.9°±17.2° in the group in which a pop did not occur ($F=.114$, $P=.74$). The improvement in modified ODQ scores in the group in which a pop occurred was 13.7±14.7 compared with 10.4±12.9 in the group in which a pop did not occur ($F=.49$, $P=.49$). The mean percent change in OSW is displayed in figure 2. The improvement in PRS scores in the group in which a pop occurred was 1.5±2.3 compared with 0.9±1.8 in the group in which a pop did not occur ($F=1.50$, $P=.23$).

Nineteen of the 71 (27%) patients improved dramatically (mean drop in modified ODQ, 67.6%) after the initial manipulation. In 14 of the 19 dramatic responders, a manipulative pop occurred. When the groups were dichotomized by dramatic success, the presence of a manipulative pop was not related to dramatic improvement (model $\chi^2_1=.13$, $P=.72$). Furthermore, the odds ratio (1.2; 95% confidence interval, 0.38–4.04) suggested that the odds of success was essentially unchanged whether or not there was an audible pop.

DISCUSSION

Clinicians who use HVT spinal manipulation often believe that an audible pop is necessary if a manipulation technique is to result in improvements in ROM, pain, and function. This belief persists despite a paucity of evidence regarding this relationship.[11,12] We did not find any statistical or minimal clinically important differences[18,22] between the group that experienced an audible and the group that did not. Our results show that an audible pop during a spinal manipulation occurs frequently (70%), yet is not related to the outcome of the intervention.

It is unclear what the audible pop that may occur during spinal manipulation represents. There is little evidence to suggest that the cavitation phenomenon thought to be responsible for the audible pop in the MCP joint is the same mechanism responsible for the audible pop produced during spinal manipulation.[11] Alternative theories of the biomechanical effects of spinal manipulation have been proposed, and they incorporate the "snapping back" of distended capsular ligaments or the movements of fat pads in and out of the zygapophyseal joint.[12,23]

In our study, there was no mechanism available to verify from where in the lumbopelvic region the sound emanated. The therapists attempted specifically to localize down to the SI region and ensure that the SI region was where the noise occurred. However, this is very difficult to verify in clinical practice. Anecdotally, we and others have described the sound from an SI region manipulation to be more of a "clunk" rather than a "pop." However, any joint sound that was present was considered a positive audible pop regardless of the tone of the sound. Although the treating therapists documented whether an

Table 2: Disability, Pain, and ROM Scores Before and After Manipulation

	Audible Pop (n=50)		No Audible Pop (n=21)		
Variable	Baseline	Follow-Up	Baseline	Follow-Up	*P*
Modified ODQ score	42.9±12.4	29.2±14.9	41.3±9.8	30.9±9.8	.49
PRS score	5.2±2.0	3.6±2.1	5.1±1.5	4.2±1.7	.23
Lumbopelvic flexion ROM (deg)	76.0±27.5	91.2±24.2	83.2±29.1	94.1±18.5	.74

NOTE. Values are mean ± SD.

audible pop occurred or was felt by the patient, therapists did not consider different popping sounds to be associated with different outcomes. There was no independent verification of this sound via microphone or accelerometers in our study.

It has been shown[10] that the practitioner's perception of the occurrence of cavitation during spinal manipulation is very accurate. Furthermore, all of the therapists were experienced providers of HVT spinal manipulation and during practice sessions consistently showed the technique and reported if joint noise occurred. Therefore, it is unlikely that the results would be markedly affected by this factor. In addition, it is the audible pop, perceived by both the patient and clinician, that is generally thought to represent a successful manipulation procedure.

The fact that a large number of subjects experienced a pop (70%) and many (27%) improved markedly (>50% improvement in modified ODQ) without an audible pop suggests that the pop should not be the focus of the clinician or the patient during spinal manipulation. Our study supports the assertion of Bourdillon, who stated that the belief shared by some patients and operators that if there is no joint noise associated with manipulative procedure then nothing happened is incorrect.[24]

CONCLUSION

It appears that there is little to no relationship between the manipulative pop that occurs during this manipulation and improvement in ROM, pain, and disability in individuals with nonradicular LBP. Furthermore, the occurrence of a pop did not improve the odds of a dramatic improvement after spinal manipulation. Therefore, clinicians who use these techniques should be cautious in attributing any therapeutic benefit to the audible pop.

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