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Meta-analysis in Emergency Medicine

Should we use cervical collars for neck stabilization in trauma patients? Evidence from a systematic review with meta-analysis

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Abstract

Introduction: The aim of this study was to evaluate the impact of neck stabilization with cervical collar on optic nerve strength diameter.

Methods: A literature search of PubMed, Scopus, EMBASE and Web of Science databases from their inception to December 22, 2021 was conducted. The search was conducted using the terms: "cervical collar" OR "collar" AND "intercranial pressure" OR "optic nerve strength diameter" OR "ONSD" OR "traumatic" OR "brain injury" and restricted to English language documents.

Results: The pooled analysis showed that optic nerve sheath diameter (ONSD) without collar was 4.5 ± 0.9mm. After insertion of the cervical collar and stabilization of the cervical spine for 20 minutes, an increase in ONSD was observed (4.9 ± 1.5mm; SMD = 0.89; 95%CI: 0.39 to 1.39; p =0.01). In clinical trial ONSD at baseline (4.8 ± 0.9mm) and 20-minutes after fitting the flange (5 ± 0.9mm; SMD = 0.22; 95%CI: -0.07 to 0.51; p =0.13). In experimental trials, the pooled analysis showed statistically significantly higher ONSD values for a 20-minute cervical collar application (4.86 ± 1.74 vs. 4.35 ± 0.91mm, respectively; SMD = 1.05; 95%CI: 0.46 to 1.65; p <0.001).

Discussion and Conclusion: Our meta-analysis showed that stabilizing the cervical spine with a cervical collar increases the intracranial pressure even in healthy volunteers, with the NextSplit collar being the least stressful. Large prospective, randomized studies are needed to confirm the obtained results.

Take-home message: Stabilizing the cervical spine with a cervical collar may increase the intracranial pressure even in healthy volunteers.

Key words: cervical collar; trauma patient; optic nerve strength diameter; ONSD; meta-analysis.

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INTRODUCTION

Stabilization of the cervical spine is one of the basic procedures used in pre-hospital management with trauma patients [1–3]. It is recommended for patients with suspected spinal cord injury and aims to reduce the risk of secondary spinal cord injury in this group of patients [4]. The history of activities aimed at protection against secondary spinal cord injuries during medical activities and the patient transport itself dates back almost half a century [5]. Currently, the procedure aimed at stabilizing the cervical spine using a cervical collar and an orthopaedic board can be found, among others, in the guidelines of Advanced Trauma Life Support (ATLS) [6] or Prehospital Trauma Life Support (PhTLS) [2]. There have been disputes regarding the validity of the routine use of cervical collars for many years because of the risk of increased intracranial pressure due to an impaired venous outflow of blood from the cranial cavity [7]. The simplest method of monitoring intracranial pressure is by ultrasound measurement of the thickness of the optic nerve sheath diameter (ONSD) [8]. Because the optic nerve is an extension of the central nervous system - the sheath of the nerve is made of the same meninges as the brain - any increase in intracranial pressure results in the displacement of fluid from the subarachnoid space into the optic nerve sheath, increasing its diameter [9]. Therefore, it is believed that acute and chronic diseases associated with ICP increase (e.g. idiopathic intracranial hypertension, craniocerebral trauma, intracranial haemorrhage, decompensated hydrocephalus) may lead to an increase in optic nerve diameter (ONSD) [10]. In turn, as indicated by research, among others, Wilson et al. low ONSD values may indicate intracranial hypotension [11]. Both experimental and human studies have shown an immediate change in ONSD corresponding to intracranial pressure changes [12].

With these premises, a systematic review and meta-analysis were conducted to evaluate the effect of cervical collar use on increased intracranial pressure.

METHODS

We conducted this systematic review and meta-analysis in accordance with the Preferred Reporting Items for Systematic Review and Meta-analysis (PRISMA) statement [13]. Due to the nature of the study (meta-analysis), the consent of the ethics committee was not required.

Inclusion and exclusion criteria

Studies included in this meta-analysis met the following PICOS criteria:

(1) PARTICIPANTS: patients over 18-years old;

(2) INTERVENTION: neck stabilization with cervical collar;

(3) COMPARISON: without cervical collar stabilization;

(4) OUTCOMES: optic nerve strength diameter;

(5) STUDY DESIGN: randomized controlled trials; observational trials; prospective trials.

Studies were excluded if they were reviews, case reports, conference, or poster abstracts or studies not containing original data.

Search strategy

For this purpose, two independent reviewers (MP, LS) systematically searched PubMed, Scopus, EMBASE and Web of Science from database inception to December 22, 2021 and retrieved only original studies. Full papers were then examined for eligibility. Disagreements were resolved by discussion. The search was conducted using the terms: "cervical collar" OR "collar" AND "intercranial pressure" OR "optic nerve strength diameter" OR "ONSD" OR "traumatic" OR "brain injury" and restricted to English language documents.

Data extraction

Screening and data extraction were carried out by FC and checked by GN. Authors extracted information on author(s), year of publication, population target, number of studies included, prevalence of BOS, whether a meta-analysis was conducted or not, quality assessment of the original studies, and overall findings.

Methodological quality

Two reviewers (MJ, MP) independently assessed the included studies. Disagreements were solved by consensus. Data heterogeneity and methodological quality of the included studies were assessed using The Newcastle-Ottawa Scale [14]. The scale is divided in three different sections: study selection; comparability and verification of exposure; and outcome investigated. Questions from each section were analyzed to receive a star/point. According the number of points received, cohort studies were categorized as following: 1) High risk of bias - up to 3 points; 2) Moderate risk of bias - 4–6 points and; 3) Low risk of bias - 7–9 points; and cross-sectional studies were categorized as following: 1) High risk of bias - up to 4 points; 2) Moderate risk of bias - 5–6 points; 3) Low risk of bias - 7–8 points; 4) Very low risk of bias - 9–10 points.

Data analysis

All analyses were performed using Cochrane Review Manager (ver.5.4EN). Continuous data were analyzed using an inverse variance model with a 95% CI, and values are reported as standardized mean difference (SMD) with a random-effects model. A level of significance of 0.05 was used for the statistical tests.

RESULTS

Description of the studies included

The literature search yielded 729 potentially relevant articles, of which 798 were ejected upon the title and abstract evaluation. The remaining 21 articles underwent full-text evaluation. Finally, only six trials met inclusion criteria and were included in the meta-analysis [7,8,15–18]. From those studies, one study was performed in a clinical setting, and the other five were performed on healthy volunteers (Figure 1). All studies presented low or very low risk of bias (Table 1).

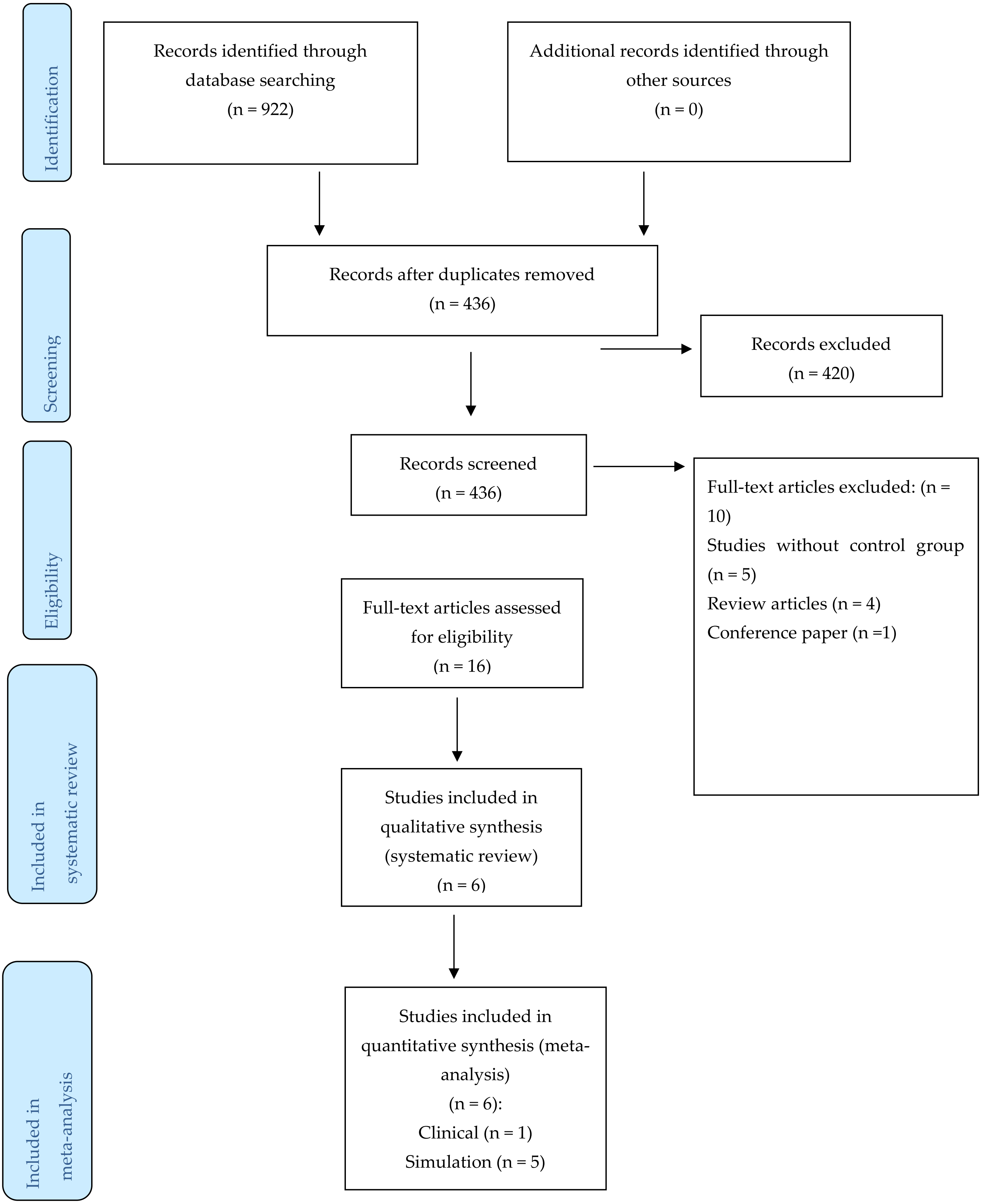
Identification
Records identified through database searching (n = 922)
Additional records identified through other sources (n = 0)
Screening
Records after duplicates removed (n = 436)
Records excluded (n = 420)
Eligibility
Records screened (n = 436)
Full-text articles excluded: (n = 10)
Studies without control group (n = 5)
Review articles (n = 4)
Conference paper (n =1)
Full-text articles assessed for eligibility (n = 16)
Included in systematic review
Studies included in qualitative synthesis (systematic review) (n = 6)
Included in meta-analysis
Studies included in quantitative synthesis (meta-analysis) (n = 6):
Clinical (n = 1)
Simulation (n = 5)

Figure 1. Flowchart for identification of studies included in the systematic review and meta-analysis (*n*=6).

Table 1. Characteristics of included trials (n=6).

Study	Country	Study design	No. of patients	Age, years	Sex, male
Colak et al. 2020 [15]	Turkey	Prospective clinical trial	94	42.0 ± 16.1	51 (54.3%)
Ladny et al. 2020 [16]	Poland	Prospective, crossover study involving volunteers	60	35.1 ± 3.6	39 (65.0%)
Szarpak et al, 2018 [18]	Poland	Prospective, crossover study involving volunteers	20	33.5 ± 2.3	20 (100%)
Woster et al. 2019 [8]	USA	Prospective, crossover study involving volunteers	20	37.1 ± 10.6	5 (25.0%)
Yard et al, 2019 [7]	USA	Prospective, crossover study involving volunteers	30	29.7 ± 4.57	21 (70.0%)
Özdoğan et al. 2019 [17]	Turkey	Prospective study involving volunteers	140	29.3 ± 6.27	70 (50.0%)

The pooled analysis showed that ONSD without collar was 4.5 ± 0.9mm. After insertion of the cervical collar and stabilization of the cervical spine for 20 minutes, an increase in ONSD was observed (4.9 ± 1.5mm; SMD = 0.89; 95%CI: 0.39 to 1.39; p =0.01).

The study by Colak et al. [15] reported ONSD at baseline (4.8 ± 0.9mm) and 20-minutes after fitting the flange (5 ± 0.9mm; SMD = 0.22; 95%CI: -0.07 to 0.51; p =0.13). Five studies [7,8,16–18] reported experimental trials on healthy participants. The pooled analysis showed statistically significantly higher ONSD values for a 20-minute cervical collar application (4.86 ± 1.74 vs. 4.35 ± 0.91mm, respectively; SMD = 1.05; 95% CI: 0.46, 1.65; p <0.001; Figure 2).

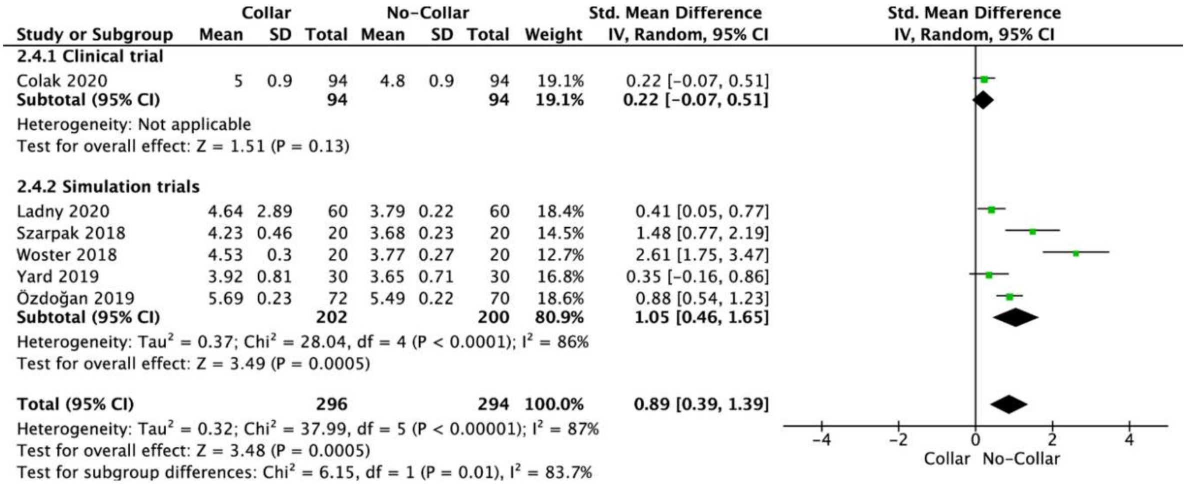

Figure 2. Forest plot of ONSD in the cervical collar vs. non-cervical collar groups. The square centers represent the weighted standard mean difference for individual trials, and the corresponding horizontal lines stand for the 95% CI. The diamonds represent pooled results. Legend: CI = Confidence Interval.

Additionally, an analysis was performed depending on the type of the cervical collar used. The analysis shows that the smallest changes in blood pressure were caused when the NeckLite collar was used (Figure 3).

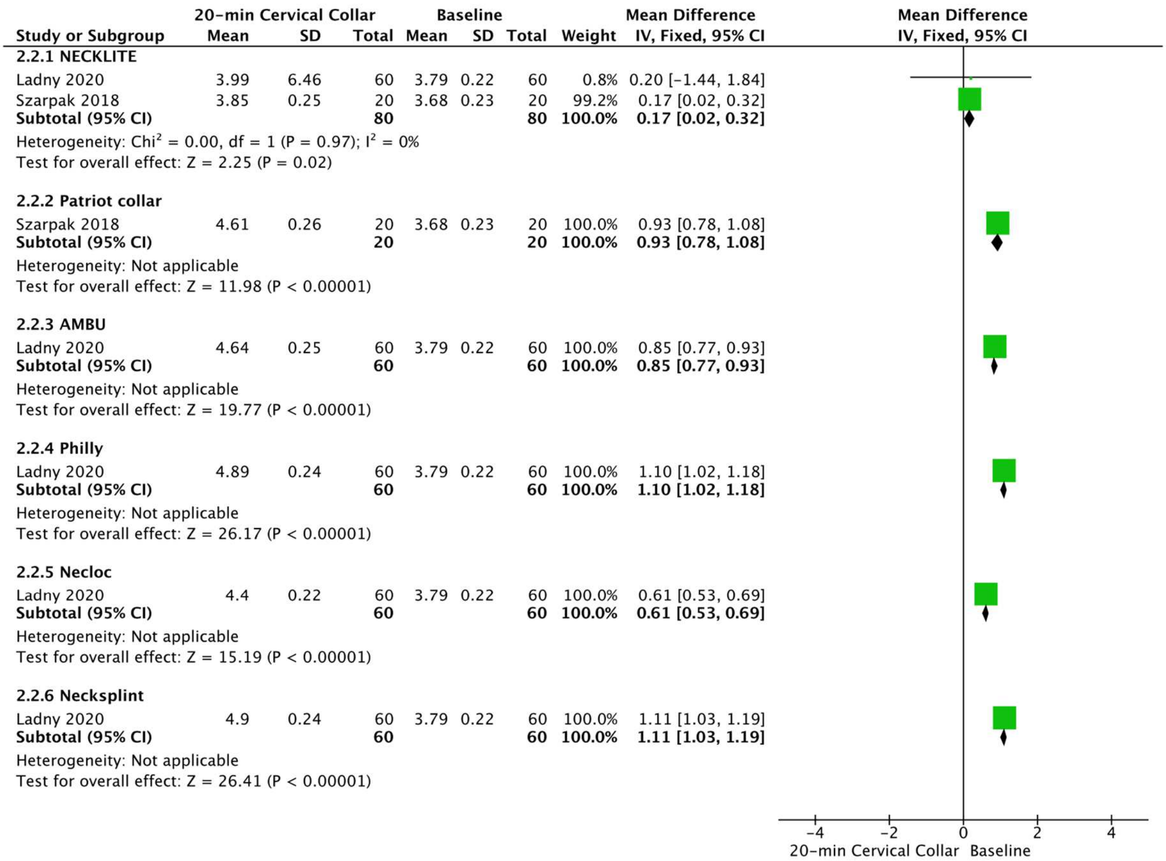

Figure 3. Forest plot of ONSD after 20-min of cervical collar application vs. baseline. The square centers represent the weighted mean difference for individual trials, and the corresponding

horizontal lines stand for the 95% CI. The diamonds represent pooled results. Legend: CI = confidence interval.

DISCUSSION

The performed meta-analysis showed that the use of cervical collars as a method of stabilizing the cervical spine results in a statistically significant increase in ONSD. Therefore, it can be concluded that it also influences the increase in intracranial pressure. The ATLS protocol assumes that all people with blunt trauma to the cervical spine have its trauma until the injury is definitively ruled out [19]. It is important to prevent unintentional damage to the cervical spine during rescue operations. That is why it is so important to stabilize the patient's head when examining and performing medical procedures. In recent years, numerous studies have appeared indicating the dangers of prolonged immobilization or an incorrectly selected cervical collar. As indicated by a systematic review by Oteir et al. There is a lack of high-level evidence on the effect of prehospital cervical spine immobilization on patient outcomes. Moreover, Otheri et al indicate that there is a clear need for large prospective studies to determine the clinical benefit of prehospital spinal immobilization as well as to identify the subgroup of patients most likely to benefit [20]. Similar views are made by the team of Sundstrøm et al [21]. They also add to the essential aspect - that prehospital management should, by no means, delay transportation of critically injured patients to definitive care.

The performed meta-analysis has both limitations and strengths. Among the limitations, we can mention, among others Only 6 studies were qualified for the study, of which five were experimental studies involving healthy protectors. However, as shown by previous systematic reviews, there is insufficient scientific evidence on the impact of using cervical collars in the setting of trauma patients. Among the strengths, it should be noted that this is the first meta-analysis showing the differences in the effect of flanges on ONSD depending on the type of flange used.

CONCLUSION

In summary, our meta-analysis showed that stabilizing the cervical spine with a cervical collar increases the intracranial pressure even in healthy volunteers, with the NextSplit collar being the least stressful. Large prospective, randomized studies are needed to confirm the obtained results.

Author Contributions: Conceptualization, study design, methodology, formal analysis, writing- original draft, writing- review & editing: ML, MP, LS. Search of articles: ML, MP. Data collection, writing- review & editing: LS, FC, GN. Resources, and supervision: LS. Supervision, formal analysis, writing- review & editing: LS, FC.

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Conflicts of Interest: None

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