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Factors associated with outcomes following microvascular decompression for the treatment of primary trigeminal neuralgia in adults: a systematic review and meta-analysis

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This study aimed to evaluate pain assessment strategies and factors associated with outcomes after microvascular decompression for the treatment of primary trigeminal neuralgia in adults. We conducted a systematic review and meta-analysis of English, Spanish, and French literature. We searched three databases, PubMed, Ovid, and EBSCO, from 2010 to 2022 and selected studies including patients with primary trigeminal neuralgia, clear pain assessment, and pain outcomes. Population means and standard deviations were calculated. Studies that included factors associated with postoperative outcomes were included in the meta-analysis. A total of 995 studies involving 5673 patients with primary trigeminal neuralgia following microvascular decompression were included. Patients with arteries compressing the trigeminal nerve demonstrated optimal outcomes following microvascular decompression (odds ratio [OR]= 0.39; 95% confidence interval [CI] = 0.19–0.80; X^2 = 46.31; Dof = 15; I^2 = 68%; P = < 0.0001). Conversely, when comparing arterial vs venous compression of the trigeminal nerve (OR = 2.72; 95% CI = 1.16–6.38; X^2 = 23.23; Dof = 10; I^2 = 57%; P = 0.01), venous compression demonstrated poor outcomes after microvascular decompression. Additionally, when comparing single-vessel vs multiple-vessel compression (OR = 2.72; 95% CI = 1.18–6.25; X^2 = 21.17; Dof = 9; I^2 = 57%; P = 0.01), patients demonstrated unfavorable outcomes after microvascular decompression. This systematic review and meta-analysis evaluated factors associated with outcomes following microvascular decompression (MVD) for primary trigeminal neuralgia (PTN). Although MVD is an optimal treatment strategy for PTN, a gap exists in interpreting the results when considering the lack of evidence for most pain assessment strategies.

Keywords: Microvascular Decompression Surgery; Pain Assessment; Trigeminal Neuralgia.

INTRODUCTION

Trigeminal neuralgia (TN) is the most common form of craniofacial neuropathic pain and is considered one of the most intensely painful and debilitating conditions in science. It can cause tremendous physical and emotional distress, leading to chronic pain, reduced quality of life,

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and medication overuse [1]. TN significantly affects essential human psychological, physical, and social functions such as facial touch, speech, eating, and drinking. TN is a rare condition with an estimated incidence of 4 to 13 people per 100,000 annually and an overall prevalence in the general population of 0.015% which increases significantly with age, ranging from 0.1 in < 19-year-olds to 23.1 per 100,000 person-years in > 80-year-olds [2,3]. Similar to patients with other causes of chronic pain, patients with TN experience increased anxiety, depression, and sleep disturbances, resulting in some degree of psychosocial disability, emphasizing the adverse effects of the condition on mental health and quality of life [4]. Therefore, several pain assessment strategies have been used throughout the years to determine pain outcomes following TN treatment. However, little attention has been paid to the development of standardized pain assessment strategies. Scales such as the Barrow Neurological Institute pain assessment scale (BNI-PS) and the Numerical Rating Scale (NRS) are the most widely used pain assessment strategies, although both lack content validity, which raises concerns regarding their interpretation [5].

TN is neuropathic. The central hypothesis for the pathophysiology of TN involves anatomical compression of the nerve root at the prepontine cistern, leading to nerve damage [4,6]. This aberrant organization can cause abnormal pain perception in the somatosensory cortex after relaying with afferent neurons in the primary trigeminal sensory nucleus in the pons, the trigeminal mesencephalic nucleus in the midbrain, and the spinal nucleus in the medulla [4] (Fig. 1). Additional neurophysiological mechanisms contribute to the onset and recurrence of pain [6]. Over the past decade, significant scientific advancements have been made in the understanding of TN, including its symptoms, causes, underlying mechanisms, classification, and treatment modalities. These findings have contributed to the establishment of the most recent classification system for TN, classifying TN as classical, secondary, or idiopathic, which has been endorsed by both the International Headache Society and the International Association for the Study of Pain [7]. The European Academy of Neurology classifies TN as either primary trigeminal neuralgia (PTN) or secondary trigeminal neuralgia (STN). PTN is subdivided into either classically idiopathic, depending on the degree of neurovascular contact. The STN is subdivided into pain caused by pathologies other than neurovascular contact [7,8].

Microvascular decompression (MVD) is the primary surgical option for patients diagnosed with classical PTN when pharmacological strategies fail. Treatment of MVD is based on the assumption that PTN is caused by compression of the trigeminal nerve by an abnormal vascular loop [6]. Once the offending vessel was identified, it was separated from the trigeminal nerve, and a sponge was inserted between both structures to prevent any further painful signaling. A pooled analysis involving 5149 patients demonstrated a generally high success rate for MVD, with 62–89% of patients reporting freedom from pain during follow-up periods ranging from 3 to 11 years [6,8]. In MVD, several factors can affect the outcomes, and sustained successful pain resolution is not always achieved.

This systematic review and meta-analysis examined the factors associated with favorable or adverse outcomes following MVD for the treatment of PTN in adults. The secondary objectives were to determine patient characteristics, pain assessment strategy, and overall MVD success rate.

METHODS

1. Search strategy

This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [9]. This systematic review was registered and accepted in PROSPERO (registration number: CRD42023457181). PubMed, Ovid, and Ebsco databases were searched from 2010 to 2022 for information regarding MVD as a treatment for TN

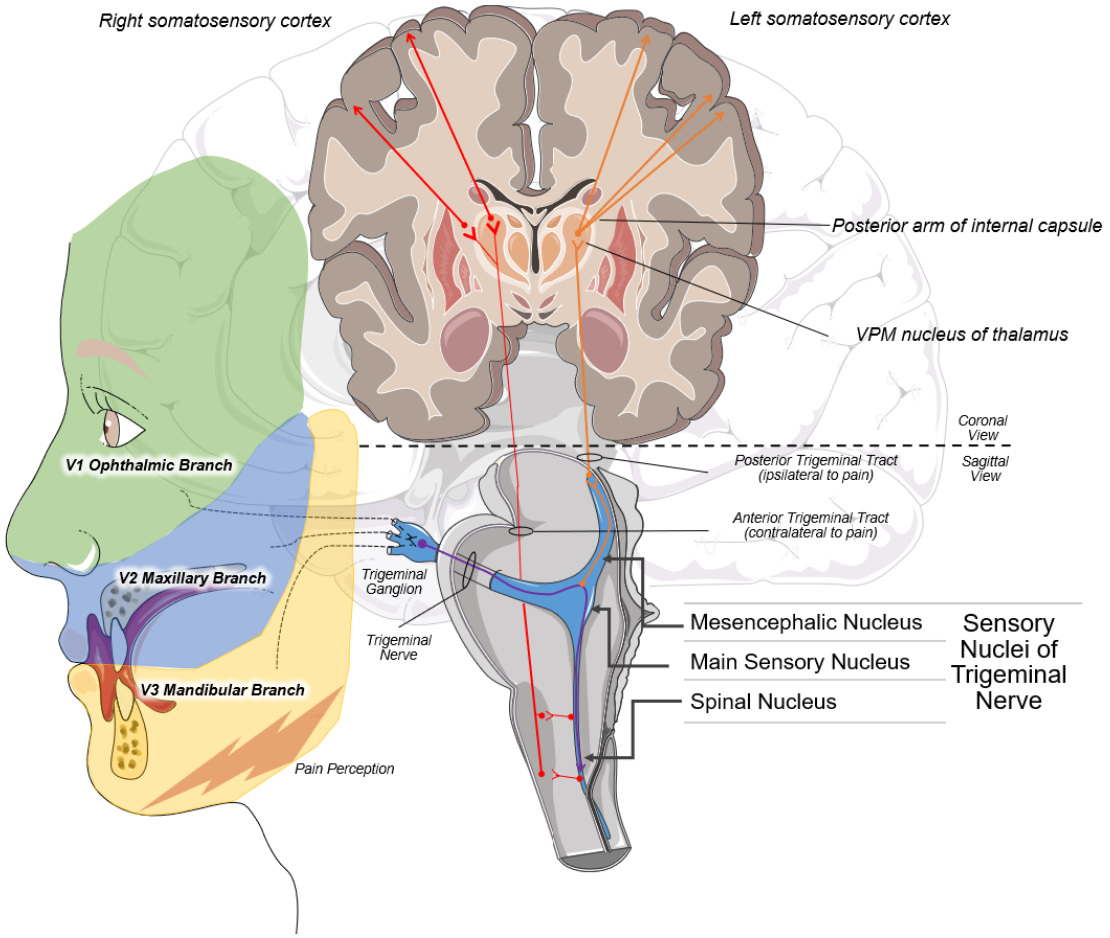


Fig. 1. Cranial nerve V sensitive pathway. VPM, Ventral posteromedial.

in adults, using the following search strategy: (((trigeminal neuralgia) AND (microvascular decompression)) AND (retrospective study, OR prospective study, OR clinical study)) NOT (systematic review OR meta-analysis OR case report). Fig. 2 shows the screening process.

2. Selection criteria

We decided to conduct this study, including patients with PTN who underwent MVD treatment, to determine which factors were associated with outcomes after MVD. The inclusion criteria were as follows: 1. Studies with clear pain assessment; 2. pain outcomes after MVD; 3. PTN diagnosis; 4. adult patients; 5. Spanish, English, or French literature; and 6. human subjects. The exclusion criteria were as follows: 1. No clear follow-up; 2. follow-up shorter than 12 months; and 3. recurrence cases; 4. patients undergoing a second surgical treatment; 5. case reports; 6. case series, including < 10 patients; and 7. studies that did not report outcomes related to pain assessment after MVD.

3. Data extraction

Three authors (D. P., P. S., M. S.) independently searched the literature, screened eligible studies, and extracted the following data: number of patients, type of study, sex, mean age, trigeminal nerve (CN-V) branch affected, pain laterality, offending vessel characteristics, pain scale used, complications following MVD, recurrence or surgical failure rate, disease duration, follow-up time, and studies including the NRS for pain, or the BNI-PS preMVD and postMVD values. Finally, in our study, for papers that included the BNI-PS, a value of III was the cutoff point when considering recurrence

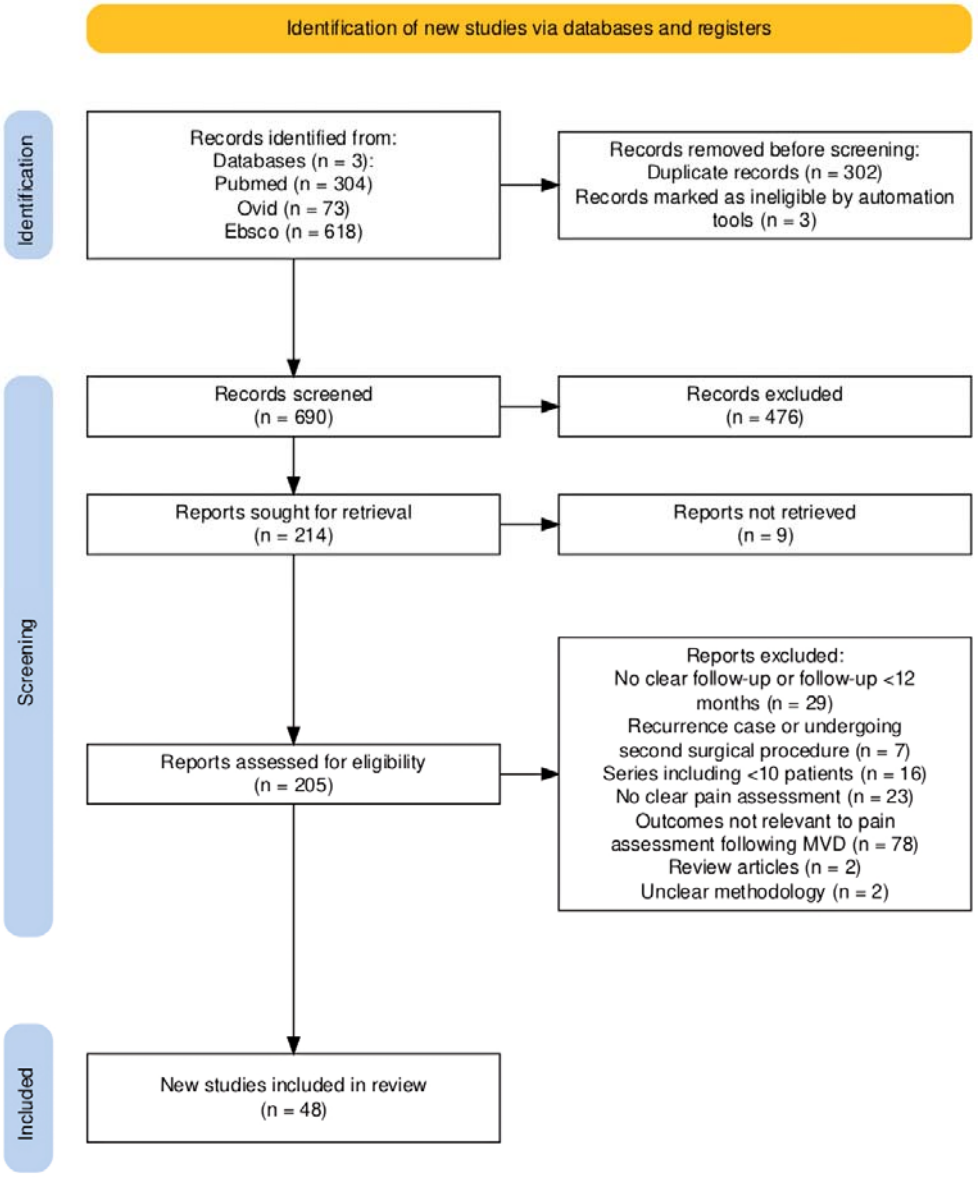


Fig. 2. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow chart. n, number.

and failure. A quality assessment of the included studies was performed using the Strengthening the Reporting of Observational Studies in Epidemiology checklist [10].

4. Statistical analysis

Means and standard deviations were calculated for continuous data. For categorical variables, the data were subdivided into favorable and adverse outcomes (recurrence or failure), and chi-square test was performed. For the meta-analysis, we calculated combined odds ratio (OR) and 95% confidence interval (CI) using the Mantel–Haenszel test to evaluate the impact of categorical variables on recurrence after MVD. We conducted a Higgins I^2 test for the heterogeneity of each variable in the study. For data with I^2 results of $\geq$40%, we conducted a random effects model, contrarily for when I^2 resulted in a value of < 40%, in which a fixed effects model was preferred, following the recommendations by Cochrane [11]. Review Manager v5.4.1 was used for statistical analyses [12]. Statistical significance was defined as a CI of 95% and a P value of < 0.05.

Table 1a. Demographics

Variable	n (SD)
Patients	5,673
Gender (m/f)	(2,271/3,402)
Age (mean)	58 (± 5.9)
Time with TN mean (SD) *	6.6 (± 7.1)
Follow-up mean in months (SD)	36 (± 18.3)
Average success rate (%)	84

*Time is in years. n, number; SD, standard deviation; TN, trigeminal neuralgia.

Table 1b. Pain assessment scales

Variable	Number of studies*
BNI-PS	35
NRS	10
Mcgill	1
PFPS	1
Other	6

*Total number of studies = 48 due to multiple authors utilizing NRS and BNI-PS for assessment. BNI-PS, Barrow Neurological Institute Pain Scale; n, number; NRS, Numerical Rating Scale; PFPS, Penn Facial Pain Scale.

Table 2a. Vessel involvement

Variable	n (%)
Artery	**2835 (66)**
SCA	1411 (72)
AICA	310 (16)
VA	25 (1)
BA	30 (2)
PICA	16 (0.8)
TA	1 (0.05)
Small arteries	154 (8)
Vein	**709 (17)**
SPV	34 (65)
TPV	13 (25)
Cerebropontine fissure	2 (4)
Plexus venosus	2 (4)
TGV	1 (2)
Multiple	**658 (15)**
No vessel	**90 (2)**

AICA, anterior inferior cerebellar artery; BA, basilar artery; CN, cranial nerve; n, number; PICA, posteroinferior cerebellar artery; SCA, superior cerebellar artery; SPV, superior petrosal vein; TA, trigeminal artery; TGV, Trigeminovascular system; TPV, transverse petrosal vein; VA, vertebral artery.

Table 2b. Cranial nerve V branch and side involvement

Variable	n (%)
Trigeminal branch	
V1	206 (7)
V2	932 (32)
V3	729 (25)
V1-V2	250 (8)
V2-V3	548 (19)
V1-V3	286 (10)
Side	
Right	2853 (58)
Left	2075 (42)
Bilateral	31 (0.63)

n, number.

RESULTS

A total of 995 studies were retrieved from PubMed (n = 304), Ovid (n = 73), and EBSCO (n = 618). Forty-eight studies involving 5673 patients suffering from PTN following MVD treatment were included in our study [13-61]. Fig. 2 shows the specific screening process in a PRISMA flowchart. The patient demographics are presented in Table 1a. Of our group of patients studied, 40% of them were males and 60 % females, with a mean age of 58 (± 6) years old and a mean disease duration of 7 (± 7) years. Overall, the average for success rate was 84%, with a mean follow-up duration of 36 (± 18) months. The pain assessment of patients who underwent MVD is shown in Table 1b.

1. Anatomical aspects

The studies analyzed, including 4292 patients, reported vessel involvement during MVD. The results are listed in Table 2a. Arteries represented 66% of all compressive structures, followed by veins and multiple vessels (either artery + artery or vein + artery) at 17% and 15%, respectively. Finally, 2% of patients had no vessel involvement during MVD. The variations in the offending vessels during MVD are shown in Fig. 3. The results for trigeminal branch and side involvement are presented in Table 2b. CNV divisions that showed the highest involvement were V2 (32%), V3 (25%), and V2–3 (19%). The complications associated with MVD are shown in Table 3.

2. Meta-analysis

Twenty-one studies were included [13-33]. We

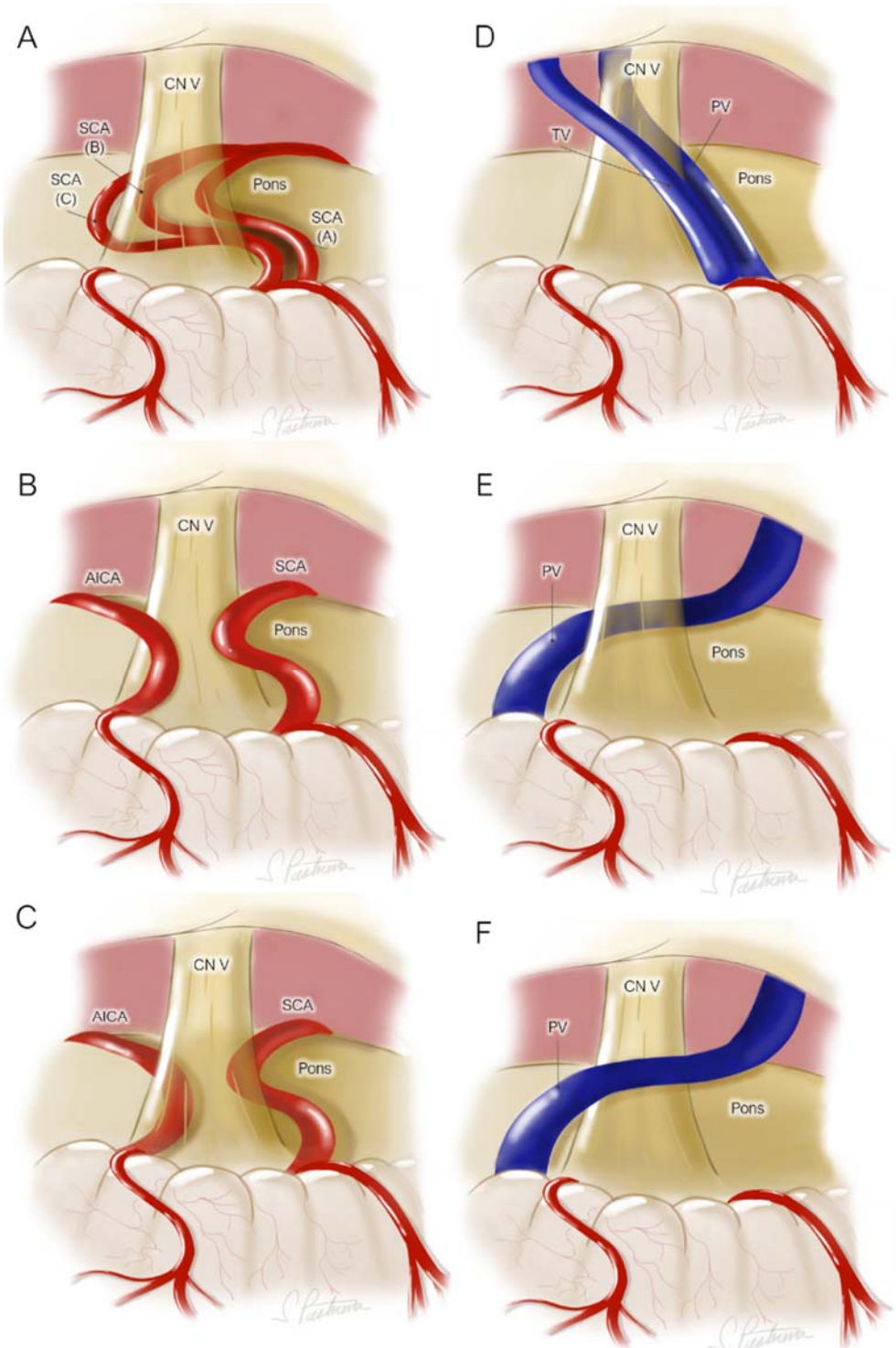


Fig. 3. Neurovascular conflict. AICA, Anterior inferior cerebellar artery; CN V, Cranial nerve V; PV, petrosal vein; SCA, Superior cerebellar artery (A) trunk (B, C) branches; TV, Trigeminal vein.

conducted a preliminary analysis of age (dichotomized between younger than 60 years and older), sex, disease duration (< 4 years and longer), offending vessel, trigeminal branch involvement, and affected side. The results are summarized in Table 4. Analysis of offending vessels reported a significant difference (X^2 = 60.59; Dof

= 3; I^2 = 95%; P < 0.001). No statistically significant differences was seen on analysis for age (X^2 = 2.13; Dof = 1; I^2 = 53%; P = 0.14), sex (X^2 = 0.79; Dof = 1; I^2 = 0%; P = 0.373), disease duration (X^2 = 0.06; Dof = 1; I^2 = 0%; P = 0.807), affected side (X^2 = 0.02; Dof = 1; I^2 = 0%; P = 0.879), or trigeminal branch involvement (X^2 = 0.67, Dof = 5, I^2 = 25%, P = 0.243).

Table 3. Complications following microvascular decompression (MVD)

Complication	n (%)
Facial hypoesthesia/paresthesia	254 (39)
CSF leak	109 (17)
Auditory alterations	44 (7)
Wound infection	33 (5)
Diplopia	27 (4)
Transitory Facial paralysis	22 (3)
Pseudomeningocele	14 (2)
Permanent auditory alterations	20 (3)
Intracranial bleeding	11 (2)
Chronic subdural hematoma	2 (0.31)
Teflon granuloma	2 (0.31)
Other*	117 (18)
Total	**655**

*Other: Dysphagia, hypertensive crisis, transitory ischemic attack (TIA), meningitis, dizziness, headache, nausea, loss of corneal reflex, masticatory weakness, dry eye, cerebellar dysfunction, diplopia, stroke

Nevertheless, the decision to conduct a formal meta-analysis was made upon revision of the findings from previous studies and our preliminary analysis of the variables most associated with either recurrence or failure. The following variables were analyzed: age (< 60 or > 60 years), disease duration (< 4 or > 4 years), offending vessel (artery, vein, and multiple compressions), and V2 involvement. We did not include patients without offending vessels in our analysis due to the small number of reported patients.

A random-effects meta-analysis was conducted on the offending vessels due to the high heterogeneity of our results. Arterial involvement vs. noninvolvement (OR = 0.39; 95% CI = 0.19–0.80; X^2 = 46.31; Dof = 15; I^2 = 68%; P = < 0.001) was shown to be the only factor associated with good outcomes following MVD. Contrarily, multiple-vessel compression resulted in an association with poor outcomes (OR = 2.72; 95% CI = 1.18–6.25; X^2 = 21.17; Dof = 9; I^2 = 57%; P = 0.01). Furthermore, when comparing venous vs. arterial compression patients who present with venous compression had less favorable outcomes (OR = 2.72;

Table 4. Characteristics of studies included for meta-analysis

Author	Year	n	Gender (W)	Age (mean)	Success rate (%)
Zacest [17]	2010	13	9	51.5	77
Chai [31]	2010	167	94	57.6	92
Chakravarthi [30]	2011	40	25	48	93
Hong [27]	2011	15	14	55.6	74
Yang [18]	2012	10	5	63.9	100
Leal [24]	2014	50	30	54.4	94
Kawano [26]	2014	70	44	60.4	67
Li [23]	2015	23	10	61.7	83
Duan [29]	2015	26	18	65.3	74
Dumot [28]	2017	55	25	46.6	71
Wang [20]	2017	164	98	63	58
Obata [14]	2018	51	26	61.94	91
Nunta-Aree [22]	2018	110	70	53.6	40
Zhao [15]	2018	13	9	58	100
Zhang [36]	2018	155	101	65.5	64
Abdulrauf [32]	2018	10	6	65,5	90
Kumar [25]	2019	53	32	51	95
Li [13]	2020	111	65	60	94
Shi [21]	2020	184	68	59	60
Wang [19]	2021	222	147	57	81
Abougamil [33]	2022	20	8	51	95

n, number; W, women.

Table 5. Variables associated with outcomes

Variable	Pain-free (n,%)	Failure or recurrence (n,%)	P
Age			0.14
< 60 years	139 (78)	37 (22)	
> 60 years	122 (85)	21 (15)	
Gender			0.37
Male	269 (74)	94 (26)	
Female	341 (71)	137 (29)	
Time TN			0.8
< 4years	117 (81)	27 (19)	
> 4years	103 (82)	22 (18)	
Vessel			< 0.0001
Artery	569 (81)	134 (19)	
Vein	91 (75)	31 (25)	
Mix	103 (57)	85 (43)	
None	15 (53)	13 (47)	
V2 involvement			0.7
Involvement	446 (79)	116 (21)	
No involvement	135 (78)	38 (22)	
Side			0.87
Right	196 (74)	67 (26)	
Left	193 (73)	68 (27)	

n, number; TN, trigeminal neuralgia.

95% CI = 1.16–6.38; X^2 = 23.23; Dof = 10; I^2 = 57%; P= 0.01).

For the remaining variables in the meta-analysis (age, disease duration, venous compression, and V2 involvement), a fixed-effects model was used because of low heterogeneity. However, no significant results were obtained for the remaining variables. Although when comparing age, patients >60 years of age presented a tendency towards better outcomes (OR = 0.60; 95% CI = 0.32–1.12; X^2 = 4.71; Dof = 7; I^2 = 0%; P = 0.70) (Table 5). The results of the meta-analysis and the forest plots are demonstrated in Figs. 4 and 5, respectively. The risk of bias was assessed by examining funnel plots for each analysis (Fig. 6).

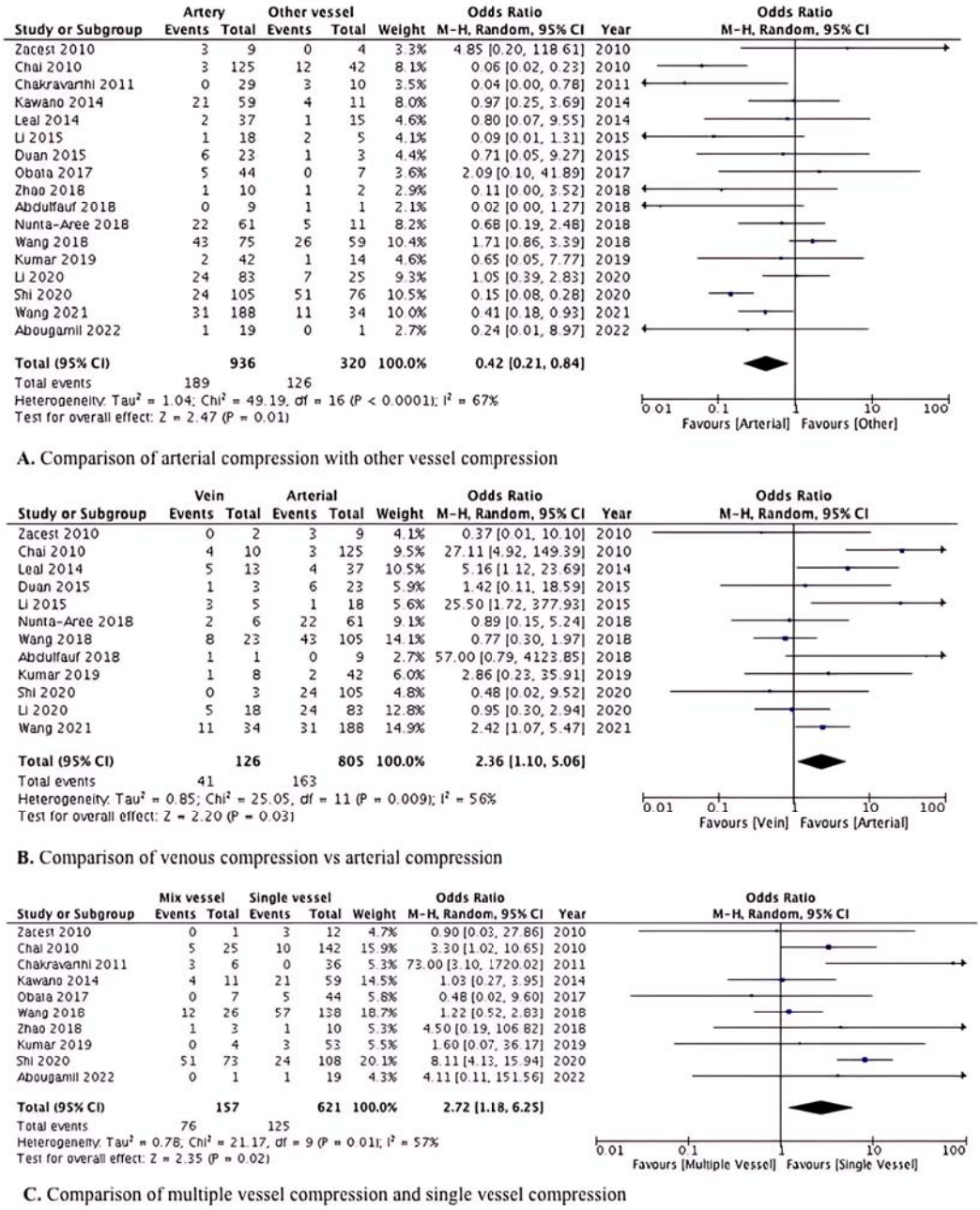
DISCUSSION

In this systematic review and meta-analysis, we analyzed the main factors influencing the outcomes after MVD. The most widely used pain assessment tool is the BNI-PS, followed by the NRS. The mean success rate of MVD in our study was 84%, which is consistent with the reports in the literature. In most reports, immediate post-operative relief ranges from 92% to 98% [62,63], while the success rate at long-term follow-up varies widely between studies, ranging from 73% to 85% at 1-year follow-up [54,55]. This consistently declines over longer follow-up periods, reaching a 64–73% success rate at 10 years [54,61,64]. Therefore, we decided to explore factors that may influence outcomes during a relatively long-term follow-up period. We found that arterial compression was consistently associated with good postsurgical outcomes, in addition to patients older than 60 years, who showed a tendency towards better pain outcomes. Conversely, multiple-vessel compression, when compared to single-vessel compression, and venous compression, when compared to arterial compression, were factors strongly associated with poor outcomes after MVD. Neither symptom duration nor V2 involvement were significantly predictive of outcomes after MVD.

1. Vessel compression

Arterial compression was the only factor under analysis related to favorable outcomes, which is consistent with reports in the current literature [65]. Additionally, when comparing venous compression with arterial compression alone, patients who underwent venous compression showed worse outcomes. This correlates with the results of the study by Nair et al. that found better outcomes in pain reduction after arterial compression than after venous compression [66,67]. This may be due to the grade of nerve atrophy and degree of compression in patients with arterial conflict. As shown in studies by Sindou et al. and Cheng et al., patients with a higher degree of compression, and hence a higher grade of nerve atrophy, had better outcomes [64,68]. This may explain why, even though arterial compression has a pulsatile nature and a higher force is applied by the muscular wall, patients experience better pain outcomes [66].

Similarly, patients with multi-vessel compression had a higher risk of recurrence. This was further evaluated



A. Comparison of arterial compression with other vessel compression

B. Comparison of venous compression vs arterial compression

C. Comparison of multiple vessel compression and single vessel compression

Fig. 4. Forest plot portraying analysis of factors associated with outcomes. (A) Comparison of arterial compression with other vessel compression. (B) Comparison of venous compression and arterial compression. (C) Comparison of multiple vessel compression and single vessel compression.

in a study by Raymond et al., in which the authors compared the outcomes of single compression with those of multiple-vessel compression. In this report, the authors concluded that patients with multiple vessel compression not only had a higher and earlier rate of recurrence but also a higher level of preoperative pain [69].

2. Disease progression

Multiple authors have previously evaluated disease progression and outcomes of patients who underwent PTN for 5–10 years before undergoing surgical treatment [70]. As MVD has become more widely available, patients tend to undergo surgical treatment at an earlier stage of the disease. Therefore, our study aimed to

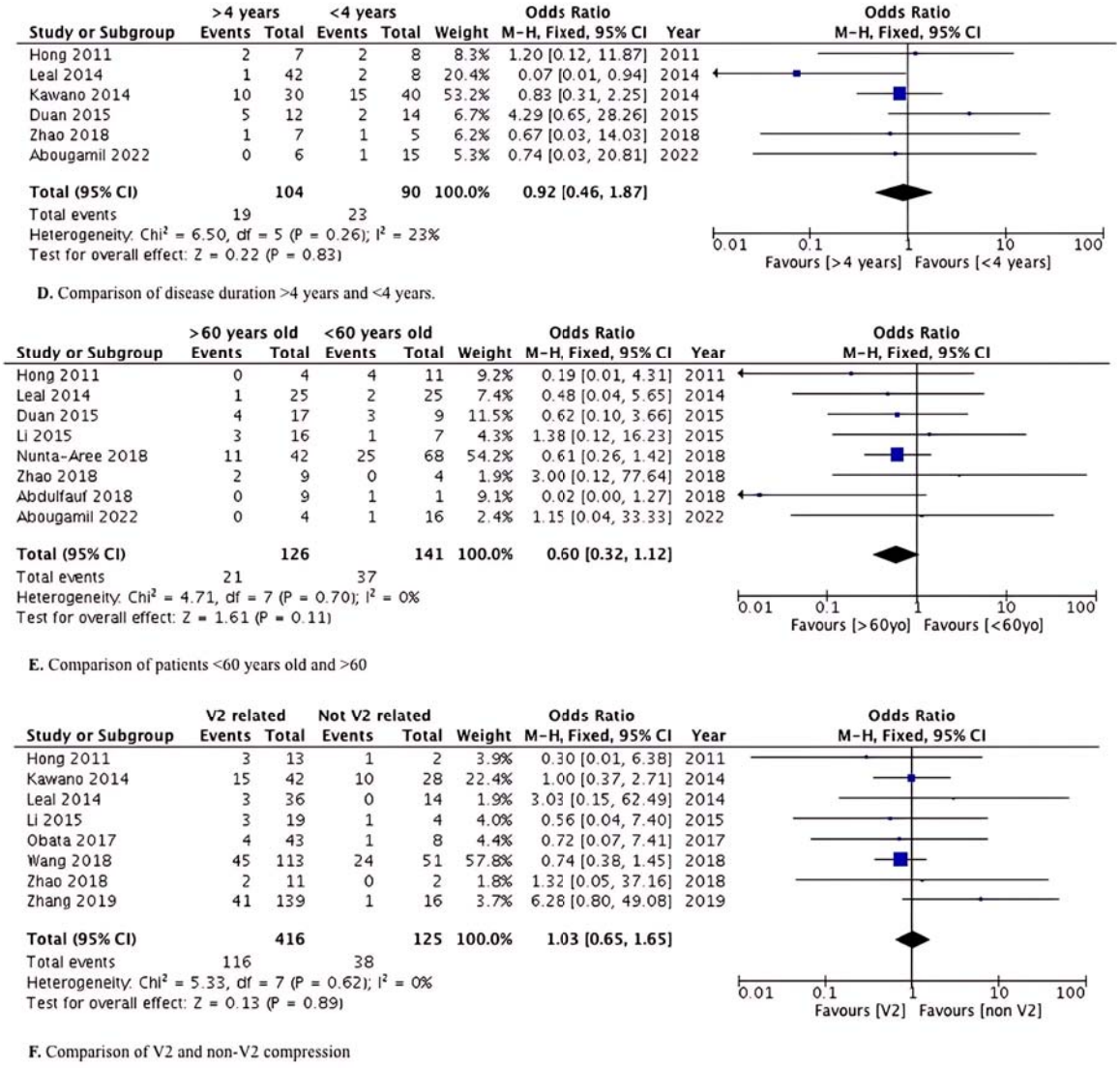


Fig. 5. Forest plot portraying analysis of factors associated with outcomes. (D) Comparison of disease duration > 4 years and < 4 years. (E) Comparison of patients < 60 years old and > 60 years. (F) Comparison of V2 and non-V2 compression.

evaluate disease evolution in patients living with PTN for < 4 years or longer than 4 years. In our study, disease progression of less than 4 years was not associated with significantly better outcomes. This may be due to the grade of nerve demyelination, which was not consistently found in our study, considering the mean time that patients presented with PTN before MVD. It is believed that demyelinated nerve fibers can become hyper-excitable, which may affect the patient response and outcomes after MVD [71].

Although there are no clear reasons for the demyelination present in CN V, we hypothesized that disease duration may influence this, thus making patients with longer disease durations more prone to recurrence. This is also represented by the study of Bederson et al., in which authors evaluated a cohort of 252 patients, and concluded that symptom duration of longer than 8 years had an impact on outcomes, while the worst outcomes were in patients with >13 years, contrasting with the ones with < 4 years of disease duration, which had the best outcomes following MVD [72].

3. Age as a factor for good prognosis

The dilemma of procedural risks and benefits for elderly

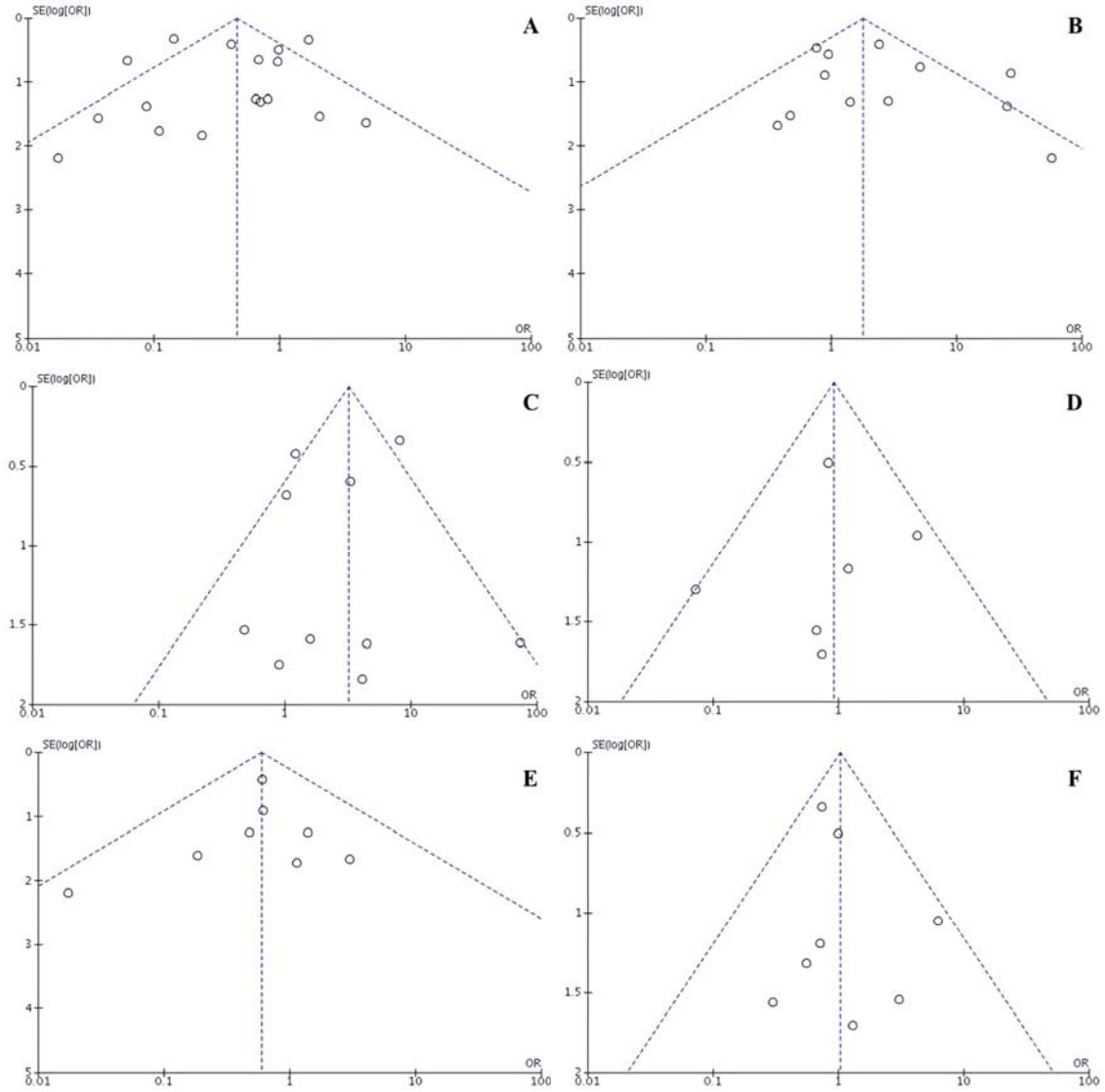


Fig. 6. Risk of bias assessment. Funnel plots for the studies included in each analysis. (A) Arterial compression with other vessel compression. (B) Venous compression and arterial compression. (C) Multiple-vessel compression and single-vessel compression. (D) Disease duration > 4 years and < 4 years. (E) Comparison of patients < 60 years old and > 60 years. (F) Comparison of V2 and non-V2 compression.

patients has been widely discussed. The intrinsic risks of craniotomy in this group of patients, in addition to a higher frequency of comorbidities, such as hypertension and diabetes, may predispose them to higher morbidity and mortality rates and may be associated with poor pain outcomes. This has been evaluated throughout the literature in studies such as the report by Yang et al. in which there were success rates after MVD of 93% and 92% for elderly and young patients, respectively, which is similar to other studies [41,73]. In our study, elderly patients showed a tendency towards better pain outcomes than younger patients, although no conclusive statements could be made, which has also been demonstrated in other clinical studies [73,74]. The reason for better outcomes may be the anatomical features that differ between the two age groups. Elderly patients present with pronounced atrophy of the cerebellum and widening of the cisterns, which allows for a larger space for exploration and decompression and should prevent cranial nerve traction injuries, improve pain outcomes, and decrease post-surgical complications directly associated with MVD [73].

4. Pain assessment

For patients with TN, despite wide developments in treatment strategies, there is still a great need for an adequate and standardized pain assessment strategy. Although there are a large number of studies, including the BNI-PS, there is still a lack of consensus on which values should be considered indicative of favorable or adverse outcomes, and most authors report outcomes according to their criteria. In addition, most of the studies included in the review did not measure or include pain assessment before the surgical procedure, for which it is complicated to determine whether pain was relieved or partially relieved, similar to previous reports [75]. The leading cause of inadequate pain assessment in patients with TN is the lack of consensus on the scale and parameters that define the outcomes [76]. Even though the multi-institutional Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) has proposed the following criteria when assessing pain and pain outcomes in patients with TN, little attention has been paid to this and validating existing questionnaires [5].

With regard to QOL, no single study included in this report assessed the effects of TN or MVD either preoperatively or postoperatively, which seems counterproductive as with chronic pain; QOL and its influencing factors are reported to be the first to show improvement after treatment [77]. Many scales have been proposed for the assessment of TN and its biopsychosocial effects, including the Brief Pain Inventory (BPI) and Penn Facial Pain Scale. Two recent studies explored the importance of content validity in TN. In a study by Symonds et al., the authors conducted interviews to adapt the Penn-FPS with patient content validity, which resulted in an adjusted version of the BPI and Penn-FPS with the retention of some of the original concepts, in addition to assessing the impact of weather/temperature and the inclusion of three concepts of QOL from the BPI (daily activities, mood, and relationships) [78]. While the TN Core Outcome Set (TRINCOS) study gathered patients, clinicians, and researchers to develop a core outcome set for patients under medical or surgical treatment for TN [79], they identified 11 outcomes that should be considered when treating patients with TN, including health-related quality of life, ability to participate in social roles and activities, and satisfaction with treatment [79]. Sufficient evidence emphasizes the importance of adequate pain assessment in patients with TN. Therefore, clinicians should avoid using pain scales without content validity, in which the only benefit over patient care is ease of use [5].

CONCLUSIONS

Our study had several limitations. Given that most of the included studies were retrospective, which seems to be consistent with neurosurgical studies, there is a risk of potential bias, given the strategies undertaken to collect data from patients. Second, there was a high level of heterogeneity in some of the analyses presented in our study, although this may be an intrinsic characteristic of meta-analyses of neurosurgery. Finally, the pain assessment strategies used in the studies varied according to the reviewed literature, which may have imposed bias when analyzing patient data. This systematic review and meta-analysis evaluated factors associated with outcomes following MVD for PTN. Factors associated with favorable outcomes were arterial compression and age >60 years, whereas multiple-vessel compression and venous compression, when compared to arterial compression, were factors associated with a poor outcome. Although MVD is a good treatment strategy for PTN, with a mean success rate of 84% at the 36-month follow-up, there is still a gap in interpreting the results when considering the lack of evidence in most pain assessment strategies.

Abbreviations

MVD, microvascular decompression; TN, trigeminal neuralgia; CN V, trigeminal nerve; PTN, primary

trigeminal neuralgia; BNI-PS, Barrow Neurological Institute pain scale; NRS, numerical rating scale; PFPS, Penn Institute Facial pain scale; BPI, Brief Pain Inventory; QOL, quality of life; SCA, superior cerebellar artery; AICA, anterior inferior cerebellar artery; VA, vertebral artery; BA, basilar artery; PICA, posteroinferior cerebellar artery; TA, trigeminal artery; SPV, superior petrosal vein; TPV, transverse petrosal vein; TGV, Trigeminovascular system

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2. Figure 1 was modified with text and annotation after adaptation of "Brain," "Brain Sections," and "Brainstem" from Servier Medical Art by Servier, licensed under a Creative Commons Attribution 3.0 Unported License"
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