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Effect of Mobilization and Screw Thrust Mobilization in T4 Syndrome

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Abstract:

- ***Introduction:***

The thoracic spine, consisting of twelve vertebrae (T1–T12), plays a crucial role in spinal stability and autonomic nervous system function. T4 syndrome, a dysfunction localized at the T4 vertebral level, presents with a combination of musculoskeletal and autonomic symptoms, including upper limb paresthesia, thoracic stiffness, and sympathetic nervous system disturbances. Although the exact pathophysiology is unclear, mechanical irritation of the sympathetic chain by hypomobile thoracic joints is hypothesized to contribute to symptom development.

- ***Methods:***

50 participants aged 18 to 50 years with a clinical diagnosis of T4 syndrome were selected for the study. The participants were randomly divided into two groups of 25 each. Group A received mobilization therapy daily for one week, while Group B received screw thrust mobilization therapy on alternate days over the course of one week.

- ***Results:***

Both interventions resulted in statistically significant improvements across all measured outcomes. In Group A (mobilization), VAS scores decreased by 4.40 points ($p < 0.0001$), flexion and extension ROM increased by 0.464 and 0.368 units, respectively ($p < 0.0001$), and PSFS scores improved by 2.86 points ($p < 0.0001$). In Group B (screw thrust), VAS scores decreased by 3.76 points ($p < 0.0001$), with flexion and extension gains of 0.468 and 0.228 units, respectively, and PSFS scores increased by 2.40 points ($p < 0.0001$). Although mobilisation showed slightly greater improvements in pain reduction, flexion ROM, and functional ability, the differences were not statistically significant, except for thoracic extension ROM, where mobilisation significantly outperformed screw thrust ($p = 0.0087$).

- ***Conclusion:***

Both mobilisation and screw thrust mobilization techniques are effective in reducing pain, improving thoracic mobility, and enhancing functional activity in patients with T4 Syndrome. Mobilization demonstrated slightly greater clinical benefits, particularly in thoracic extension. These findings support the use of manual therapy as a primary intervention for managing T4 Syndrome and emphasize the need for further research to explore long-term outcomes and autonomic nervous system modulation.

Keywords: *T4 Syndrome, Mobilisation, Screw Thrust Mobilisation.*

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I. INTRODUCTION

The thoracic spine is composed of twelve vertebrae (T1–T12)[1], which are structurally and functionally distinct. These vertebrae are classified into typical (T2–T8) and atypical (T1, T9–T12) based on morphological differences. Each typical thoracic vertebra consists of a vertebral body, vertebral arch, and seven distinct processes—comprising two pedicles, two laminae, a single spinous process, two transverse processes, and superior and inferior articular facets.[2] The thoracic vertebrae are innervated by twelve pairs of thoracic spinal nerves (T1–T12),[3] and their vascular supply primarily originate from branches of the posterior intercostal arteries. Notably, the T4 spinal nerve contributes sensory innervation to portions of the upper abdominal wall. Joint articulation in the thoracic region is complex and includes the costovertebral, costotransverse, and zygapophyseal (facet) joints. Ribs 2 through 9 articulate with the demifacets of two adjacent vertebrae and the intervening intervertebral disc, whereas ribs 1, 10, 11, and 12 each articulate with a single vertebra. The costotransverse joints are formed between ribs 1–10 and the transverse processes of their corresponding vertebrae. [(11)] Facet orientation in the thoracic spine varies along its length. From T2 to T11, the superior articular facets are generally directed posteriorly and laterally, while the inferior facets are oriented anteriorly and medially, allowing for limited rotation and flexion. Between T4 and T9, the facet joints display a near-vertical (approximately 90°) orientation.

[(11)] Vertebral size also changes progressively throughout the thoracic region, with the bodies decreasing in size from T1 to T3 and then gradually increasing toward T12 to accommodate greater load-bearing demands. The spinous processes between T4 and T6 project moderately downward, contributing to the restriction of extension in the mid-thoracic spine. Thoracic vertebrae are supported by a complex ligamentous network, including the anterior and posterior longitudinal ligaments, ligamentum flavum, interspinous and supraspinous ligaments, and the anterior costotransverse and inter-articular ligaments, all of which contribute to the stability and flexibility of the thoracic spine. [1] The movements flexion (2.7cm difference in tap measure length normal), extension (2.5cm difference in tap measure length normal),11 lateral flexion, axial rotation and the zygapophyseal articular facets from T1-T6 limits flexion and extension in region. 4 palpate the thoracic vertebrae by ½ inch lateral and 4mm upward.

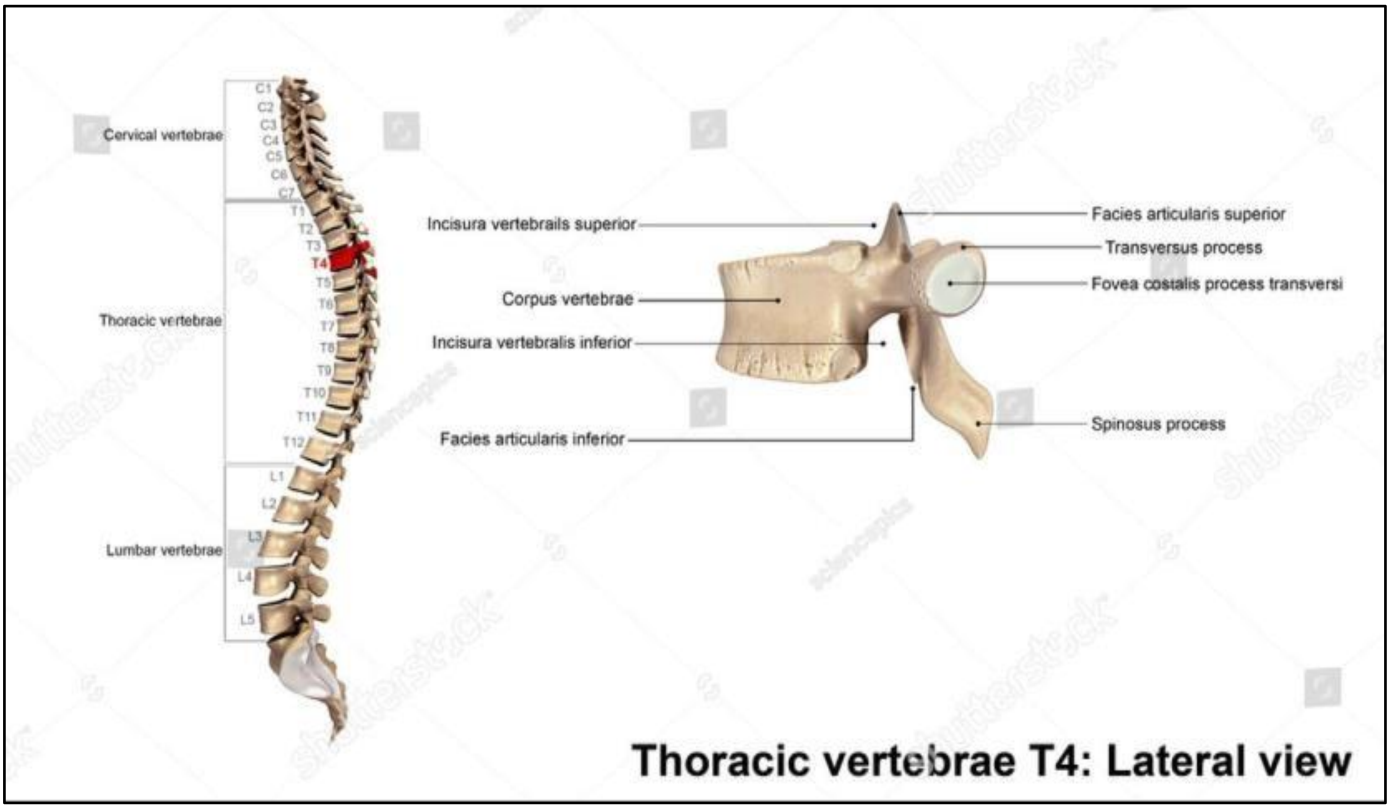

Fig 1 Thoracic vertebrae T4 Lateral View

As a dysfunction of the thoracic spine of any level from which sympathetic nerve originate. Evans introduced the term “Upper Thoracic Syndrome” to encompass a group of clinical conditions associated with dysfunction in the upper thoracic spine, among which T4 syndrome and T10 syndrome are the most commonly reported. The present study specifically focuses on T4 syndrome, a condition characterized by a constellation of symptoms potentially linked to autonomic dysregulation within the upper thoracic region.[8,12,] T4 syndrome is clinically defined as a set of symptoms attributed to dysfunction around the T4 vertebral segment, with manifestations not only at the site of pathology but also in distal regions such as the occiput and upper extremities, either unilaterally or bilaterally. Although the precise pathophysiological mechanisms remain undetermined, it is hypothesized that the condition arises from sympathetic

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nervous system involvement.[5]Patients typically present with non-dermatomal paresthesia, sensations of cold or heat in the hands, and diffuse pain in the upper limbs, particularly the arms and forearms.[18,19.] In some cases, symptoms extend to the interscapular region and the chest wall, often accompanied by stiffness, restricted thoracic motion, and nocturnal exacerbation of symptoms[.6,21]Sympathetic Dysfunction as a Contributing Factor One proposed mechanism suggests that joint hypomobility, dysfunction, or inflammatory changes at the facet or costovertebral joints around the T4 level may irritate or compress the sympathetic chain or adjacent paravertebral ganglia. This mechanical irritation is thought to disrupt sympathetic outflow, resulting in a variety of autonomic symptoms, including:

- Non-dermatomal paresthesia (tingling or numbness)
- Coldness, heaviness, or temperature fluctuations in the hands
- Altered sudomotor function (changes in sweating)
- Deep, aching discomfort in the upper limbs or periscapular region[5,6,21]

Preliminary evidence from a cross-over feasibility study investigating the acute effects of thoracic spine mobilization techniques at the T4 level has suggested a potential modulatory impact on sympathetic nervous system function. However, the current body of literature lacks sufficient large-scale, controlled trials to substantiate these findings, highlighting the need for further investigation to clarify the autonomic implications of T4 syndrome.[16] Management of T4 syndrome frequently incorporates manual therapy techniques aimed at restoring joint function and reducing autonomic-related symptoms.[10]

T4 syndrome manifests through a combination of musculoskeletal and autonomic symptoms. Musculoskeletal features typically include mid-thoracic hypomobility, forward head posture, increased thoracic kyphosis or flat thoracic spine, and associated upper extremity paresthesia or referred pain. Autonomic signs may involve temperature fluctuations in the hands, swelling, and bilateral hand discomfort or paresthesia. In some cases, symptoms extend to mimic visceral pain patterns, such as cardiac or esophageal discomfort, as well as neurovascular compression-related sensations. These symptoms may contribute to secondary effects like sleep disturbances, anxiety, and reduced quality of life. The clinical presentation reflects an interplay of neurophysiological, biopsychosocial, and somatovisceral factors, emphasizing the complexity of assessment and the importance of a multidimensional treatment approach.[18]

Therapeutic interventions commonly include spinal mobilization, muscle stretching, strengthening exercises, and postural re-education, all designed to improve thoracic segmental mobility and reduce neurogenic irritation. Spinal mobilization is a central component of manual therapy. Maitland defined mobilization as a small-amplitude, passive movement applied externally to induce joint gliding or traction[8.] In contrast, the American Physical Therapy Association (APTA) characterizes mobilization more broadly as a continuum of skilled passive movements applied to joints and associated soft tissues[9.] These movements vary in both amplitude and speed, ranging from low-velocity, large-amplitude techniques to high-velocity, small-amplitude thrusts, enabling clinicians to adapt the technique based on the specific clinical context.[7] These passive mobilization techniques are intended not only to address mechanical joint restrictions but also to influence sympathetic nervous system activity. Previous studies have demonstrated the efficacy of mobilization in modulating autonomic responses[10.] In the context of T4 syndrome, evidence suggests that unilateral Grade III rotary posteroanterior mobilizations at the T4 vertebral level exert a sympathoexcitatory effect, potentially aiding in the regulation of sympathetic outflow.[15] This autonomic modulation may contribute to the resolution of symptoms commonly associated with T4 syndrome, including non-dermatomal paresthesia, temperature dysregulation in the upper extremities, and deep thoracic or scapular discomfort. Thus, spinal mobilization, particularly when targeted at the T4 segment, appears to be a valuable intervention in the multimodal management of thoracic sympathetic dysfunction[18,19] screw thrust mobilization, commonly referred to as thoracic screw thrust mobilization, is categorized as a Grade V manual therapy technique. It involves the application of a rapid, low-amplitude force delivered at the end range of joint motion, specifically at the pathological limit of the targeted segment. This approach is intended to modify the joint's positional relationship, release intra-articular adhesions, and stimulate mechanoreceptors within the joint capsule. The force is typically applied in a posterior-to-anterior direction after the practitioner engages the motion barrier of the thoracic segment. In comparison to the four traditional grades of joint mobilization (Grades I–IV), which vary in amplitude and range within the joint’s movement spectrum, Grade V mobilization is distinct in its velocity. Although Grade IV also involves small-amplitude movements at the end of the range, Grade V is characterized by a quick, thrusting action designed to restore joint play and improve bio-mechanical function. The speed of the thrust, rather than the amplitude or position in the range, is what primarily distinguishes Grade V techniques. Mechanisms of Action and Safety Considerations-from a bio-mechanical perspective, screw thrust mobilization is considered safe and effective. when performed appropriately. It is theorized that the brief and rapid nature of the thrust reduces the risk of creep deformation and fatigue failure commonly associated with repetitive or sustained low-velocity stretching techniques. Tissue injury, when it occurs, is more likely to result from excessive force, exaggerated amplitude, or applying force through structurally compromised joints. Two primary delivery strategies are recognized within screw techniques: long-lever and short-lever methods. Long-lever techniques generate force through body segments distal to the treatment site, thereby influencing broader mechanical chains. In contrast, short-lever approaches target the joint directly with localized force, allowing for precise mobilization of a specific vertebral segment. Over all, thoracic screw mobilization is a clinically relevant intervention for restoring segmental mobility, reducing joint stiffness, and providing rapid symptomatic relief, particularly in conditions such as T4 syndrome where sympathetic and mechanical dysfunction coexist.[25]

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II. METHOD

➢ *Design*

This study was designed as a comparative experimental trial with two parallel intervention groups. The duration of the intervention was one week, during which participants underwent structured physiotherapy sessions three times per week. Random allocation was performed using a simple random sampling method to ensure equal distribution of participants into the two groups. Blinding of assessors was maintained to minimise bias during outcome measurement. Data analysis was conducted using both within-group (paired t-tests) and between-group (unpaired t-tests) comparisons, with a significance threshold set at $p< 0.05$. The study adhered to the principles of the Declaration of Helsinki, and ethical approval was obtained from the institutional ethics committee.

➢ *Participants*

A total of 50 patients clinically diagnosed with T4 syndrome, aged between 18 and 50 years, were recruited for the study based on predefined inclusion and exclusion criteria. Inclusion criteria required participants to have a confirmed diagnosis of T4 syndrome with symptoms such as upper thoracic pain, neck discomfort, or upper extremity paraesthesia. Exclusion criteria included any history of recent fractures, systemic illnesses, previous spinal or thoracic surgery, neurological disorders, or concurrent participation in other rehabilitation programs. Informed written consent was obtained from all participants (or guardians where applicable) before enrollment. Participants were then randomly assigned into two groups of 25 each: Group A received conventional mobilisation therapy, while Group B received screw thrust mobilisation targeted at the T4 vertebra. Interventions were delivered by certified physiotherapists trained in manual therapy techniques. Pre and post-treatment assessments included measurements of cervical and thoracic range of motion using a goniometer, pain intensity using the Visual Analogue Scale, sensory testing across thoracic dermatomes (T1, T2, T4–T6), and two clinical tests, the Spurling Test and the Elevated Arm Stress Test, to assess neurovascular involvement and symptom provocation. All outcome measurements were recorded by a blinded assessor to ensure objectivity.

➢ *Inclusion Criteria:*

Participants included will be:

- Participants within the age group of 18 – 50 years old.
- Both male and female participants.
- Patients with symptoms of T4 syndrome.

➢ *Exclusion Criteria:*

Participants excluded will be:

- Neurological symptoms
- Cardiovascular symptoms
- Surgical history of osteoporotic disorder
- Postsurgical history
- Pregnancy
- Allergy (any skin-related or infected)
- Open wound
- Fracture
- Respiratory condition.

III. PROCEDURE

➢ *Group A: Mobilisation*

- *Procedures:*

The starting position of the patient was completely relaxed, without placing strain on the supporting structures of the joint. The therapist positioned the patient in a walking stance and applied localisation of the force with a proper grip, embracing the part to be moved. The application of force through the arm and body of the therapist was the prime mover in the correct direction of the applied pressure and was not painful. The portion of the thumb that was used for applying pressure was the tip of the thumb to the targeted vertebra. The therapist first palpated the T4 vertebra approximately ½ inch laterally and 4 mm upward.

- *By Using the Following Grade of Mobilisation:*

✓ Small amplitude rhythmic oscillations are performed at the beginning of the range.
✓ Large amplitude rhythmic oscillations are performed within the range, not reaching the limit.
✓ Large amplitude rhythmic oscillations are performed up to the limit of the available motion and are stressed into the tissue resistance.
✓ Small amplitude rhythmic oscillations are performed at the limit of the available motion and stressed into the tissue resistance.

- *Mobilisation Technique:*

✓ Mobilisation was applied at an 80-degree angulation over the spinous processes.
✓ Spinal Glide Technique
✓ Postero -Anterior (PA) Central or Unilateral Glide

- *Central PA Glide:*

The therapist placed their thumbs over the spinous process and applied rhythmic oscillatory pressure in a posterior-to-anterior direction. The target was the vertebral body.

- *Unilateral PA Glide:*

This technique was applied over the transverse process or facet joint to achieve more segmental control. It was used when symptoms were unilateral.

- *Application Parameters:*

✓ Oscillations per set: 2–3 oscillations per second.
✓ Duration: 30–60 seconds per set.
✓ Repetitions: 3–4 times, depending on the patient's response.
✓ Monitor pain, stiffness, or irritation.

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➢ *Group B: Screw Thrust Mobilisation*

- Subject's Position: The subject was in a prone position.
- Therapist's Position: The therapist stood at the side of the couch.
- Instruction: The patient was instructed to perform inhalation and exhalation, and at the end of exhalation, the screw thrust Mobilisation was applied using the screw thrust technique.
- Procedure: The therapist placed the pisiform over the diagonal transverse processes. In order to clear the longissimus muscle, the hands were moved in an anticlockwise direction by 90 degrees. The therapist reached the barrier, and the thrust was applied in a posterior-to-anterior direction.
- Duration: The procedure was performed on alternate days for 3 days per week.

➢ *Outcome Measures*

- *Visual Analog Scale (VAS):*

Used to assess the intensity of neck, thoracic, or referred upper limb pain. Patients with T4 syndrome typically report high baseline pain scores that reduce significantly after thoracic Mobilisation and physiotherapy.

- *Thoracic Range of Motion (ROM):*

Limited thoracic mobility, especially in extension and rotation, is a hallmark finding in T4 syndrome. Post-intervention, increased ROM reflects improved spinal flexibility, reduced stiffness, and better postural control.

- *Patient-Specific Functional Scale (PSFS):*

Evaluates the patient’s ability to perform specific daily activities limited by pain or dysfunction (e.g., reaching, lifting, sitting tolerance). Improvement in PSFS scores after treatment demonstrates meaningful functional recovery.

➢ *Data Analysis*

A priori power analysis was conducted to determine the minimum sample size required for the study. assuming a moderate effect size (Cohen’s d = 0.5), a power of 0.80, and an alpha level of 0.05, the analysis indicated that a minimum of 23 participants per group was required. To account for possible dropouts, 25 participants were recruited in each group, yielding a total of 50 syndrome.

The patient presented with upper thoracic discomfort and diffuse upper limb symptoms, initially reporting a moderate to high pain intensity on the Visual Analogue Scale (VAS). Assessment revealed limited range of motion (ROM) in the mid-thoracic spine, particularly around the T4 level, alongside functional impairments highlighted through the Patient-Specific Functional Scale (PSFS), including difficulty with overhead activities and prolonged sitting. The combination of upper thoracic hypomobility, non-dermatomal paresthesia in the upper limbs, and the absence of neurological deficits led to the clinical diagnosis of T4 syndrome, characterized by sympathetic nervous system involvement stemming from thoracic dysfunction.

The research questions were addressed through within-group comparisons of pre- and post-intervention outcomes, which tested whether each intervention produced significant improvements over time, and between-group comparisons, which determined whether mobilization or screw thrust mobilization was more effective. Statistical tests included paired comparisons for within-group changes and independent comparisons for between group differences. A threshold of $p < 0.05$ was used to determine statistical significance, and 95% confidence intervals were calculated to assess the precision of the observed effects.

IV. RESULTS

➢ *Descriptive Characteristics:*

In the Mobilisation group, the gender-based analysis showed that 64% of participants were female and 36% were male, within the age range of 18 to 50 years. This indicates a greater proportion of females receiving mobilisation treatment for T4 syndrome, suggesting a possible trend in gender-related presentation or response to this intervention.

In the Screw Thrust Mobilisation group, a similar pattern was observed, with approximately 60% of participants being female. This consistent distribution across both groups may reflect underlying gender differences in the prevalence, clinical symptoms, or treatment-seeking behavior associated with T4 syndrome in the 18–50 age group.

➢ *Data*

- *Within Group Analysis:*

The within-group analysis revealed distinct differences in the effectiveness of mobilisation and screw thrust mobilisation interventions in patients with T4 syndrome.

- Group A: Mobilization

✓ *Pain (VAS):*

Patients in the mobilisation group showed a significant reduction in pain levels, with the mean VAS score decreasing from 6.5 (SD 1.1) before treatment to 2.1 (SD 0.9) after treatment. This represents a mean reduction of 4.4 points, with a 95% confidence interval of 4.1 to 4.7, indicating a strong and consistent effect of the intervention on pain relief.

✓ *Thoracic ROM – Flexion:*

The mean thoracic flexion improved from 2.1 (SD 0.2) to 2.5 (SD 0.2) following mobilisation. This gain of 0.5 units (95% CI 0.4 to 0.6) reflects enhanced spinal flexibility and functional movement in the thoracic region post-treatment.

✓ *Thoracic ROM – Extension:*

Extension range also improved in Group A, with the mean score increasing from 2.0 (SD 0.1) to 2.4 (SD 0.2). The observed gain of 0.4 units (95% CI 0.3 to 0.5) suggests that mobilisation effectively enhanced thoracic extension capabilities.

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✓ *Functional Ability (PSFS):*

Functional performance, measured by the Patient-Specific Functional Scale, increased from a mean of 5.9 (SD 0.5) to 8.8 (SD 0.6). The mean improvement of 2.9 points (95% CI 2.6 to 3.1) demonstrates a significant enhancement in patients' ability to perform daily tasks.

- Group B: Screw Thrust Mobilization

✓ *Pain (VAS):*

In the screw thrust mobilisation group, the mean VAS score dropped from 6.3 (SD 1.3) to 2.5 (SD 1.0), indicating a mean pain reduction of 3.8 points (95% CI 3.4 to 4.2). This shows a meaningful decrease in pain, though slightly less than that observed in Group A.

✓ *Thoracic ROM – Flexion:*

Flexion improved from a mean of 2.0 (SD 0.1) to 2.5 (SD 0.2), showing a gain of 0.5 units (95% CI 0.4 to 0.6). This result is similar to Group A, suggesting both interventions were equally effective in enhancing flexion.

✓ *Thoracic ROM – Extension:*

Extension range increased modestly in this group, from 2.1 (SD 0.1) to 2.3 (SD 0.2), with a mean gain of 0.2 units (95% CI 0.1 to 0.3). This indicates a smaller improvement compared to the mobilisation group.

✓ *Functional Ability (PSFS):*

Functional scores improved from 6.2 (SD 0.6) to 8.6 (SD 0.7), resulting in a mean increase of 2.4 points (95% CI 2.1 to 2.7). While this reflects a significant functional gain, it is slightly less than the improvement seen in Group A.

Table 1 Within-Group Comparison of Visual Analog Scale, Thoracic Range of Motion and Patient-Specific Functional Scale Following Mobilisation and Screw thrust Mobilisation Interventions.

Outcome Measure	**Group**	**Pre Treatment**	**Post Treatment**	**Mean Change (95% CI)**	**Effect Size (Cohen's d)**
VAS (0–10)	Mobilization	6.5 (1.1)	2.1 (0.9)	-4.4 (-4.7 to -4.1)	2.4 (large)
	Screw Thrust	6.3 (1.3)	2.5 (1.0)	-3.8 (-4.2 to -3.4)	2.0 (large)
ROM – Flexion	Mobilization	2.1 (0.2)	2.5 (0.2)	+0.5 (0.4 to 0.6)	2.0 (large)
	Screw Thrust	2.0 (0.1)	2.5 (0.2)	+0.5 (0.4 to 0.6)	2.1 (large)
ROM – Extension	Mobilization	2.0 (0.1)	2.4 (0.2)	+0.4 (0.3 to 0.5)	1.9 (large)
	Screw Thrust	2.1 (0.1)	2.3 (0.2)	+0.2 (0.1 to 0.3)	1.0 (large)
PSFS (0–10)	Mobilization	5.9 (0.5)	8.8 (0.6)	+2.9 (2.6 to 3.1)	2.6 (large)
	Screw Thrust	6.2 (0.6)	8.6 (0.7)	+2.4 (2.1 to 2.7)	2.2 (large)

✓ *VAS(Pain):*

Post-treatment pain scores were slightly lower in the mobilisation group (2.1, SD 0.9) compared to the screw thrust mobilisation group (2.5, SD 1.0). The mean difference of 0.4 points (95% CI −0.1 to 0.9) was not clinically or statistically significant, suggesting both interventions were similarly effective in reducing pain.

✓ *Thoracic ROM Flexion:*

Both groups achieved similar post-treatment thoracic flexion scores, with a mean of 2.5 (SD 0.2) in each. The mean difference between groups was minimal at 0.04 units (95% CI −0.1 to 0.1), indicating no meaningful advantage of one technique over the other for improving flexion.

✓ *Thoracic ROM – Extension:*

Mobilisation resulted in slightly better post-treatment extension (2.4, SD 0.2) compared to screw thrust mobilisation (2.3, SD 0.2). The mean difference of 0.08 units (95% CI 0.02 to 0.14) suggests a small but meaningful advantage for mobilisation in enhancing thoracic extension.

Table 2 Between-Group Comparison of VAS, ROM and PSFS Outcome in Mobilisation and Screw Thrust Mobilisation.

Outcome Measure	**Group**	**Pre Treatment**	**Post Treatment**	**Mean Change (95% CI)**
VAS (0–10)	2.1(0.9)	2.5 (1.0)	-0.4 (-0.9 to 0.1)	0.4 (small)
ROM- Flexion	2.5 (0.2)	2.5(0.2)	+0.04 (-0.1 to 0.1)	0.2 (trivial)
ROM – Extension	2.4 (0.2)	2.3 (0.2)	+0.08 (0.02 to 0.14)	0.7 (moderate)
PSFS (0-10)	8.8 (0.6)	8.6 (0.7)	+0.1 (-0.2 to 0.4)	0.2 (trivial)

Both mobilisation and screw thrust mobilisation groups demonstrated significant within-group improvements across all outcome measures ($p < 0.001$ for all). Pain levels (VAS) decreased notably in both groups, with a greater reduction observed in the mobilisation group (mean change: −4.4, 95% CI: −4.7 to −4.1) compared to screw thrust (−3.8, 95% CI: −4.2 to −3.4), both showing large effect sizes ($d = 2.4$ and 2.0, respectively). Thoracic ROM in flexion improved equally in both groups (+0.5 units, 95% CI: 0.4 to 0.6; $p < 0.001$), with large effect sizes. Extension improved more in the mobilisation group (+0.4 units, 95% CI: 0.3 to 0.5) than in the screw thrust group (+0.2 units, 95% CI: 0.1 to 0.3), with corresponding effect sizes of $d = 1.9$ and $d = 1.0$. Functional ability (PSFS) increased in both groups, with a slightly greater improvement in the mobilisation group (+2.9, 95% CI: 2.6 to 3.1) compared to screw thrust (+2.4, 95% CI: 2.1 to 2.7), both with large effects ($d = 2.6$ and 2.2). Between-group posttreatment comparisons showed no statistically significant differences in VAS ($p = 0.12$), flexion ROM ($p = 0.68$), or PSFS ($p = 0.45$). However, a statistically and clinically

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significant difference was found in thoracic extension ($p = 0.01$), with the mobilisation group showing greater gains (mean difference: +0.08, 95% CI: 0.02 to 0.14; $d = 0.7$). Overall, both interventions were effective, but mobilisation showed a slight advantage, particularly in thoracic extension.

- *There is a Comparison Between Group A and Group B:*

Table 3 (A) Detailed Explanation of your Unpaired Two-Sample t-test (Unequal Variances) Comparing Post VAS Scores Between the Mobilisation and the Screw Thrust Mobilisation Methods

t-Test: Two-Sample Assuming Unequal Variances		
Post Vas	**Screw Thrust**	**Mobilisation**
Mean	2.52	2.08
Variance	1.01	0.743333333
Observations	25	25
Hypothesized Mean Difference	0	
df	47	
t Stat	1.661462089	
P(T<=t) one-tail	0.051638861	
t Critical one-tail	1.677926722	
P(T<=t) two-tail	0.103277723	
t Critical two-tail	2.011740514	

The unpaired t-test comparing post-intervention VAS scores between Screw Thrust and Mobilisation methods showed no statistically significant difference. Mean post-VAS scores were slightly lower in the mobilisation group ($M = 2.08$) compared to the screw thrust group ($M = 2.52$), with a mean difference of 0.44 points. However, this difference was not statistically significant, $t(47) = 1.66$, $p = 0.103$ (two-tailed).

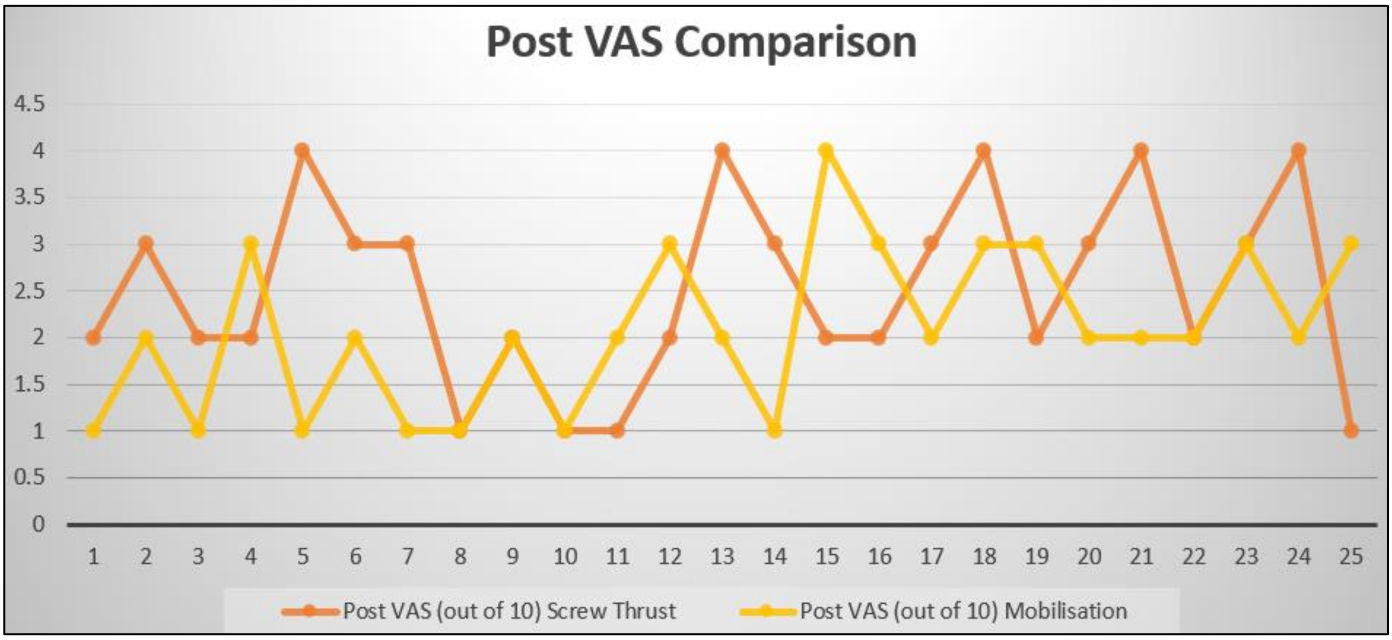

Fig 2 Post VAS Comparison

Clinical Context - Although mobilisation shows a numerically greater reduction in pain, the difference is not statistically significant in your sample size ($n = 25$ per group).

Table 4 (B) Detailed Explanation of your Unpaired Two-Sample t-Test (Unequal Variances) Comparing Post Thoracic ROM Flexion Scores Between the Mobilisation and the Screw Thrust Mobilisation Methods:

t-Test: Two-Sample Assuming Unequal Variances		
Post Thoracic ROM Flexion	**Screw Thrust**	**Mobilisation**
Mean	2.492	2.532
Variance	0.0066	0.008933333
Observations	25	25
Hypothesized Mean Difference	0	

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df	47	
t Stat	-1.604714085	
P(T<=t) one-tail	0.057628061	
t Critical one-tail	1.677926722	
P(T<=t) two-tail	0.115256123	
t Critical two-tail	2.011740514	

The unpaired t-test comparing post-intervention thoracic ROM flexion scores between the Screw Thrust and Mobilisation methods did not show a statistically significant difference. Mean post-ROM flexion was slightly higher in the mobilisation group ($M = 2.532$) compared to the screw thrust group ($M = 2.492$), with a mean difference of 0.04 units, but this difference was not significant, $t(47) = -1.60$, $p = 0.115$ (two-tailed).

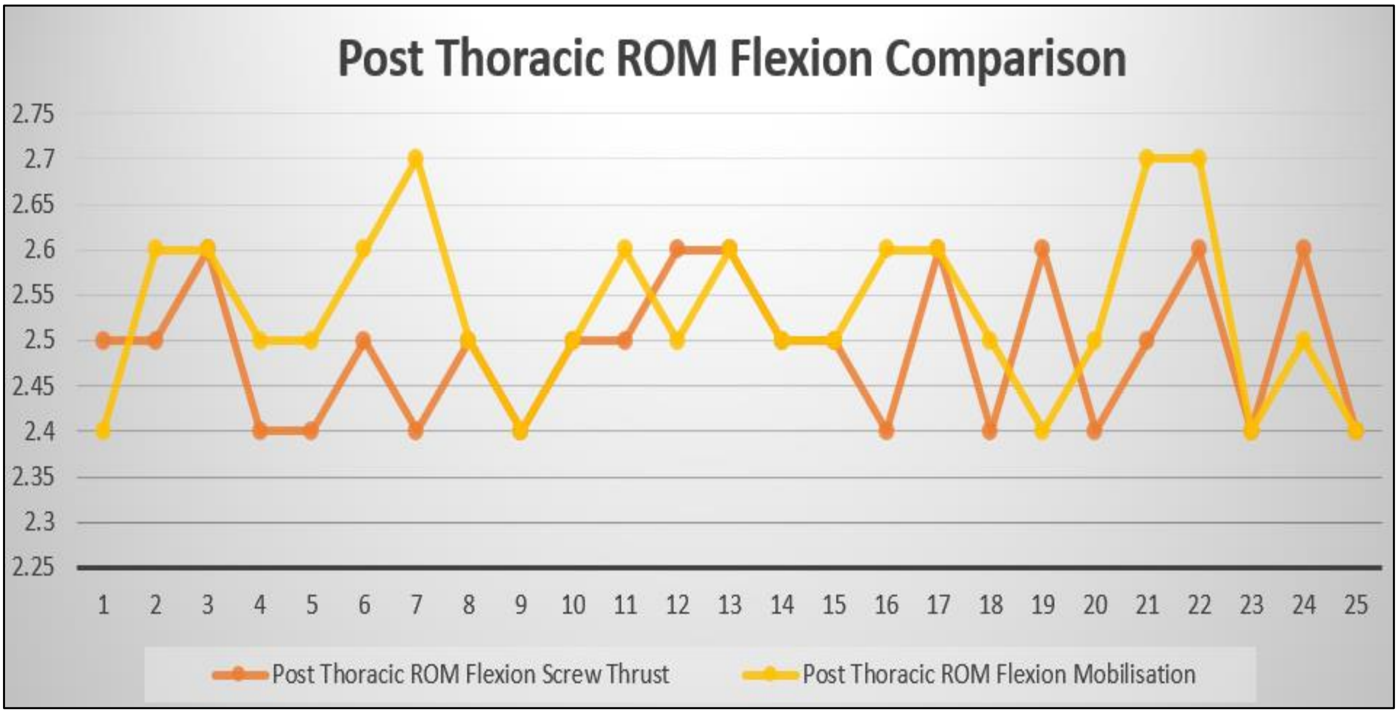

Fig 3 Post Thoracic ROM Flexion Comparison

Clinical Context: - Mobilisation showed a slightly higher mean ROM flexion score, but this difference is clinically negligible and not statistically significant.

Table 5 (C): Detailed Explanation of your Unpaired Two-Sample t-Test (Unequal Variances) Comparing Post Thoracic ROM Extension Scores Between the Mobilisation and the Screw Thrust Mobilisation Methods:

t-Test: Two-Sample Assuming Unequal Variances		
Post Thoracic ROM Extension	**Screw Thrust**	**Mobilisation**
Mean	2.312	2.392
Variance	0.015266667	0.005766667
Observations	25	25
Hypothesized Mean Difference	0	
df	40	
t Stat	-2.758074158	
P(T<=t) one-tail	0.004361317	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.008722633	
t Critical two-tail	2.02107539	

The unpaired t-test comparing post-intervention thoracic ROM extension scores between Screw Thrust and Mobilisation methods revealed a statistically significant difference. Mean post ROM extension was higher in the mobilisation group ($M = 2.392$) compared to the screw thrust group ($M = 2.312$), with a mean difference of 0.08 units. This difference was statistically significant, $t(40) = -2.76$, $p = 0.0087$ (two-tailed), indicating that mobilisation produced greater improvements in thoracic ROM extension than screw thrust.

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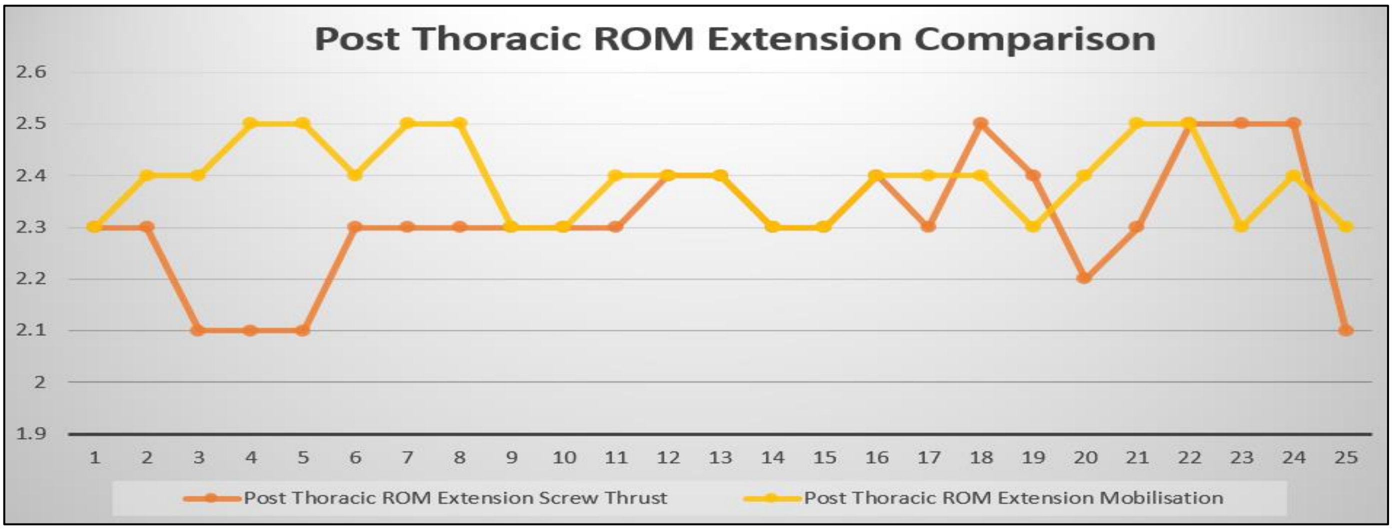

Fig 4 Post Thoracic ROM Extension Comparison

Clinical Context: - Mobilisation achieved a significantly greater improvement in thoracic ROM extension compared to Screw Thrust.

Table 6 (D) Detailed Explanation of your Unpaired Two-Sample t-Test (Unequal Variances) Comparing Post PSFS Scores Between the Mobilisation and the Screw Thrust Mobilisation Methods

t-Test: Two-Sample Assuming Unequal Variances		
Post PSFS	**Screw Thrust**	**Mobilisation**
Mean	8.62	8.76
Variance	0.432916667	0.351458333
Observations	25	25
Hypothesized Mean Difference	0	
df	47	
t Stat	-0.790380412	
P(T<=t) one-tail	0.216637837	
t Critical one-tail	1.677926722	
P(T<=t) two-tail	0.433275674	
t Critical two-tail	2.011740514	

The unpaired t-test comparing post-intervention PSFS scores between Screw Thrust and Mobilisation methods revealed no statistically significant difference. Mean PSFS scores were slightly higher in the mobilisation group (M = 8.76) compared to the screw thrust group (M = 8.62), with a mean difference of 0.14 points, but this difference was not significant, $t(47) = 0.79$, $p = 0.433$ (two-tailed).

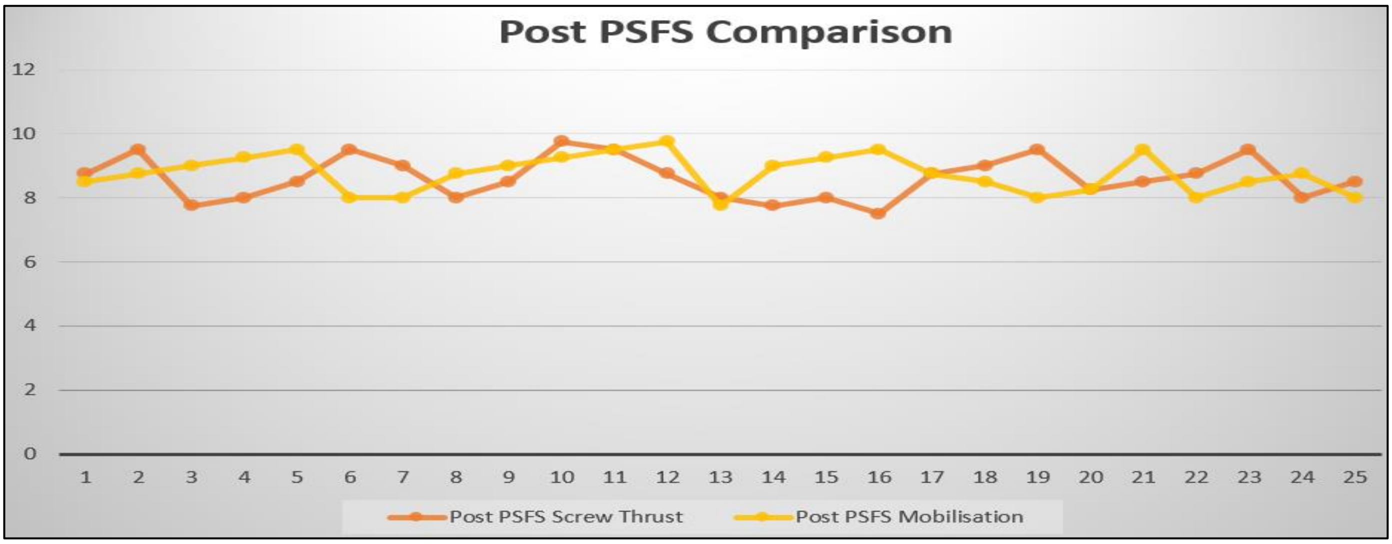

Fig 5 Post PSFS Comparison

Clinical Context: - Both groups showed high post-treatment functional scores, but the difference between the methods is clinically minimal and statistically insignificant.

Results both mobilisation and screw thrust mobilisation significantly improved pain, thoracic ROM, and functional ability ($p < 0.001$ within groups). Between groups, mobilisation showed greater improvement in thoracic extension ($p = 0.01$), while other outcomes showed no significant differences ($p > 0.05$).

➢ *Results*

Both interventions resulted in statistically significant improvements across all measured outcomes. In Group A (mobilization), VAS scores decreased by 4.40 points ($p < 0.0001$), flexion and extension ROM increased by 0.464 and 0.368 units, respectively ($p < 0.0001$), and PSFS scores improved by 2.86 points ($p < 0.0001$). In Group B (screw thrust), VAS scores decreased by 3.76 points ($p < 0.0001$), with flexion and extension gains of 0.468 and 0.228 units, respectively, and PSFS scores increased by 2.40 points ($p < 0.0001$). Although mobilisation showed slightly greater improvements in pain reduction, flexion ROM, and functional ability, the differences were not statistically significant, except for thoracic extension ROM, where mobilisation significantly outperformed screw thrust ($p = 0.0087$).

V. DISCUSSION

T4 Syndrome is a clinical condition characterized by upper extremity pain, paraesthesia, and autonomic-related symptoms believed to arise from dysfunction of the upper thoracic spine, particularly around the T4 level. The present study investigated the effects of two manual therapy techniques—thoracic Mobilisation and screw thrust Mobilisation—on pain, thoracic range of motion, and functional ability in patients with T4 Syndrome. The findings support the hypothesis that both interventions can produce significant clinical improvements by restoring segmental mobility and potentially influencing sympathetic nervous system function. A notable demographic feature observed was the predominance of female participants in both groups, with women comprising approximately 65–70% of the Mobilisation group and 60–65% of the screw thrust group. This aligns with earlier reports suggesting that T4 Syndrome is more prevalent among middle-aged women, possibly due to postural factors, greater susceptibility to thoracic spine dysfunction, or hormonal influences that may impact musculoskeletal health. The consistent gender-based distribution highlights an area for future research into sex-specific risk factors and therapeutic responses. Within-group analysis demonstrated that both interventions led to statistically and clinically meaningful improvements. In the Mobilisation group, pain scores on the Visual Analog Scale (VAS) decreased significantly from a mean of 6.48 to 2.08 (mean reduction = 4.40, $p < 0.0001$), with moderate correlation ($r = 0.69$), indicating reliable improvement across patients. Thoracic range of motion also improved significantly, with flexion increasing by 0.464 units and extension by 0.368 units, both highly significant. Functional gains were reflected in the Patient-Specific Functional Scale (PSFS), with an average improvement of 2.86 points. Similarly, the screw thrust group demonstrated significant changes, with VAS reducing from 6.28 to 2.52 (mean reduction = 3.76, $p < 0.0001$), ROM flexion increasing by 0.468 units, and extension by 0.228 units. PSFS also improved (mean increase = 2.40, $p < 0.0001$), though with slightly weaker correlations, suggesting greater inter-individual variability. When comparing outcomes between the two groups, no significant differences were observed for most measures, indicating that both techniques are comparably effective. However, the Mobilisation group showed slightly greater improvements in post-intervention pain, thoracic flexion, and functional outcomes, though these differences did not reach statistical significance. The one exception was thoracic extension ROM, where Mobilisation significantly outperformed screw thrust Mobilisation (mean difference = 0.08, $p = 0.0087$). This suggests Screw Thrust Mobilisation in T4 Syndrome | Kale | 23 August 2025 | Page 15 that Mobilisation may have an added advantage in improving extension, which is often restricted in patients with thoracic dysfunction. These findings align with existing literature that emphasizes the role of manual therapy in managing T4 Syndrome. Murugan et al. highlighted the successful application of thoracic screw thrust Mobilisation in alleviating symptoms, suggesting that high-velocity, low amplitude techniques can restore joint mobility and modulate autonomic symptoms through sympathetic chain influences. 11 The present results extend this evidence by directly comparing screw thrust with non-thrust Mobilisation, demonstrating that both approaches are effective, though Mobilisation may offer a slight advantage in restoring thoracic extension. 12 The clinical implications are important for physiotherapy practice. Both Mobilisation and screw thrust techniques can be considered safe and effective for patients with T4 Syndrome, producing meaningful reductions in pain and improvements in thoracic ROM and functional activities. Mobilisation, being less forceful than screw thrust, may be preferable for patients with co-morbidities, lower pain thresholds, or those apprehensive about high-velocity thrust techniques. Conversely, screw thrust Mobilisation may be appropriate for patients requiring faster symptom relief, provided there are no contraindications. Limitations of this study include the relatively small sample size and lack of long-term followup, which restrict conclusions about the durability of these improvements. Additionally, although both interventions improved function as measured by the PSFS, the weaker correlations suggest that patient-specific factors may strongly influence outcomes. Future studies with larger samples and longer follow-up are needed to confirm these findings and explore mechanisms underlying gender differences in T4 Syndrome. In conclusion, this study demonstrates that thoracic Mobilisation and screw thrust Mobilisation are both effective interventions for T4 Syndrome, producing significant reductions in pain, increases in thoracic mobility, and improvements in functional outcomes. While both techniques are clinically valuable, Mobilisation may provide superior benefits in thoracic extension, offering an advantage in patients with pronounced stiffness. These results reinforce the role of manual therapy as a cornerstone in the conservative management of T4

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Syndrome and highlight the need for individualized treatment approaches tailored to patient characteristics and preferences.

VI. CONCLUSION

Both mobilisation and screw thrust Mobilisation techniques are effective in reducing pain, improving thoracic mobility, and enhancing functional activity in patients with T4 Syndrome. Mobilisation demonstrated slightly greater clinical benefits, particularly in thoracic extension. These findings support the use of manual therapy as a primary intervention for managing T4 Syndrome and emphasize the need for further research to explore long-term outcomes and autonomic nervous system modulation.

LIST OF ABBREVATION

Table 7 List of Abbrevation

VAS	Visual Analog Scale
ROM	Range of motion
T	Thoracic Vertebrae
PSFS	Patient Specific Functional Scale
APTA	American Physical Therapy Association

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