

# Innovative Use of Color Awareness Vibrational Therapy in Patients with Patella Malalignment

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## ABSTRACT

Interventions involving mindfulness have been integrated into mainstream rehabilitation programs over the last decade. The technique used in this case series was rooted in previous theories. Through blending the mindful awareness of color therapy and physical stimulation of vibration therapy during exercise the patients felt an improved outcomes in pain and function. While providing care to patients competing in intercollegiate athletics the primary investigator/ clinician started to experiment with color, vibration, and exercise therapies. Each patient was classified with patella malalignment through a medical evaluation. For the three patients in this case series, exercise paired with manual vibration massage associated with color perception of the physical stimuli led to improvement in NRS, PSFS, and LEFS scores. All of the patients maintained their level of competition throughout the entirety of the treatment duration. The targeted manual therapy with cognitive focus assisted them in their health and performance goals. Clinicians creating and practicing these mind-body connecting interventions can strengthen patient-provider relationships. It may be beneficial for more research to be designed and completed on the relationship between manual stimulation and perceived sensation related to patient outcomes.

**Keywords:** Activation, Neurophysiological, Connection

## Abbreviations

NRS	: Numeric Pain Rating Scale
PSFS	: Patient Specific Functional Scale
LEFS	: Lower Extremity Functional Scale
PF	: Patella Femoral
MCID	: Minimal Clinically Important Difference
MDC	: Minimal Detectable Change
TVR	: Tonic Vibrational Reflex

## Introduction

Knee pain is one of the most common issues limiting patients competing in college athletics [1-3]. When determining the root

cause of knee pain, it is imperative to rule out the tibial femoral joint and then assess the patella femoral (PF) joint [4]. Often patients with diffuse pain over the whole knee are associated with having PF joint pathology. Conditions related to PF are likely to have a cognitive awareness component due to the sensitivity of the patella to pain [4]. The innovative intervention completed in this study led to improved outcomes in the three patients treated. Color and vibration therapy can be used together to blend cognitive awareness and physiological contractile tissue engagement. Often patients with a physiological diagnosis are treated with mechanical tissue healing modalities instead of exploring when a global intervention can support the entire patient [5].

## Patients

The three patients included in this case series had past medical histories that potentially contributed to their current diagnosis

of patella malalignment. Two had previous surgeries (meniscus repair and ACL reconstruction) that they successfully completed rehabilitation and returned to full participation levels. The third patient had persistent knee pain that limited performance in explosive jumping activities (i.e. triple jump, long jump). All three patients were limited in specific activities based on their knee pain. Traditional strengthening and stretching at the hip and knee paired with balance training helped decrease symptoms but did not resolve the issue. The knee pain occurred during activity and was not painful at rest. Each patient was open to trying an innovative intervention.

All the patients had similar symptoms and were provided with a conservative prognosis. The team physician concluded that the patients were having pain and limited function based on strength deficits. The patients were all in their competitive seasons and actively practicing and competing. Two patients were participating in American Football, one was a quarterback and the other a linebacker. Even though their sport was the same the dynamic loading at and around the knee was different based on position. The quarterback engaged in pivoting at the knee to throw the football. The linebacker was responsible for strong explosive loads to complete tackles. While the track and field athlete focused on triple and long jump with explosive knee extension.

Based on the evaluation of each patient it was determined that a diagnosis of patella malalignment was an appropriate classification. Each patient had sharp knee pain behind the patella, described as anterior knee pain. The pain was related to the amount of knee flexion and each shared three specific functional activities that were limited. Walking down a flight of stairs, standing from a seated position, and squatting were provocative. limited movements. The compressive forces of the patella during these movement have been well researched in the literature [4].

The position of the patella, frog-eyed, and limited open chain terminal knee extension also directed the diagnosis [4]. On radiographic studies, the patella did not show bone abnormalities nor was lower-extremity malalignment present. The tension in muscles around the knee joint and lateral thigh lead to a causal classification of imbalance peri-patellar soft-tissue tension. For all these reasons, the plan of care was created with non-surgical, conservative care first.

### Treatment

The intervention technique that was provided combined color, vibration, and exercise therapy. Through this innovative approach of mindfulness exercise connected to color and manual vibration, positive outcomes were reported with these patients. The exercise component progressed throughout the rehabilitative sessions to increase awareness in different movement patterns, while the color and vibration stimuli were performed to activate or relax muscles throughout the sessions. Color selection was based on the goal of the vibration stimuli. For these patients, red was the color used for areas of minimal or decrease muscle activation during tasks. The red color was paired with a vigorous and deep fingertip vibrational massage. Then a blue color with more palm contact and slow, light touch was completed on overactive muscles. Green was used in muscles that were activating effectively with a goal of helping retrain a movement pattern to balance peripatellar soft-tissue tension [6].

The completed exercises included quad setting, heel touches, chair squats, split-squats, step-ups, lateral lunge, and tri-extension reach. Also, conventional hip strengthen exercises were completed [7]. The manual vibration and color stimuli were provided during each exercise to promote the desired muscle activation levels.

**Table 1: Outcome Scores of the Course of Treatment**

#### Numeric Pain Rating Scale

	Initial Evaluation	Pre-Treatment	Post-Treatment	Post 3 Treatments	Post 6 Treatments	Discharge	2-week FU
Patient 1	4	5	2*	2	0	0	0
Patient 2	3	3	2	2	1*	0	0
Patient 3	4	4	2*	0	0	0	0

#### Patient Specific Functional Scale

	Initial Evaluation	Pre-Treatment	Post-Treatment	Post 3 Treatments	Post 6 Treatments	Discharge	2-week FU
Patient 1	6.5	6	8	9*	10	10	9
Patient 2	7	7	8.5	10*	10	10	10
Patient 3	7	7	8.6	9.5*	9.5	10	10

#### Lower Extremity Functional Scale

	Initial Evaluation	Pre-Treatment	Post-Treatment	Post 3 Treatments	Post 6 Treatments	Discharge	2-week FU
Patient 1	67	N/A	N/A	75	78#	78	76
Patient 2	72	N/A	N/A	74	78	78	77
Patient 3	74	N/A	N/A	80	80	80	80

## Outcomes

The outcome measures gathered for these patients included Numeric Pain Rating Scale (NRS), Patient Specific Functional Scale (PSFS), and the Lower Extremity Functional Scale (LEFS). To guide the care and determine the effectiveness of treatment being provided the surveys were completed at initial assessment (only evaluation no treatment), first intervention, after three sessions, after six sessions, discharge, and two-week follow-up. (Table 1)

As a measurement of pain, the Numeric Pain Rating Scale (NPRS), is an 11-point scale, where 0 equals “no pain” and 10 is the “worst pain imaginable. The NPRS, a valid outcome measure, provides an objective measurement to a subjective assessment of level of pain. If a decrease of 2 points occurs that is considered a minimal clinically important difference (MCID) [8].

The Patient Specific Functional Scale (PSFS), a valid PRO, is used to label and determine specific functional level for patient select activities. The labeled activity is assessed on a 0-10 scale with 0 being “unable to perform the activity” to 10 being the “ability to perform the activity at the same level as before injury or problem.” The MCID for the PSFS is 3 points for a single functional activity or 2 points for an average score [9].

The Lower Extremity Functional Scale (LEFS) is a researched PRO including 20 items with possible score of 0-80. The goal is to objectively measure the perceived functional level of the patient’s lower extremity. Each item is scored by the patient on a scale of 0-4, with 0 meaning most impairment and 4 indicating normal activity. The MCID for the LEFS is an increase in score by 9 points [10].

## Discussion

A combination of therapeutic exercise, color therapy, and vibrational therapy was used to improve the outcomes for the three patients in this study. The mechanisms by which these outcome changes occurred are worth exploring. Possible mechanisms include vibrational stimuli, color perception, and neurophysiological adaptations related to exercise [11-14]. The improvements did not necessarily follow tissue healing timeframes as no specific tissue damage was associated with the patients’ symptoms. While creating an innovative therapy it is helpful to explore possible mechanisms to ensure best care for those treated.

The pain these patients felt was a warning sign of the potential for physiological damage. Therefore, the decreased pain, measured through the NRS, was a possible modification to the autonomic nervous system similar to other manual therapies [15,16]. With the higher levels of awareness, through vibration, color cognitive resetting, or repetition of exercise, the sense of instability or risk of injury to the knee and surrounding structures was minimized. Changing the sensations downregulated the nervous system and allowed the body to move through normal ranges of motion without the constant warning of tissue damage, perceived as pain [17,18].

Vibration therapy is commonly associated with mechanical stimulation through percussion massage guns or full-body

vibrational platforms [19]. These techniques have been effective in treating a patient with cervical disk herniation [20], posterior shoulder tightness [21], neck myofascial trigger points [11], DOMS [22], heart rate effects [5], dementia [23], and Parkinsons [24]. One explanation for the outcomes achieved by these patients is the Tonic Vibrational Reflex (TVR) [19]. The patients were believed to have imbalanced peripatellar soft-tissue tension. Muscles surrounding the patella could have been lacking in contractability or had elevated muscle tone that was leading to the perceived imbalance. Through conventional strengthening or stretching rehabilitation the goal is to strengthen the muscles that are weak and stretch muscles that are tight at a local range. Through the TVR, the intervention could have elicited the central nervous system to decrease muscle tone or increase contractability in the muscles that needed that change [25]. Vibration sensations are transmitted to the spinal cord which responded with a descending motor signal to begin tonic contractions. The imbalances could have been corrected with some muscles regaining muscle tone or turning down the heightened activation response, inhibiting the muscle.

Improvement in the LEFS occurred over the length of the treatment plan. (Table 1) There was a ceiling effect with two patients not able to reach an MDC based on their initial scores. When completing these assessments, it was clinically helpful to objectively see where the patients scored ‘squatting’ and ‘going up and down 10 stairs. This added a second dimension to the PSFS scores. It is possible that the LEFS scores improved due to increased joint position sense from the vibration therapy [20]. Another option is that the patient had a change in their association with the sensation they had been feeling around their knee through the change in color perception.

Similarly to the LEFS improvements, the improvements in the PSFS outcomes could have been related to joint position sense during the tasks or changes in color perception and sensations in the area. It is also possible that the repetitive exercise improved the scores as the quality of movement was enhanced with practice. Physiologically the response to the color red should be a cooling/ calming as the wavelengths are slower than blue light and blue light should illicit a warming/activation. Our brain has the power to associate the colors with past experiences and not simply the frequency of wavelengths. It has also been observed that “explosive” movements did not significantly improve following a manual activation massage or use of mechanical massage device [26].

Therefore, it is possible that a cognitive connection or mindfulness can enhance the effects of color therapy. Although the individual techniques have been successful in a variety of patients, it is the combination vibration, color, and exercises therapies that make the current intervention innovative [6,12,13,23]. It is the pairing of color therapy principles centered in mindfulness that increases the effectiveness of vibration therapy to promote muscle activation or inhabitation during specific therapeutic exercise. This promotion of awareness can be beneficial in patients with persistent conditions that are less related to muscle strength or length and more related to muscular imbalances. The change in awareness may also illicit a central nervous system adaptation to down-regulate or upregulate the allostasis process.

There are other techniques that have been used by rehabilitation specialists to downregulate the central nervous system. Clinical outcomes in case series support the use of manual therapies to alter the central nervous system. Although the cognitive relationship is important in techniques such as Positional Release Technique, it is not de-tailed in the skill of providing the intervention [16]. Incorporating color or other cognitive networks along with manual stimulation can have a positive effect on patient-provider connection.

### Conclusions

Through this novel technique completed with therapeutic exercises clinical improvements at the level of MCID and MDC occurred in all three patients. During the renaissance of alternative therapies and transition from the golden to platinum rule in healthcare it is imperative that providers expand their array of modalities. The cognitive connection patients forge with their pain or movement patterns has been the moving target for isolated physical-based interventions [27]. Moreover, the development of innovative techniques that combine theory, practice, and patient experience will continue to enhance the skills of some providers and separate providers maintaining the status quo.

### Author Contributions

Conceptualization, CM and LB; methodology, CY; resources, LB, CM, and CY; writing---original draft preparation, LB, CM, and CY; writing---review and editing, LB; 199 patient care, LB, CM, and CY.

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### Conflicts of Interest

The authors declare no conflicts of interest.

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