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Kinesiological interventions in patients with musculoskeletal injuries following traffic accidents.

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Raquel Noemi Argüello de Barrios Title/
Training: Magíster en Administración Hospitalaria Institution: Instituto Superior
en Ciencias de la Salud Santa Rosa Mística ORCID: https://orcid.org/0009-0006-4235-0828
City/Country: Capiatá, Paraguay E-mail:
Key652009@hotmail.com

Rossana Elizabeth Barría Domínguez
Title/Training: Magister in Communication and Scientific Periodism Institution:
Instituto Superior en Ciencias de la Salud Santa Rosa Mística ORCID: https://
orcid.org/0000-0002-1348-2921 City/Country:
Capiatá, Paraguay E-mail:
rossy.barria@gmail.com

Cristhian De Jesús Alvarez Olmedo Title/
Training: Student of Degree in Fisioterapia and Kinesiología Institution: Instituto Superior en Ciencias
de la Salud Santa Rosa Mística ORCID: https://orcid.org/0009-0003-7247-4088 City/Country:
Capiatá, Paraguay E-mail: cristhkiki2022@gmail.com

Carolina Concepción Agüero Britos Degree/
Education: Bachelor's degree. in kinesiology and physiotherapy
Institution: Instituto Superior en Ciencias de la Salud Santa Rosa Mística ORCID: https://
orcid.org/0009-0005-0738-9762 City/Country: Capiatá,
Paraguay E-mail: karol_ag@hotmail.com

Joaquin Miguel Canesio
Title/Training: Degree Student in Physiotherapy and Kinesiology Institution: Instituto
Superior en Ciencias de la Salud Santa Rosa Mística ORCID: https://orcid.org/
0009-0005-8106-7454 City/Country: Piribebuy,
Paraguay E-mail:
Joaquinmcanesio@gmail.com

Elena Belén Lovera López
Degree/Education: Bachelor's degree. in physiotherapy and
kinesiology Institution: Instituto Superior en Ciencias de la Salud Santa Rosa
Mística ORCID: https://orcid.org/0009-0005-3800-9232
City/Country: Piribebuy, Paraguay E-
mail: eleni22lovera@gmail.com

María Isabel Abente Sanabria Title/
Training: Degree Student in Physiotherapy and Kinesiology Institution: Instituto Superior en Ciencias
de la Salud Santa Rosa Mística ORCID: https://orcid.org/0009-0005-0960-5983 City/Country:
Concepción, Paraguay E-mail: abenteisabel@gmail.com

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Rosa Marina Delgadillo Riveros
Degree/Education: Bachelor's degree in physiotherapy and kinesiology
Institution: Instituto Superior en Ciencias de la Salud Santa Rosa Mística
ORCID: https://orcid.org/0009-0008-7881-5943
City/Country: Concepción, Paraguay
Email: rosamarina16@hotmail.com

Summary

The objective of this study was to compare the effectiveness of different kinesiological interventions in the functional recovery of patients with musculoskeletal injuries following a traffic accident. A quantitative, comparative, cuasiperimental and longitudinal study was carried out at the Instituto de Ciencias de la Salud Santa Rosa Mística, Paraguay, during the period July–December 2025. The sample was comprised of 60 patients, distributed among three groups according to the intervention received: therapeutic exercise, manual therapy and electrotherapy combined with therapeutic exercise. The intensity of pain was evaluated using the Visual Analogue Scale, the range of movement using goniometry and the level of functionality using the Functional Scale. The Student's t test was applied to related and independent samples, considering $p < 0.05$ to be significant. The results showed improvements in all groups. The group treated with combined electrotherapy showed a greater reduction in pain (ÿ 4.8), greater gain in range of movement (+51°) and greater functional improvement (+41%). It is concluded that combined interventions are more effective than isolated therapies, which constitutes an optimal strategy for the rehabilitation of patients with musculoskeletal injuries following a traffic accident.

Keywords: Rehabilitation; Kinesiology; Musculoskeletal injuries; Pain; Physical therapy

Abstract

This study aimed to compare the effectiveness of various kinesiological interventions for the functional recovery of patients with musculoskeletal injuries sustained in traffic accidents. A quantitative, comparative, quasi-experimental, and longitudinal study was conducted at the Santa Rosa Mística Institute of Health Sciences in Paraguay, from July to December 2025. The sample consisted of 60 patients distributed into three groups according to the intervention received: therapeutic exercise, manual therapy, and electrotherapy combined with therapeutic exercise. Pain intensity was assessed using the Visual Analog Scale, range of motion through goniometric measurements, and functional level using a general functional scale. Statistical analysis included descriptive statistics and Student's t-test for both paired and independent samples, considering a significance level of $p < 0.05$. The results showed improvements in all groups. The group treated with combined electrotherapy and therapeutic exercise demonstrated the greatest reduction in pain (ÿ 4.8), the highest increase in range of motion (+51°), and the greatest functional improvement (+41%). It is concluded that combined interventions are more effective than isolated therapies, representing an optimal strategy for the rehabilitation of patients with musculoskeletal injuries following traffic accidents.

Keywords. Rehabilitation; Kinesiology; Musculoskeletal injuries; Pain; physical therapy

Introduction

Musculoskeletal injuries represent one of the main causes of disability and functional limitation at a global level, significantly affecting the quality of life of individuals[1]. These injuries are especially frequent in the context of car accidents.

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traffic, which constitutes an important public health problem due to its high incidence, morbidity and associated costs[2]. Among the most common injuries are injuries, fractures, bruises and soft tissue injuries, which require intervention therapy to recover functionality[3].

Kinesiology, as a discipline oriented towards movement rehabilitation, performs a fundamental role in the recovery of these patients. Kinesiological interventions It includes several techniques, such as therapeutic exercise, manual therapy, electrotherapy and functional reeducation, which seeks to reduce pain, improve mobility and restore functional capacityÿ. However, the effectiveness of these interventions varies depending on the type of injury, severity and individual characteristics of the patientÿ.

Despite the widespread use of these therapeutic strategies, a gap in knowledge regarding the comparison of the effectiveness of different interventions kinesiological techniques applied in academic contexts, particularly when carried out by students in training under professional supervision. This situation highlights the need to generate evidence that allows you to optimize rehabilitation processes and improve results clinical.

Therefore, the objective of this study is to compare the effectiveness of different interventions kinesiology in the functional recovery of patients with musculoskeletal injuries traffic accidents, treated by students in the Physiotherapy and Kinesiology career.

Theoretical Framework

Musculoskeletal injuries secondary to traffic accidents represent a challenge clinical significance due to its multifactorial impact on the patient's functionality. These Ground injuries imply direct tissue damage, but also changes in coordination neuromuscular and movement patrons, which could compromise recovery itself do not intervene appropriatelyÿ. In Latin American contexts, this problem is aggravated due to the high incidence of road injuries and due to inequalities in access to services specialized rehabilitation servicesÿ.

From a physiological point of view, trauma triggers inflammatory responses and protective mechanisms such as muscle inhibition reflect, which limits movement and favors the establishment of dysfunctional movement patronsÿ. Furthermore, if there is evidenced that persistent pain may be associated with central sensitization processes, in which the nervous system amplifies the perception of pain to more structural damage

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initialÿ. This phenomenon explains why some patients develop chronic limitations even after the apparent resolution of the injury.

In this context, modern rehabilitation is oriented towards an active and focused approach. patient. Progressive therapeutic exercise is positioned as a key intervention for restore function, which allows you to improve strength, mobility and motor control, in addition to positively influence the perception of painÿ. The evidence suggests that programs individualized, adjusted to the patient's evolution, generates better functional results in comparison with standard interventionsÿ.

For its part, manual therapy continues to be a relevant tool within the approach kinesiological, especially in the initial stages, which contributes to the reduction of pain and to the improvement of joint mobilityÿ. However, its greatest effectiveness is observed when integrated into programs that include active exercise, rather than being used as a treatment isolatedÿ.

In relation to electrophysical modalities, such as transcutaneous electrical stimulation and therapeutic ultrasound, current literature shows heterogeneous results, which is led to replant its role in rehabilitation programs, prioritizing interventions active against passive ones[1]ÿ. At the same time, strategies such as education in pain charged with relevance, which allows them to modify erroneous beliefs and improve adherence to treatment, which favors a more complete recovery[11].

A particularly relevant element in the region is the development of clinical practice in academic environments. University clinics constitute spaces in which they are integrated professional training and health care, which allows the application of interventions kinesiology under teaching supervision[12]. However, the variability in their experience students and in the application of therapeutic protocols plant the need to evaluate it real effectiveness of these interventions in training contexts.

In this sense, the generation of local evidence is fundamental to strengthen the practice based on evidence, optimize rehabilitation processes and contribute to continued improvement both patient care and academic training in physiotherapy and kinesiology.

Materials and Methods

This study corresponds to a quantitative, comparative, experimental and experimental design longitudinal, carried out at the Instituto de Ciencias de la Salud Santa Rosa Mística,

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including the central headquarters of Capiatá and branches of Piribebuy and Concepción, Paraguay, during the period between July and December 2025.

The data processing and analysis will be carried out using computer tools (Microsoft Excel), which allows you to organize, tabulate and statistically analyze information collected again.

For the statistical analysis of data, descriptive statistics were used, including the average and the standard deviation for the quantitative variables. Asimismo, if you apply the test of Student for related (paired) samples with the aim of comparing pre-measurements post-treatment in each studio group, evaluating changes in the intensity of pain and en el rango de movimiento.

Additionally, Student's test was used for independent samples to compare differences between intervention groups and determine the relative effectiveness of each kinesiological treatment.

A statistical significance level of $p < 0.05$ was considered, which indicates that values Below this level there are statistically significant differences.

Table 1. Distribution of population and study museum according to headquarters

Thirst	Población (N)	Museum (n)	Type of museum
Headquarters (Capiatá)	80	20	Not probabilistic for convenience
Piribebuy Branch	80	20	Not probabilistic for convenience
Branch Concepción	80	20	Not probabilistic for convenience
Total	**80**	**60**	—

Source. Own elaboration

Inclusion criteria

Patients of both sexes, aged between 20 and 35 years, diagnosed post-traffic musculoskeletal injury doctor, who initiates treatment kinesiology at the institution and agreed to participate voluntarily through the firm's signature informed consent.

Exclusion criteria

Patients with associated neurological pathologies, uncontrolled chronic illnesses, history of recent surgeries unrelated to the accident or those not completed the established treatment protocol.

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The variables studied were

Intensity of pain, range of movement and level of functionality. The intensity of the pain was evaluated using the Visual Analogue Scale (EVA), the range of movement using goniometric measurement and functionality using the General Functionality Scale.

Table 2. Distribution of kinesiological interventions according to thirst and treatment characteristics

Group	Thirst	Type of intervention	Treatment applied	Duration	Frequency	Responsible
Group 1	Headquarters (Capiatá)	Therapeutic exercise	Active and progressive exercises: muscle strengthening, joint movement, stretching and functional re-education	4–6 weeks	2–3 sessions per week	Students of Physiotherapy and Kinesiology under professional supervision
Group 2	Branch Piribebuy	Manual therapy	Manual techniques: joint movements, myofascial release, therapeutic masotherapy and assisted stretching	4–6 weeks	2–3 sessions per week	Students of Physiotherapy and Kinesiology under professional supervision
Group 3	Branch Concepción	Electrotherapy + therapeutic exercise	Application of TENS and therapeutic ultrasound combined with exercises for strengthening, mobility and functionality	4–6 weeks	2–3 sessions per week	Students of Physiotherapy and Kinesiology under professional supervision

Source. Own elaboration

For data analysis, descriptive statistics (average, standard deviation) were used.
y percentages) and comparative analysis between groups to determine the effectiveness of applied interventions.

Regarding ethical aspects, the study developed according to the principles of Declaration of Helsinki. Data confidentiality and participation are guaranteed voluntary participation of subjects through the signature of informed consent.

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Results

The hallmarks obtained after the application of different kinesiological interventions in patients with musculoskeletal injuries following traffic accidents. The results if present in a comparative manner between study groups, considering the variables analyzed before and after treatment, including the intensity of pain, the range of movement and level of functionality.

Table 3. Distribution of results from the evaluation of the intensity of pain before and after treatment rehabilitation.

Group	Thirst	Initial EVA (Media ± DE)	EVA Final (Media ± DE)	Decrease of pain
Group 1	Headquarters (Capiatá)	7.5 ± 1.0	3.2 ± 0.8	ÿ 4.3
Group 2	Piribebuy Branch	7.3 ± 1.1	4.0 ± 0.9	ÿ 3.3
Group 3	Concepción Branch	7.6 ± 0.9	2.8 ± 0.7	ÿ 4.8

Source. Own elaboration

Description. In relation to the intensity of pain, evaluated using the Visual Scale Analogical (EVA), improvements were observed in all groups following kinesiological intervention (Table 3).

Group 1, corresponding to the central headquarters of Capiatá and treated through exercise therapy, there was a significant reduction in pain, going from an initial average of 7.5 ± 1.0 to 3.2 ± 0.8, which represents a reduction of 4.3 points on the EVA scale.

For its part, Group 2, belonging to the Piribebuy branch and which received manual therapy, evidenced a decrease in pain from 7.3 ± 1.1 to 4.0 ± 0.9, with a total reduction of 3.3 points, this being the group with the smallest relative decrease between the three.

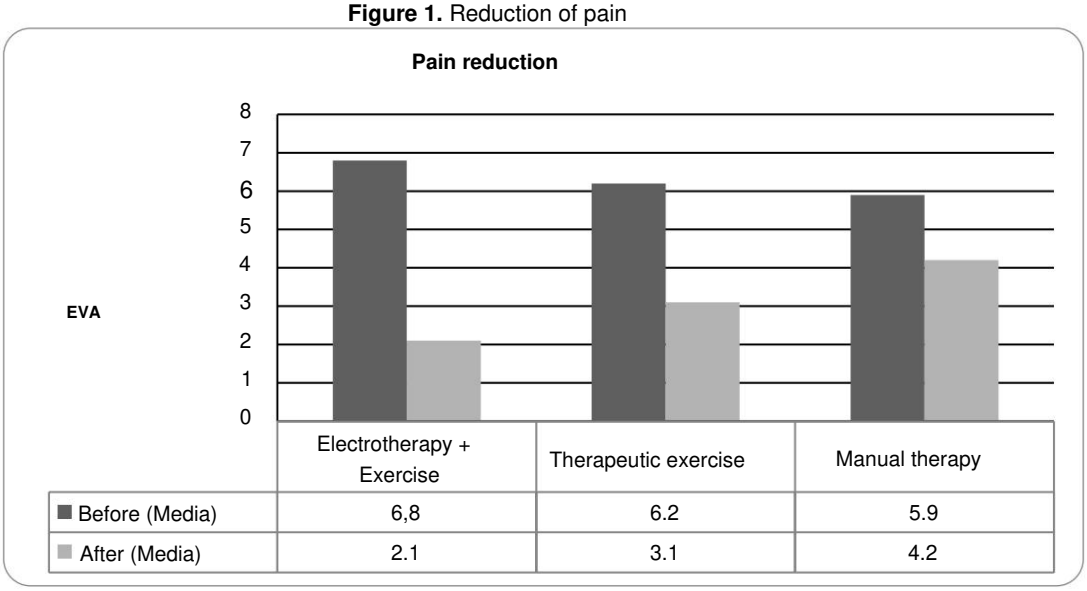
While in Group 3, corresponding to the Concepción branch, undergoing electrotherapy combined with therapeutic exercise, greater improvement is recorded, with a reduction in pain from 7.6 ± 0.9 to 2.8 ± 0.7, equivalent to a decrease of 4.8 points on the EVA scale.

These results suggest that, if all interventions were effective in reduction of pain, the combination of electrotherapy with therapeutic exercise showed a greater effectiveness in comparison with interventions applied in isolation, as if muestra en la tabla 4.

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Figure 1. Reduction of pain



Source. Own elaboration

The statistical analysis using Student's test for related samples evidenced a significant decrease in pain in the three study groups. The group that received electrotherapy combined with therapeutic exercise presents the greatest difference statistically significant ($p < 0.001$), followed by the therapeutic exercise group ($p < 0.001$) and manual therapy group ($p < 0.01$).

Thus, when comparing groups, statistically significant differences were observed in favor of the combined electrotherapy group, which suggests greater effectiveness of this intervention.

Table 4. Comparison of the effectiveness of kinesiological interventions according to pain reduction (EVA)

Group	Type of treatment	Thirst	Initial EVA	EVE End	Disminución (ÿ)	Effectiveness
Group 1	Therapeutic exercise	Capiatá	7.5	3.2	4.3	High
Group 2	Manual therapy	Piribebuy	7.3	4.0	3.3	Moderate
Group 3	Electrotherapy + exercise	Concepción	7.6	2.8	4.8	Very high

Source. Own elaboration

Description. When comparing the interventions, it was observed that the group treated with electrotherapy combined with therapeutic exercise presents the greatest effectiveness in

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reduction of pain, followed by the group treated with therapeutic exercise. In contrast, there manual therapy showed moderate effectiveness compared to other treatments

Table 5. Distribution of results from the evaluation of movement range (ROM) pre and post rehabilitation treatment

Group	Thirst	Initial ROM (Media ± DE)	Final ROM (Average ± DE)	Increase ROM
Group 1	Headquarters (Capiatá)	65° ± 8.0	110° ± 6.5	ÿ 45°
Group 2	Piribebuy Branch	68° ± 7.5	100° ± 7.0	ÿ 32°
Group 3	Branch Concepción	64° ± 7.0	115° ± 6.0	ÿ 51°

Source. Own elaboration

Description. In relation to the movement range (ROM), an improvement was observed in all the groups behind the kinesiological intervention.

Group 1, corresponding to the central headquarters of Capiatá and treated through exercise therapy, showed an increase in ROM from 65° ± 8.0 to 110° ± 6.5, which represents a total gain of 45°, showing a significant improvement in joint movement.

For its part, Group 2, belonging to the Piribebuy branch that received manual therapy, I showed an increase in ROM from 68° ± 7.5 to 100° ± 7.0, with a gain of 32°, which is why become in the group with the least improvement compared to others.

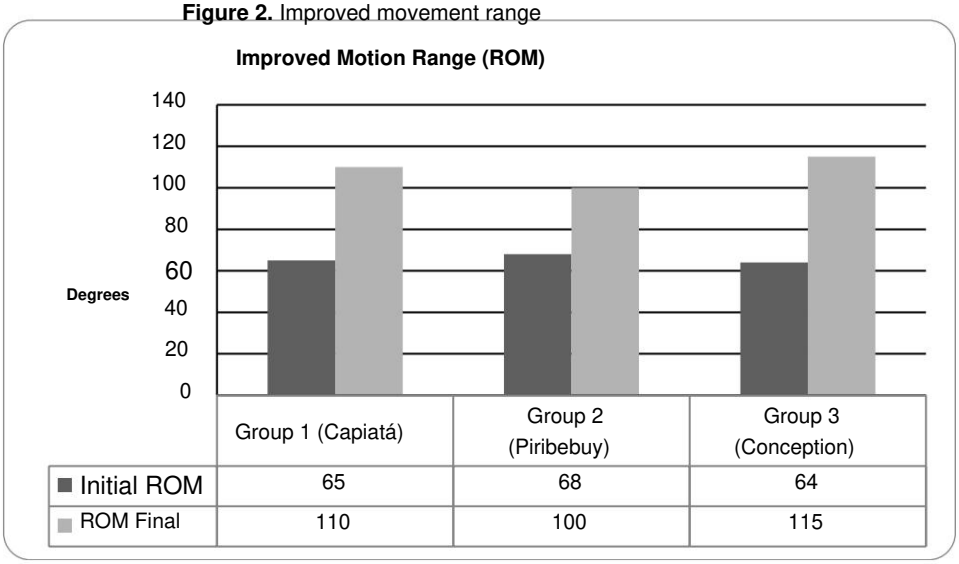
While in Group 3, corresponding to the Concepción branch, undergoing electrotherapy combined with therapeutic exercise, the greatest increase in range of movement was recorded, going from 64° ± 7.0 to 115° ± 6.0, which is equivalent to a gain of 51°.

These findings indicate that, although all interventions were effective in improving it mobility, the combination of electrotherapy with therapeutic exercise showed greater effectiveness in recovering range of movement, followed by applied therapeutic exercise in an isolated way, as shown in table 6.

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Figure 2. Improved movement range



Source. Own elaboration

The statistical analysis using Student's test for related samples showed a significant increase in the range of movement (ROM) in the three studio groups behind kinesiological intervention. The group corresponding to the Concepción Branch presents the mayor statistically significant difference ($p < 0.001$), followed by the central headquarters group (Capiatá) ($p < 0.001$) and the Piribebuy Branch group ($p < 0.01$).

Thus, when comparing the groups, statistically significant differences were observed in favor of the Concepción Branch group, which suggests greater effectiveness of the intervention applied in this group in terms of recovery of joint movement range.

Table 6. Comparison of improvement in movement range (ROM) according to type of intervention

Group	Seat Type ROM Improved treatment		Initial (ÿ°) (°)	ROM Final (°)		Effectiveness
Group 1	Therapeutic exercise	Capiatá	65°	110°	+45°	High
Group 2	Manual therapy	Piribebuy	68°	100°	+32°	Moderate
Group 3	Electrotherapy + exercise	Concepción	64°	115°	+51°	Very high

Source: own elaboration.

Description. In relation to the movement range (ROM), an improvement was observed in all the groups behind the kinesiological intervention (Table 5). The group treated with electrotherapy combined with therapeutic exercise presents greater gain in mobility levels (+51°), followed by the therapeutic exercise group (+45°). On the other hand, the group that received manual therapy showed a smaller improvement (+32°) compared to the other groups. These

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results indicate that active interventions, especially when combined with electrotherapy, favor greater recovery of joint movement.

Table 7. Distribution of results of the evaluation of the level of functionality pre and post rehabilitation treatment

Group	Thirst	Initial Functionality (%)	Functionality Final (%)	Functional improvement
Group 1	Headquarters (Capiatá)	45% ± 10	80% ± 8	ÿ 35%
Group 2	Piribebuy Branch	48% ± 9	75% ± 7	ÿ 27%
Group 3	Branch Concepción	44% ± 8	85% ± 6	ÿ 41%

Source: Own elaboration

Description. In relation to the level of functionality, an improvement was evident in all groups after kinesiological intervention

Group 1, corresponding to the central headquarters of Capiatá and treated through exercise therapeutic, presented an increase in functionality from 45% ± 10 to 80% ± 8, which represents an improvement of 35% and indicates a significant recovery in the capacity for carry out activities of daily life.

Group 2, belonging to the Piribebuy branch and undergoing manual therapy, showed a increase in functionality from 48% ± 9 to 75% ± 7, with a total improvement of 27%, the group with the lowest functional progress compared to others.

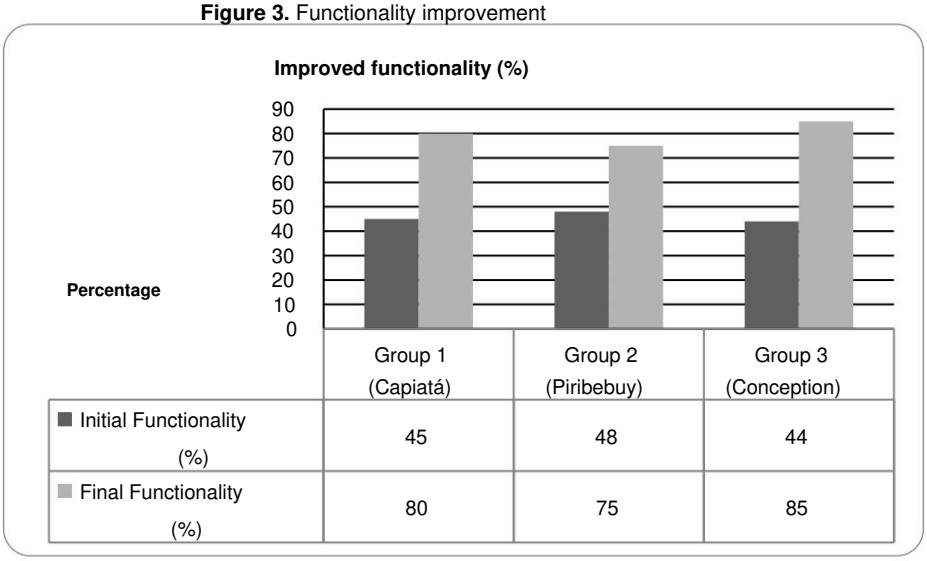
For its part, Group 3, corresponding to the Concepción branch and treated with electrotherapy combined with therapeutic exercise, evidenced greater functional recovery, compared to 44% ± 8 to 85% ± 6, which is equivalent to an improvement of 41%.

These results indicate that all interventions contributed to improving functionality of patients; However, the combination of electrotherapy and therapeutic exercise showed greater effectiveness, followed by therapeutic exercise applied in an isolated manner.

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Figure 3. Functionality improvement



Source: Own elaboration

The statistical analysis using Student's test for related samples showed a significant increase in functionality in the three study groups following the intervention kinesiology. The group corresponding to the Concepción Branch presents the greatest difference statistically significant ($p < 0.001$), followed by the group from the central headquarters (Capiatá) ($p < 0.001$) and the Piribebuy Branch group ($p < 0.01$).

Thus, when comparing groups, statistically significant differences were observed in favor of the Concepción Branch group, which suggests greater effectiveness of the intervention applied in this group in terms of functional recovery.

Table 8. Comparison of functional improvement according to type of kinesiological intervention

Effectiveness Group	Type of treatment	Thirst	Functionality Initial (%)	Functionality Final (%)	Improvement (ÿ%)	
Group 1	Therapeutic exercise	Capiatá	45%	80%	35%	High
Group 2	Manual therapy	Piribebuy	48%	75%	27%	Moderate
Group 3	Electrotherapy + exercise	Concepción	44%	85%	41%	Very high

Source: Own elaboration

Description. When comparing functional improvement between study groups, it was observed that group treated with electrotherapy combined with therapeutic exercise presented the highest effectiveness, with a 41% increase in functionality. The therapeutic exercise group showed an improvement of 35%, considered high, while the manual therapy group

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showed an improvement of less than 27%, considered moderate. These results support it superiority of combined interventions compared to therapies applied in isolation.

Discussion

The present study aims to compare the effectiveness of different interventions kinesiology in the functional recovery of patients with musculoskeletal injuries possible traffic accident. The results showed that all interventions applied produced improvements in the analyzed variables (pain, range of movement and functionality), The combination of electrotherapy with therapeutic exercise, followed by isolated therapeutic exercise and, to a lesser extent, manual therapy.

In relation to the reduction of pain, the hallmarks showed a significant reduction in the three groups, with a greater impact on the group that received combined treatment. These results coincide with recent studies that indicate that multimodal interventions generate better results in pain control in comparison with single therapies, due its synergistic effect on peripheral and central mechanisms of pain[13]. Asimism, if there is described that the combination of therapeutic exercise with electrophysical agents can enhance the modulation of pain through neurophysiological mechanisms, such as the inhibition of pain harmful transmission[1ÿ].

Regarding the movement range (ROM), the results obtained reflect a greater gain in groups that include therapeutic exercise, especially when this is combined with electrotherapy. This analysis is consistent with current evidence that highlights role of active exercise in the restoration of movement patrons and in the improvement of it joint mobility, to promote muscular and neuromotor adaptations[1ÿ]. On the other hand, Although manual therapy showed benefits, its effect was smaller than that of interventions active, which coincides with studies that suggest that its benefits are mainly the Short period and must be complemented with exercise to achieve sustainable effects[1ÿ].

Regarding functionality, a variable of greater clinical relevance, it was observed that the group with combined intervention presents greater recovery, which reinforces the importance of approach the patient from a comprehensive approach. Recent literature supports these results, highlighting that rehabilitation programs that integrate multiple therapeutic strategies achieve better results in functional capacity and in reintegration into activities la vida diaria[1ÿ]. This approach aligns with the biopsychosocial model, which considers on the ground

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physical aspects, as well as behavioral and contextual factors in the recovery of patient16.

A relevant aspect of this study is being developed in an academic context, where interventions were applied by students under professional supervision. Despite this condition, the results were favorable, which suggests that practical training supervised treatment can produce adequate clinical results. Previous studies have highlighted that clinical-academic environments on the ground contribute to the formation of skills professionals, which can also offer effective rehabilitation services when maintain adequate supervision standards[1ÿ].

However, this study presents some limitations that must be considered. First In addition, the type of non-probabilistic sampling may limit the generalization of results. Secondly, even though the age range was controlled, other variables that could influence recovery, such as the previous level of physical activity or adherence to treatment. Finally, the designation of thirst treatments could introduce six derived from contextual factors.

Despite these limitations, the results provide relevant evidence in the context regional, where the scientific production on the comparative effectiveness of interventions kinesiology in patients after traffic accidents is limited. In this sense, the studio contributes to strengthening evidence-based practice and highlights the importance of implementing combined therapeutic approaches to optimize clinical results.

Conclusion

The results of this study show that kinesiological interventions applied effective in the recovery of patients with post-accident musculoskeletal injuries traffic, observing improvements in the intensity of the pain, the range of movement and the level of functionality in all groups evaluated.

The intervention based on electrotherapy combined with therapeutic exercise proved to be greater effectiveness in comparison with others, achieving a greater reduction in pain, a greater gain in joint mobility and better functional recovery.

On the other hand, therapeutic exercise applied in an isolated way also presented results favorable, while manual therapy evidenced a lesser magnitude of improvement in variables analyzed.

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It is concluded that combined therapeutic approaches constitute a more effective strategy for the rehabilitation of this type of patients, which contributes to optimizing results clinical and functional in the context of kinesiological practice.

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