Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 4741 - 4746
Received 25 April 2021; Accepted 08 May 2021.

The Comparison of Consistency of the Result between Analysis of Q1-Q4 Angles in Footprints and Sciatic Functional Indexed in Walking Analysis of Sciatic Nerve Injury Rat Model

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ABSTRACT

Walking analysis with sciatic function index (SFI) of peripheral nerve injury model has been studied and used for a long time. Studies show the applicability of SFI and Q1-Q4 angles as parameters for walking analysis. However, scholars are questioning the effectiveness of SFI in offering conclusive evidence in walking analysis. This systematic review explores the advantages and disadvantages of using Q1-Q4 angles comparing with SFI in walking analysis. This study used three inclusion criteria when identifying the most relevant data. The study is based on secondary data from eight peer-reviewed articles derived from the PROQUEST database and other online sources. The findings show the benefits of using the Q1-Q4 angles compared to SFI since the former solves the problem associated with the latter. In particular, SFI results are affected by muscle contracture and auto-mutilation. Besides, the way that a rat walks and the walking speed affect the results of SFI in walking analysis. In contrast, measuring Q1-Q4 angles gives a consistent outcome. Therefore, Q1-Q4 angles stand out as a promising parameter that gives consistent results to show the difference between a normal and pathological hind limp of a rat. However, the applicability of SFI cannot be ignored since it is still an effective parameter for walking analysis. The strong positive correlation between Q1-Q4 angles and SFI presents a new possibility of using the two parameters together. Therefore, the former can be applied as the main parameter in walking analysis, while the latter can be used as references to confirm the results.
Q1-Q4 Angles; SFI; Walking Analysis

INTRODUCTION

For decades, scholars have been using the sciatic function index (SFI) in walking analysis. The SFI is applicable in assessing the function of the nerve through footprints in the walking analysis [1-3]. In most studies, researchers have been using a rat sciatic nerve model to explore the functional outcome [4-7]. The methodology they depicted is used progressively by the specialists who manage neuroscience. It consolidates walk investigation and the transient and spatial relationship of one impression to another during walking. The numerical estimation of the equation is named the SFI [8]. This model of estimating useful recuperation has been utilized by various scholars with predictable results. The sciatic function index has received considerable attention from researchers in their studies, focusing on walking analysis [4, 8-10]. The importance of walking analysis is based on the medical application where peripheral nerve injury is associated with huge expenses and a long span of hospitalization [4, 11,12]. Moreover, peripheral nerve injury causes limitations in motor movement. peripheral nerve injury causes limitations in motor movement and even disabilities [13-15]. Therefore, it is necessary to analyze the effectiveness of the method in the analysis of nerve injury.

However, SFI is a questionable method since it is affected by several factors such as auto-mutilation, muscle contracture, and the speed that a rat walks. For example, Margiana et al. [4] argue that auto-mutilation and muscle contraction, as well as the speed of the rat walk, affect the accuracy of the SFI method. On the same note, evidence shows a strong correlation between SFI and Q1-Q4 angles allowing investigators to use the angles as predictors of walking functions. Therefore, the current study explores the advantages and disadvantages of using Q1-Q4 angles

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comparing with SFI in walking analysis [9].

Materials and Method

The current study employs a systematic review to explore the advantages and disadvantages of using Q1-Q4 angles comparing with sciatic function index (SFI) in walking analysis. According to the review of the literature, walking analysis has received considerable attention from scholars around the world. Therefore, a systematic literature review provided the much-needed platform for the comparison of the findings to show the effectiveness of using Q1-Q4 angles comparing with SFI in walking analysis.

Data collection

The current study is based on secondary data from previously conducted studies. Therefore, the collection of data involved the review of relevant findings from previous studies. As part of data collection inclusion and exclusion criteria were applied to ensure uniformity of data, which, in turn, facilitated comparison. Also, the inclusion criteria ensured that only articles with relevant data were included.

Inclusion and exclusion criteria

Three inclusion criteria were used when identifying the most relevant data. First, only studies on SFI in the walking analysis were included. This facilitated the research by ensuring that the data collected were relevant to the study. Second, only articles that focused on experiments involving rats were included. This criterion was crucial in ensuring uniformity where the outcomes on rats were compared to draw conclusive evidence. Thirdly, only peer-reviewed articles conducted later than the year 2000 were included. This criterion was meant to ensure relevance by availing updated findings.

Data collection procedure

As Figure 1 illustrates, the selection of articles was done in a four-step process in line with the inclusion criteria. The first step involved the identification of data from PROQUEST and other sources. This was followed by screening which was crucial in eliminating articles whose full-texts were not accessible. The next step focused on assessing the articles against the inclusion criteria to ensure that they meet all of them. Finally, the articles that met all the criteria were analyzed by focusing on common themes.

Results

The analysis is based on findings from five studies that met all the inclusion criteria (Fig.1). A study by Margiana et al. [10] explored the correlation between the parameters used in walking analysis and the Q1-Q4 angles. The findings revealed a strong correlation between sciatic function index (SFI) and Q1-Q4 angles; thus, researchers can use the angles as predictors of walking functions. As the need to understand Sciatic Nerve Injury increases in the medical field, there is a need to understand the merits and demerits of using Q1-Q4 angles [10].

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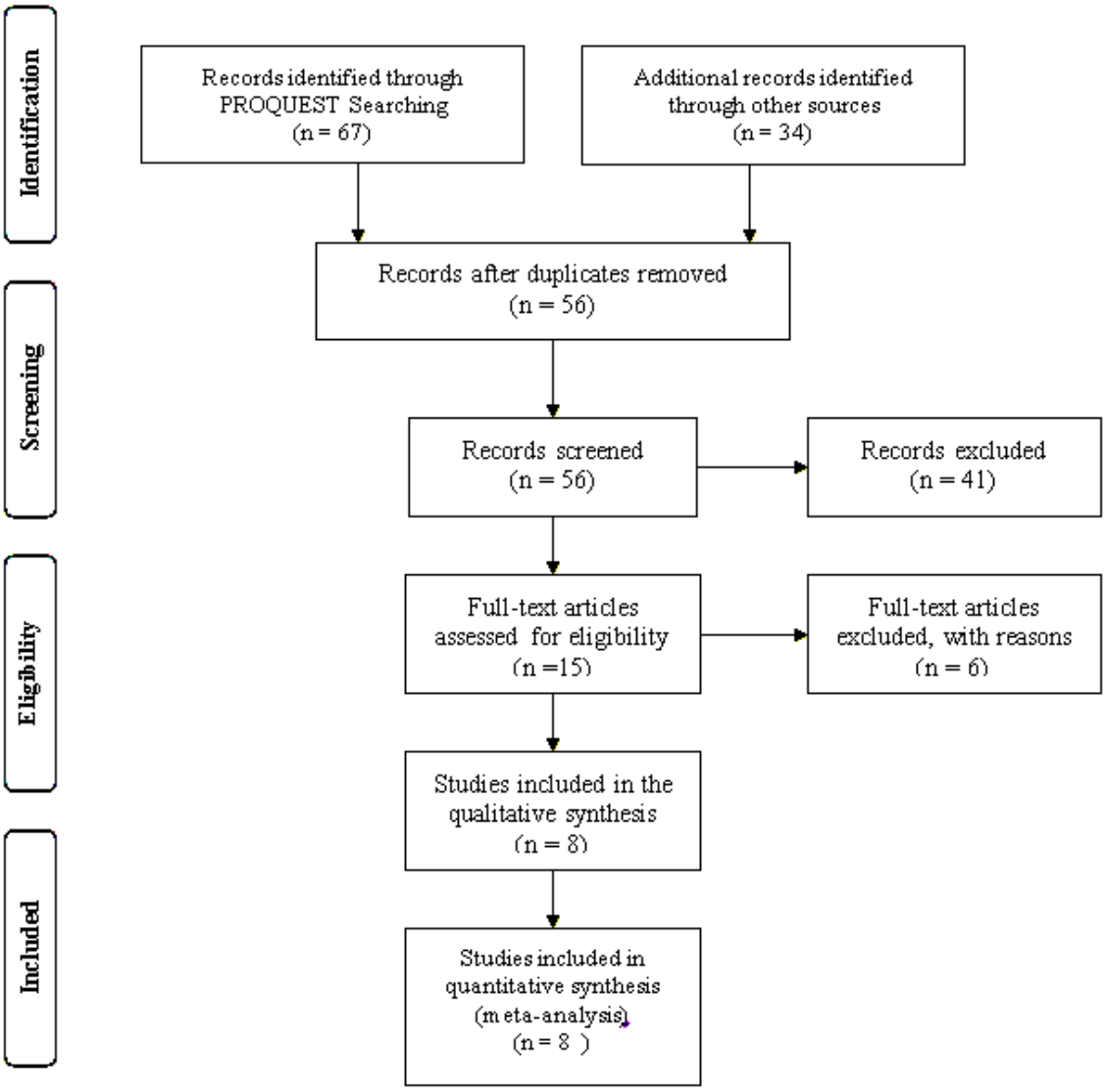

Figure 1. Analysis of the finding based on PRISMA Flow diagram

Studies on peripheral nerve damage treatment fundamentally in the sciatic nerve, tibial nerve, and regular fibular nerve wounds, for the most part, use SFI to find the impact of treatment. In Margiana et al. [16], the study examined the effect of the conditioned medium (CM) from human umbilical cord-derived mesenchymal stem cells in peripheral nerve injury models. The result showed that faster recovery results in the CM group. This study using peripheral nerve injury models and using the SFI method for the motor examination. Axotomy of sciatic nerve executed by complete transection at mid-thigh of rodents or mice is the most seasoned creature trial model of fringe nerve damage. A specific parameter is expected to quantify the impact of the treatment given. Institutionalized estimations ought to have the option to quantify what ought to be estimated and ought to be solid [10]. Estimations can be performed utilizing certain instruments. Research instruments can be as a particular device or an exceptional instrument such as a poll or a specific instrument.

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Table 1. Comparison between sciatic function index (SFI) and Q1-Q4 angles summary findings

SFI	Q1-Q4 angles
SFI results are affected by muscle contracture and auto mutilation	Muscle contracture and auto-mutilation do not affect the outcomes when this parameter is used
The way that a rat walks affects the results of SFI	The way and speed that a rat walks do not affect the results when the angles are measured as the parameter.
The parameter presents varying results depending on various factors; for example, the speed of walking and muscle contracture.	The parameters presented consistent results that show the difference between a normal and pathological hind limp of a rat.
Can be used as the main parameter in walking analysis	The angles can be used as references to compare normal and sciatic nerve-injured hind limb; therefore, can be used as an additional method for confirming the results of SFI

Discussion

In summary, the systematic review provides crucial insights regarding the differences between Q1-Q4 angles and SFI in walking analysis (Table 1). The findings show the benefits of using the angles compared to SFI. For example, SFI results are affected by muscle contracture and auto-mutilation. This problem is not reported in the case of Q1-Q4 angles. Also, the way that a rat walks and the walking speed affect the results of SFI in walking analysis. In contrast, measuring Q1-Q4 angles gives a consistent outcome. Based on these findings, the former presents varying results depending on various factors, while the latter leads to consistent results that show the difference between a normal and pathological hind limp of a rat. However, the results show that SFI is still an effective parameter for walking analysis. Also, the findings show a strong positive correlation between Q1-Q4 angles and SFI. Therefore, the former can be applied as the main parameter in walking analysis while the latter can be used as references to compare normal and sciatic nerve-injured hind limbs. This makes the Q1-Q4 angles a promising parameter that can be used as an additional method for confirming the results of SFI.

The approval of sciatic nerve damage recuperation assessment estimations in rodents that are generally utilized has been addressed in all the studies reviewed in this systematic review. These scientists think about the impact of strong contracture, auto-mutilation, speed, and the course of strolling against SFI estimation results. Subsequently, an inquiry emerges on whether the created parameter is very reliable and has a positive relationship between a few parameters. Hence, this exploration shows the many drawbacks associated with SFI and the important role that Q1-Q4 plays in supporting the model.

Conclusion

The systematic review provides crucial insights regarding models for walking analysis, their advantages, and disadvantage. First, the findings show the merits of using Q1-Q4 angles to overcome the limitations and drawbacks associated with sciatic function index (SFI) in walking analysis. In particular, SFI results are affected by muscle contracture and auto-mutilation, while

the results of Q1-Q4 angles remain constant. Also, the way that a rat walks and the walking speed affect the results of SFI, unlike the Q1-Q4 angles, which give a consistent outcome. Therefore, SFI presents varying results depending on various factors while Q1-Q4 angles present results on the difference between a normal and pathological hind limp of a rat. Based on these findings, the former can be applied as the main parameter in walking analysis while the latter can be used as references to confirm the outcome. Although the overall topic of walking analysis is well-covered, there are limited findings regarding the Q1-Q4 angles and their significance in walking analysis. Therefore, studies are required to provide more primary data to make a systematic review of a viable research approach to compare the findings.

Acknowledgment
We would like to thank you for the support of funding by Universitas Indonesia (UI) research grant, International Indexed Publications (PUTI) with contract number BA-1568/UN2.RST/PPM.00.03.01/2020.

References

[1] Dellon, A.L., Mackinnon, S.E. (1989). Sciatic nerve regeneration in the rat: Validity of walking track assessment in the presence of chronic contractures. Microsurgery, 10, 220–225.

[2] Lee, J.Y., Giusti, G., Wang, H., Friedrich, P.F., Bishop, A.T., Shin, A.Y. (2013) Functional evaluation in the rat sciatic nerve defect model: a comparison of the sciatic functional index, ankle angles, and isometric tetanic force. Plastic and reconstructive surgery. 132(5), 1173-1180.

[3] Santos, P.M., Williams, S.L., Thomas, S.S. (1995) Neuromuscular evaluation using rat gait analysis. J Neurosci Methods. 61, 79–84.

[4] Margiana, R.,Jusuf, A.A., Aman, R.A., Liem, IK. (2015) A new method in walking analysis using the angles around the midpoint between print length and toe spread by four different color footprints. Int J Sci: Basic Appl Res (IJSBAR). 21(1), 117-128.

[5] Varejão, A.S., Melo-Pinto, P., Meek, M.F., Filipe, V.M., Bulas-Cruz, J. (2004) Methods for the experimental functional assessment of rat sciatic nerve regeneration. Neurological research. 26(2), 186-194.

[6] Dijkstra, J.R., Meek, M.F., Robinson, P.H., Gramsbergen, A. (2000) Methods to evaluate functional nerve recovery in adult rats: Walking track analysis, video analysis, and the withdrawal reflex. J Neurosci Methods. 96, 89–96.

[7] Margiana, R., Pasaribu, S.R., Haikal, H.H. (2017) Comparison of Various Additional Agents on Sciatic Nerve Repair on Sciatic Functional Index. AdvSciLett. 23(7), 7005–8.

[8] Boix, J., von Hieber, D., Connor, B. (2018) Gait Analysis for Early Detection of Motor Symptoms in the 6-OHDA Rat Model of Parkinson's Disease. Front BehavNeurosci. 6, 12-39.

Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 6, 2021, Pages. 4741 - 4746
Received 25 April 2021; Accepted 08 May 2021.

[9] Monte-Raso, V.V., Barbieri, C.H., Mazzer, N. (2006) Sciatic functional index smashing injuries of rats' sciatic nerves. Evaluation of method reproducibility among examiners. ActaOrtopédicaBrasileira. 14(3), 133-136.

[10] Margiana, R., Aman, R.A., Pawitan, J.A., Jusuf, A.A., Ibrahim, N., Wibowo, H. (2018) The Correlations Between Walking Analysis Parameters and Q1–Q4 Angles in the Experimental Animal Model of Sciatic Nerve Injury. AdvSciLett. 24(8), 6245-6248.

[11] Noble, J., Munro, C., Prasad, V., Midha, R. (1998) Analysis of upper and lower extremity peripheral nerve injuries in a population of patients with multiple injuries. J Trauma. (45), 116–122.

[12] Charles, D., David, N. (1985) Textbook of small animal orthopaedics. Lippincott Company. p. 65.

[13] Evans, G.R. (2001) Peripheral nerve injury: a review and approach to tissue-engineered constructs. The Anatomical Record: An Official Publication of the American Association of Anatomists. 263(4), 396-404.

[14] Austin, P.J., Beyer, K., Bembrick, A.L., Keay, K.A. (2010) Peripheral nerve injury differentially regulates dopaminergic pathways in the nucleus accumbens of rats with either ‘pain alone’or ‘pain and disability’. Neuroscience. 171(1), 329-343.

[15] Nam, A.S., Easow, J.M., Chico-Calero, I., Villiger, M., Welt, J., Borschel, G.H., et al. (2018) Wide-field functional microscopy of peripheral nerve injury and regeneration. Scientific reports. 8(1), 1-10.

[16] Margiana. R., Aman, R.A., Pawitan, J.A., Jusuf, A.A., Ibrahim, N., Wibowo, H. (2019) The effect of human umbilical cord-derived mesenchymal stem cell-conditioned medium on the peripheral nerve regeneration of injured rats. Electron J Gen Med. 16(6), 1-15.