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BACKGROUND & AIMS

Trigeminal Neuralgia (TN) is a chronic neuropathic pain disorder characterized by paroxysmal episodes of facial pain in the distribution of the fifth cranial nerve. First-line treatment is pharmacological, while Gamma Knife radiosurgery (GKRS) becomes an option if medications fail. This study aimed to investigate facial mimicry alterations and the potential for recovery through a virtual reality (VR) rehabilitation.

METHODS

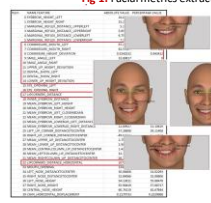
Thirteen TN patients and 29 controls age- and sex-matched underwent facial mimicry assessment. TN patients were evaluated at baseline (pre-GKRS) and 3-months post-GKRS, while controls were assessed only at baseline. Seven TN patients (TN-VR) also underwent VR-based facial mimic rehabilitation between the two timepoints. Fourteen photographs were taken during specific facial actions, and images were processed using two specific software to extract 40 facial metrics by applying 70 virtual face markers [Fig. 1]. Metrics were compared across timepoints and between rest and action positions. Comparisons were conducted between TN patients and controls, between the pain side and the no-pain side with controls, and between TN patients at baseline and follow-up.

Fig 1. Facial metrics extraction:

- Marker positioning (red squares)
- Calculation of the selected metrics for each action
- Comparison with healthy controls

Metrics selected for smiling showing teeth included:

- Vertical displacement of the upper lip
- Displacement of the oral commissures
- Angle formed between oral commissures and lower lip
- Amount of dental exposure during smiling



RESULTS

At baseline, significant differences in facial expressions were observed between all TN patients and controls during eyebrow furrowing [Fig 2], lip protrusion [Fig 3], and smiling [Fig 4]. No significant differences were found between the TN pain side and the no-pain side in TN patients; however, both sides differed significantly from controls in eyebrow furrowing and smiling [Fig 5]. Finally, longitudinal analysis revealed a significant improvement in eyebrow elevation at follow-up in TN patients [Fig 6], although no differences were observed between the VR and non-VR groups.

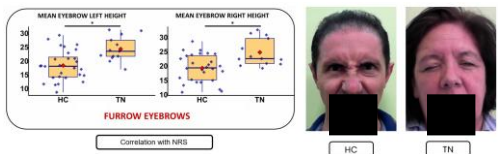


Fig 2. Reduction in eyebrow displacement during furrowing in TN patients versus healthy controls. This finding correlates with NRS, indicating that greater impairment of facial expressivity is associated with higher perceived pain levels. Abbreviations: HC=Healthy Controls; NRS=Numeric Rating Scale; TN=Trigeminal Neuralgia.

Outcome Measures	Healthy Controls	TN patients	TN-non-VR	TN-VR	p (HC vs TN ALL)	p (TN-non-VR vs TN-VR)
N	29	13	6	7	-	-
Age (years)	61.19 ± 7.98	60.25 ± 13.56	62.61 ± 16.75	58.22 ± 11.13	0.78	0.58
Sex (men/women)	22 (76%) / 7 (24%)	8 (62%) / 5 (38%)	4 (67%) / 2 (33%)	4 (57%) / 3 (43%)	0.35	0.75
Education (years)	14.52 ± 4.41	13.23 ± 2.98	13.67 ± 3.56	12.86 ± 2.61	0.35	0.65
TN duration (months)	-	71.16 ± 67.56	41.88 ± 25.80	94.36 ± 85.08	-	0.16
NRS baseline	-	4.46 ± 2.93	4.33 ± 3.27	4.57 ± 2.88	-	0.89
NRS 3-months	-	1.15 ± 2.51	0.83 ± 2.04	1.43 ± 2.99	-	0.69
PDI baseline	-	35.08 ± 20.86	39.50 ± 21.18	31.29 ± 21.44	-	0.50
PDI 3-months	-	8.54 ± 15.64	5.83 ± 8.35	10.86 ± 20.43	-	0.59

Tab 1. Sociodemographic characteristics in HC and TN patients. Red squares indicate the significant pain reduction from baseline to 3-months post GKRS. Abbreviations: HC=Healthy Control; NRS=Numeric Rating Scale; PDI=Pain Disability Index; TN=Trigeminal Neuralgia; TN-non-VR=Trigeminal Neuralgia patients without Virtual Rehabilitation group; TN-VR=Trigeminal Neuralgia patients Virtual Reality rehabilitation group.

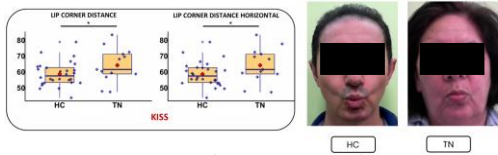


Fig 3. Decrease in convergence of the lip corners during forward lip protrusion. Abbreviations: HC=Healthy Controls; TN=Trigeminal Neuralgia.

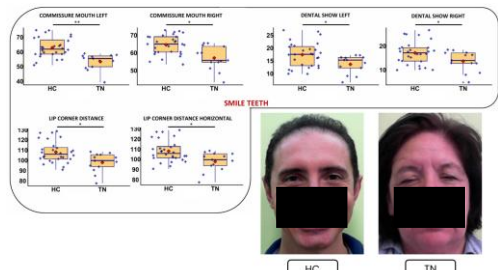


Fig 4. Reduction in smile width and decrease in dental exposure during smiling showing teeth. Abbreviations: HC=Healthy Controls; TN=Trigeminal Neuralgia.

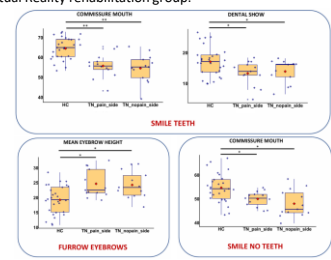


Fig 5. Pain side and no-pain side comparison. Facial mimicry alterations appear to involve the entire face, not just the painful side. Abbreviations: HC=Healthy Controls; TN=Trigeminal Neuralgia.

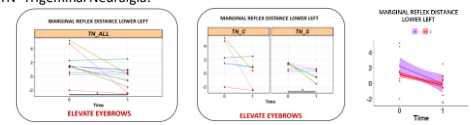


Fig 6. Significant improvement in eyebrow elevation, particularly among individuals who underwent rehabilitation. Abbreviations: TN=Trigeminal Neuralgia; TN_C=Trigeminal Neuralgia non-VR group; TN_S=Trigeminal Neuralgia VR group

CONCLUSIONS

Results suggested TN patient exhibited reduced movement in different facial muscles compared to controls, and that limitations affect significantly both pain and no-pain side. Longitudinal results highlighted that both pain and no pain sides show improvements, with more notable changes in the no pain side for VR group, but a bigger sample size is needed to explore and confirm these results. These findings suggest altered facial mimicry due to TN, with potential for recovery. The role of physiotherapy in restoring facial movement over time remains an intriguing area for future research.

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