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# **Title:** The Evaluation of the Effectiveness of Platelet-Rich Plasma (PRP) Administration in Treating Spinal Cord Injuries: A Systematic Review and Meta-Analysis of Preclinical Evidence

**Running Title**: Platelet-Rich Plasma Administration in Spinal Cord Injuries

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## Abstract

**Background**: The present systematic review and meta-analysis was designed to investigate platelet-rich plasma as an effective treatment for spinal cord injury in animal models.

**Method**: An extensive literature search was conducted using electronic databases. The included studies were summarized based on the investigated outcomes, including functional recovery and cavity size. Data were recorded as mean and standard deviation. The relationship between variables and the outcomes was investigated based on the "meta" command in the STATA 17.0 statistical program.

**Results:** In total, 9 articles were included in the present meta-analysis. Pooled data analysis showed that the administration of platelet-rich plasma significantly improved the motor function of animals (SMD= 1.5; 95%CI: 0.9 - 2.1; p< 0.0001). In subgroup analysis based on the severity of the injury, platelet-rich plasma administration significantly improved the motor function of animals in both moderate (SMD= 2.59l 95%CI: 1.59 - 3.59; p< 0.0001; $I^2$= 30.22%) and severe injuries (SMD= 1.22; 95%CI: 0.64 - 1.79; p< 0.0001; $I^2$= 56.35%); However, the recovery of function was significantly more in animals with moderate spinal cord injury (Meta-regression coefficient= -1.36; 95%CI: -2.68 - -0.09; p= 0.035). In the assessment of cavity size, pooled data analysis showed that PRP administration results in a significant reduction in cavity size (SMD= -2.2; 95%CI: -3.44 - -0.95; p< 0.0001).

**Discussion**: This meta-analysis showed that the administration of platelet-rich plasma can significantly improve motor function and reduce the cavity size in animals with moderate to severe spinal cord injuries.

**Keywords**: Spinal cord injury, Platelet-rich plasma, Functional recovery

## Introduction

Spinal cord injuries primarily affect young adults and thus have devastating physical, psychological, and social impacts. This condition places a substantial burden on healthcare systems (Badhiwala, Wilson, & Fehlings, 2019; James et al., 2019). SCI leads to sensory and/or motor deficits which often present as gait disturbances, loss of coordination, severe neuropathic pain, and incontinence. Despite advances in care, patients with spinal cord injuries often have a decreased quality of life and suffer more from morbidities due to subsequent chronic symptoms (Sezer, Akkuş, & Uğurlu, 2015).

The current management strategies for SCI involve surgery, symptomatic treatment, and physical rehabilitation (Walters et al., 2013). In the acute phase of the disease, the use of methylprednisolone is recommended during the first 8 hours. However, there is insufficient evidence to support the use of high-dose steroids after 8 hours following an acute SCI (Bracken, 2012). Although physical rehabilitation and other treatment strategies can relatively improve the complications caused by spinal cord injuries, patients often face serious lifelong disabilities and chronic morbidities. Research in this field is still in progress and various therapeutic strategies from the molecular, gene, or cellular therapy or even the use of high-tech equipment such as virtual reality have been recommended to ameliorate symptoms (Janzadeh et al., 2017; Mammana et al., 2019; Miguel-Rubio, Rubio, Salazar, Camacho, & Lucena-Anton, 2020; Nakhjavan-Shahraki et al., 2018; Sarveazad et al., 2017; Sarveazad et al., 2019; Silvestro, Bramanti, Trubiani, & Mazzon, 2020). However, advancing these treatment options for food and drug administration (FDA) approvals needs sufficient preclinical and clinical studies.

Platelet-rich plasma has recently received much attention as a potential candidate for the treatment of SCI. PRP contains several growth factors responsible for tissue regeneration and repair. The presence of growth factors and protective cytokines such as platelet-derived growth factor, transforming growth factor beta, fibroblast growth factor, insulin-like growth factor-1, insulin-like growth factor-2, vascular endothelial growth factor, epidermal growth factor, interleukin 8, keratinocyte growth factor and connective tissue growth factor makes PRP a suitable agent for the treatment of neurodegenerative and inflammatory diseases (Marx, 2004). In the pathophysiology of SCI, we observe the simultaneous occurrence of inflammation and neurodegeneration. In the acute phase of the disease, the presence of severe inflammation causes a cascade of pathophysiological events, which ultimately cause neurodegeneration and permanent lesions in the spinal cord (Alizadeh, Dyck, & Karimi-Abdolrezaee, 2019).

Recent research shows that PRP administration in the acute, subacute, and chronic phases of SCI improves locomotor function and reduces the occurrence of long-term side effects such as neuropathic pain (Salarinia et al., 2020; Salarinia et al., 2017). Administration of PRP improves angiogenesis and promotes axonal regeneration but does not have a significant effect on the immune system's reaction (Chen et al., 2018). Therefore, if it can be proven that PRP administration can prevent the occurrence of permanent damage in spinal cord injuries, it could be used as an easy and accessible treatment in the future. Moreover, the isolation and preparation of autologous PRP are simple and fast and these beneficial effects have created a promising window in the treatment of spinal cord injuries. Advances in the administration of PRP for spinal cord injuries are still in the pre-clinical phase and there is no conclusion on this matter. It is still not yet clear which treatment protocol of PRP has the best effectiveness, and the best time and method of administration are yet unknown. Therefore, to start clinical trials, it is necessary to provide valid pre-clinical evidence of PRP being a potential candidate for the treatment of SCI. The present systematic review and meta-analysis intended to collect preclinical evidence on the efficacy of different PRP administration protocols in spinal cord injuries, with an emphasis on functional recovery and cavity size. As an ancillary analysis, we assessed the effect of different PRP protocol treatments and the severity of spinal cord injury on the effectiveness of PRP treatment following spinal cord injury.

## Method

### Study design

The present systematic review and meta-analysis collected preclinical evidence on the effectiveness of PRP administration in spinal cord injuries with an emphasis on functional recovery and cavity size. For this purpose, an extensive search of the literature was conducted using the electronic databases of Medline, Embase, Scopus, and Web of science until 23rd October 2022. The search strategy was based on keywords related to platelet-rich plasma and SCI. The search strategy in the Medline database is presented in appendix 1.

### Inclusion criteria

The definition of PICO was as follows: Population: animals (rats or mice) with SCI caused by compression, contusion, transection, or hemi-section; Intervention: administration of PRP; Comparison: with a similar group that did not receive PRP and Outcome: functional recovery and cavity size. Based on this, studies conducted on animals with SCI for which PRP was administered have been included. Exclusion criteria were studies without a control group, review articles, and retracted studies.

**Data gathering**

Two independent researchers collected the data. After the search, articles were obtained from the mentioned databases and gray literature (Google and Google Scholar and the thesis section of the ProQuest database) in the 8th version of Endnote. These two researchers independently performed the initial screening process. The title and abstract of each article were reviewed, and if the article was relevant or likely to be relevant, the full text of the study was collected and studied; Then, the data of these studies were summarized in a checklist designed based on PRISMA guidelines. The extracted data included information about the study design, the characteristics of the sample and control groups (age, gender, etc.), the sample size, the type of SCI, the time interval from the occurrence of injury, and the administration of PRP, The dose of PRP, the location of SCI, the method of PRP administration and the follow-up period.

**Quality control**

The quality assessment of the articles was done by two researchers independently with the SYRCLE risk of bias tool (Hooijmans et al., 2014). In case of disagreement between the researchers, the disagreement was resolved through discussion with each other or with a third researcher.

**Statistical analyses**

The analyses were performed by the statistical program STATA 17.0. Data are recorded as mean ± standard deviation. The presence of heterogeneity has been investigated using the $I^2$ test. The relationship between the location of SCI, the severity of the injury, PRP dosage, PRP administration method and follow-up period, and the functional recovery and cavity size was assessed using the "meta" command. Egger's test and the funnel plot were also used to investigate publication bias.

## Results

The search resulted in 168 articles. After removing duplicates, 105 articles were advanced for screening. After reviewing the full text of 26 articles, the data from 9 original articles were included in the present meta-analysis (Behroozi, Ramezani, Janzadeh, Rahimi, & Nasirinezhad, 2021; Behroozi, Ramezani, & Nasirinezhad, 2022; Chen et al., 2018; EL-Seddawy, Samy, Mekkawy, Behery, & Youssef, 2020; Hu et al., 2022; Lam et al., 2016; Salarinia et al., 2020; Salarinia et al., 2017; Zhao et al., 2013) (Figure 1).

Out of these 9 articles, 8 articles were performed on rats and 1 article was performed on mice. The SCI model was carried out in the thoracic region of the spinal cord in all studies. The injury

model was compression in 3 studies, contusion in 4 studies, transection in 1 study, and hemi-section in 1 study. The severity of the injury was moderate in 3 studies and severe in 6 studies. Platelet-rich plasma was from human umbilical cord blood (xenograft) in 3 studies and peripheral blood (allograft/autograft) in 6 studies. In 5 studies, platelet-rich plasma administration was performed after 24 hours from the injury and in 3 studies during the first 24 hours. In 1 study, the intervention was done in two separate groups, less than 24 hours and after 24 hours from the time of injury. The follow-up period was more than 4 weeks in 6 studies and 4 weeks or less in 3 studies. The outcome in 7 studies was functional recovery, cavity size in one study. 1 article investigated the effect of PRP administration in both functional recovery and cavity size. In all included studies that examined functional recovery, this outcome was reported with the Basso Beattie and Bresnahan (BBB) scale. Table 1 shows the characteristics of the included articles.

**The effect of PRP administration on functional recovery**

A total of 8 articles examined functional recovery. Using the Galbraith plot to find the outlier data, it was found that the study of Seddawy et al. is an outlier; Therefore, it was excluded from the analysis. Eventually, 7 studies with 10 separate analyzes were included in the current meta-analysis. The results of the Pooled-data analysis showed that platelet-rich plasma administration has significantly improved the motor function of animals with SCI (SMD= 1.5; 95%CI: 0.9 - 2.1; p<0.0001). Due to the moderate heterogeneity ($I^2$= 67.01%), the subgroup analyses were performed (Figure 2).

In the subgroup analysis based on the severity of SCI, treatment with platelet-rich plasma in both moderate injuries (SMD= 2.59; 95%CI: 1.59 - 3.59; p<0.0001; $I^2$= 30.22%) and severe ones (SMD= 1.22; 95%CI: 0.64 - 1.79; p<0.0001; $I^2$= 56.35%) has been associated with a significant improvement in the motor function of animals; Although, the extent of this recovery in moderate injuries was significantly higher than the severe injury group (Meta-regression coefficient= -1.36; 95%CI: -2.68 - -0.09; p<0.035). Platelet-rich plasma from peripheral blood (SMD= 1.3; 95%CI: 0.62 - 1.97; p<0.0001; $I^2$=58.99%) and human umbilical-cord blood (SMD= 1.97; 95%CI: 0.63 - 3.3; p<0.0001; $I^2$= 80.74%) were both effective in improving the motor function of animals; However, no significant difference was observed between the two groups (Meta-regression coefficient = 0.62; 95% CI: -0.69 - -1.94; p = 0.35). Platelet-rich plasma administration in the first 24 hours after SCI (SMD = 0.86; 95% CI: 0.17 - 1.56; p = 0.015; $I^2$ = 32.36%) and after 24 hours (SMD= 1.87; 95%CI: 1.11 - 2.64; p<0.0001; $I^2$= 67.93%) both were effective in improving the motor function of animals. Meta-regression showed that there is no significant difference between the administration of platelet-rich plasma

in the first 24 hours and after 24 hours from injury (Meta-regression= 0.96; 95%CI: -0.16 - 2.09; p=0.09). Finally, there was no significant difference in regard to the follow-up period (Meta-regression coefficient= 0.33; 95%CI: -1.07 - 1.74; p=0.64) (Table 2).

**The effect of PRP administration on cavity size**

In this section, 2 articles and 3 analyses were included. Pooled-data analysis showed that PRP administration significantly reduces the cavity size in animals with SCI (SMD= -2.2; 95%CI: -3.44 - -0.95; p<0.0001) (Figure 3).

**Quality control**

In the quality control assessment section, none of the included articles reported housing randomization or random outcome assessment; Therefore, the risk of bias was considered unclear in these items. The risk of bias was low in other items in the included articles. Generally, the quality of data was considered fair (Table 3).

**Publication bias**

Egger's test showed that there is no publication bias in the reports of functional recovery (p=0.64) (Figure 4). Since the assessment of cavity size was reported in 3 analyses, publication bias assessment was not feasible in terms of methodology.

## Discussion

The purpose of this meta-analysis was to investigate the effectiveness of platelet-rich plasma administration in the treatment of spinal cord injuries. By analyzing the data of current original studies, we showed that PRP administration can significantly improve motor functions and cavity size after SCI. However, there was considerable heterogeneity in the findings of the articles. To find the cause of this heterogeneity, a subgroup analysis on the severity of the SCI, the origin of PRP, the time elapsed from the injury to the administration of PRP, and the length of follow-up was performed. According to these analyses, the severity of injury was the reason of heterogeneity in the articles.

The studies that were conducted on moderate spinal injuries had significantly less heterogeneity than the studies that were conducted on severe injuries. Although the improvements of motor function were significant in both moderate and severe injuries, the improvement of motor function in animals with moderate SCI was significantly higher than in animals with severe SCI. In addition to the fact that even in the absence of therapeutic intervention, moderate SCI has a better outcome than severe injury, it should be noted that the low number of analyses that were performed on moderate spinal cord injuries can be one of the reasons that we observed a significant difference.

Our study showed that the studies that used the peripheral blood of animals for the preparation of PRP had a lower heterogeneity than the studies that used human umbilical-cord blood. Although the difference between the two groups was not significant, the extent of improvement in the motor function of animals using human umbilical-cord blood was higher than the other group. The results of the grouping of articles based on the allograft/autograft and xenograft transplantation were completely the same as the grouping based on the origin of PRP.

Cell damage and the activation of inflammatory cascades in the spinal cord, by inactivating growth factors, stem cells in the injury site, reducing the activity of glial cells and increasing the activity of macrophages is responsible for the formation of scar tissue and preventing an effective regeneration of nervous tissue (Pang et al., 2021). Current treatment strategies, both in medical treatments and surgical interventions, emphasize the greater effect of treatment in faster interventions. For example, current findings emphasize the high effectiveness of spinal decompression surgeries in the first 24 hours after SCI (Li, Walker, Zhang, Shields, & Xu, 2014; Yousefifard et al., 2017). Moreover, even more recent review studies consider surgical intervention in the first 12 hours after SCI to be more effective (Yousefifard et al., 2022). Nonetheless, the evidence of greater effectiveness of platelet-rich plasma administration after 24 hours of SCI is notable in the present study.

To illustrate this more, it can be pointed out that the environment of SCI is not suitable for the survival of growth factors in the acute phase of injury due to severe inflammation (Garcia, Aguilar-Cevallos, Silva-Garcia, & Ibarra, 2016). Since the effect of PRP administration on the immune response is a matter of debate (Chen et al., 2018), therefore, the possibility of intensification of the immune response due to inflammation could reduce the survival and effectiveness of PRP growth factors in the acute phase. As a result, it seems that the administration of PRP after 24 hours of injury is a potentially suitable treatment in improving motor function following SCI.

In review studies, the intervention group and the control group are not controlled by the researcher, so it is not possible to match the confounding variables between the studied groups. In the included studies, the type and duration of antibiotic treatment have been variable. Also, one of the included studies was conducted on mice, and other studies on rats. The site of PRP administration in all studies was intra-spinal while it was intra-thecal in one study. The number of platelets in the administered PRP was not mentioned in 4 studies. In all mentioned cases, it was not possible to group the findings due to the low number of analyses.

## Conclusion

The findings of the present meta-analysis showed that PRP administration significantly improves the motor function of animals and the cavity size following SCI. Also, the present study shows the necessity of designing and implementing more comprehensive prospective studies to investigate the effectiveness of platelet-rich plasma treatment in spinal cord injuries. In addition, it is necessary to investigate the effectiveness of this treatment on other outcomes such as pain and inflammation following SCI.



### Highlights

- The administration of PRP improves the motor function of rodents with spinal cord injury.
- The administration of PRP reduces the cavity size in spinal cord injury.
- Treatment with PRP is more effective in moderate spinal cord injuries.

### Plain Language Summary

Spinal cord injury mostly affects the populations in the both ends of the age spectrum, the younger population and the elderly. Since the injuries to the spinal cord can cause debilitating, long-lasting complications, it is important to try to discover new strategies to minimize the effect of this disease on society. There are several treatment strategies for spinal cord injuries available, most of which focusing on conservative and symptomatic treatments. Therefore, researchers have turned to novel strategies, including the stem cell and molecular therapies, which their efficacy has been shown in the improvement of chronic conditions. Human blood is a rich source of proteins that enhance tissue regeneration and platelets are known to be one of the responsible cells for their production. Thus, separating these cells and molecules and administering them in the spinal cord injury could have beneficial effects. We need to gather all data provided before us, and try to reach a conclusion with what we have, and try to find the gaps of knowledge to guide other researchers redirect their point of focus. Therefore, we summarized previous studies conducted on the outcome of spinal cord injuries, after platelet-rich plasma administration. In conclusion, we showed that this treatment strategy has beneficiary effects on the movement of rodents and reduced the size of the injured tissue in the spinal cord. However, considering the low number of studies conducted on this matter, more comprehensive studies are needed to confirm our findings.

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**Conflict of interests**

All authors declared that there is no conflict of interests.

**Authors' contributions**

Study design: All authors

Data analysis: MY

Drafting: MY, AT, HAR

Revising: All authors

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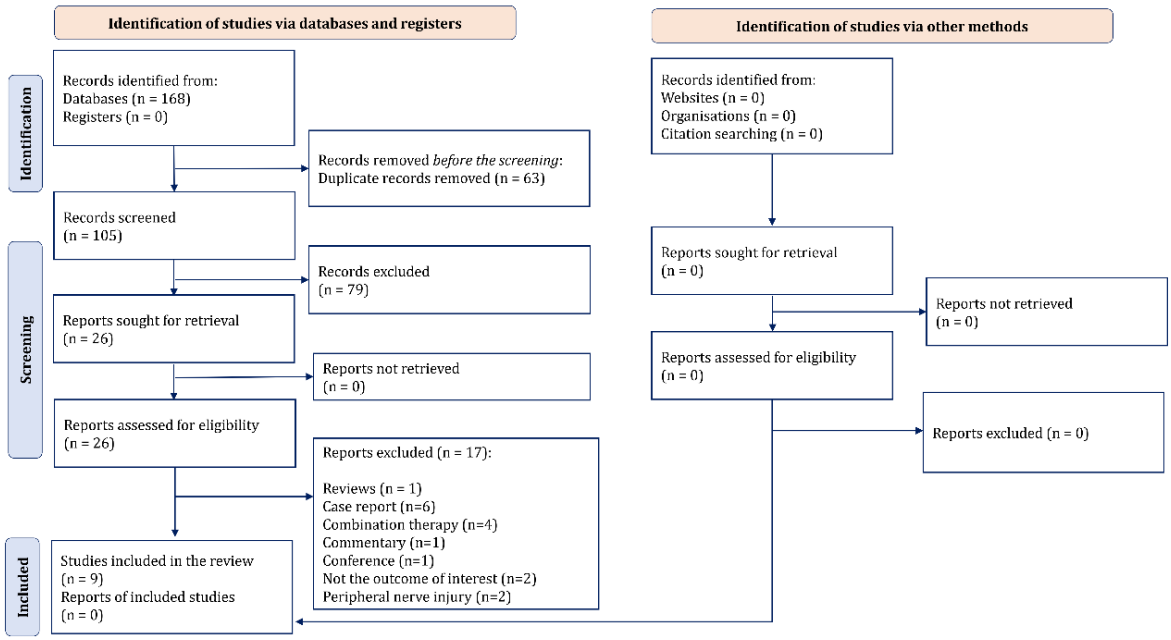


**Figure 1**: PRISMA flow-diagram of the article selection process

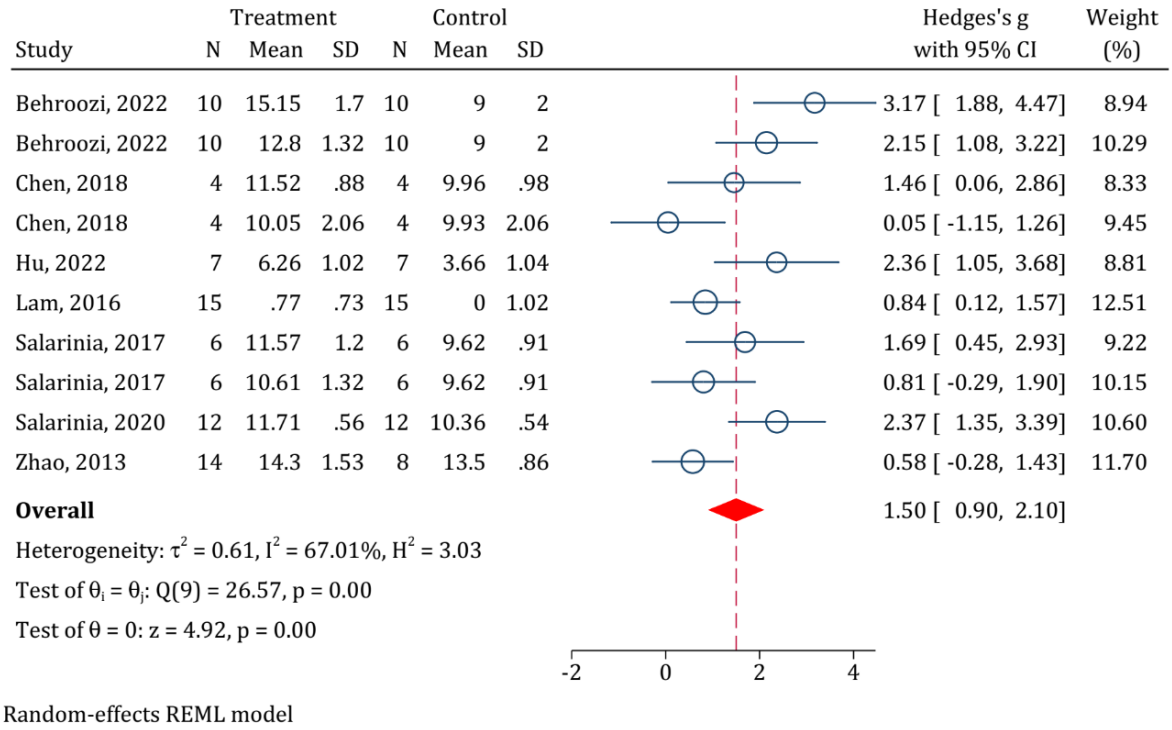


**Figure 2**: Pooled-data analysis for the assessment of functional recovery following SCI

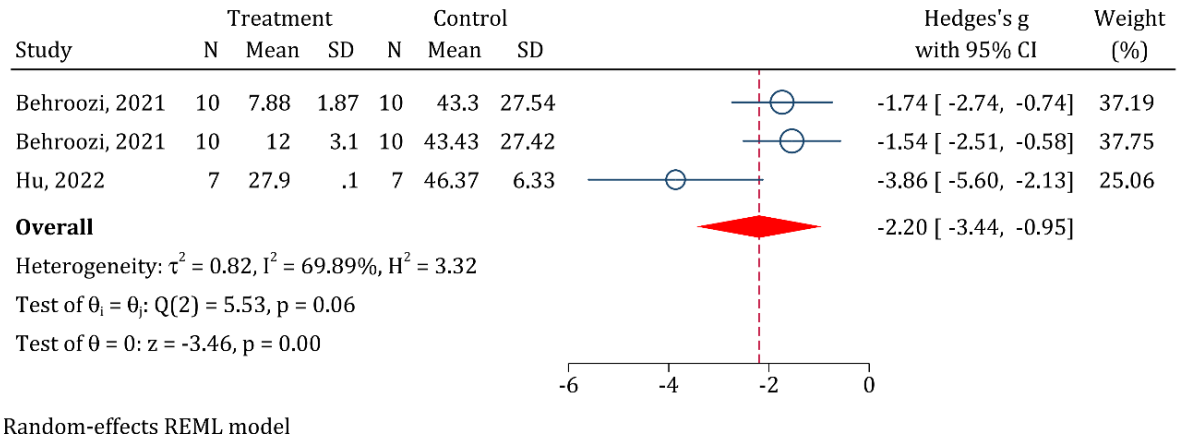


**Figure 3**: Pooled-data analysis for the assessment of cavity size following SCI

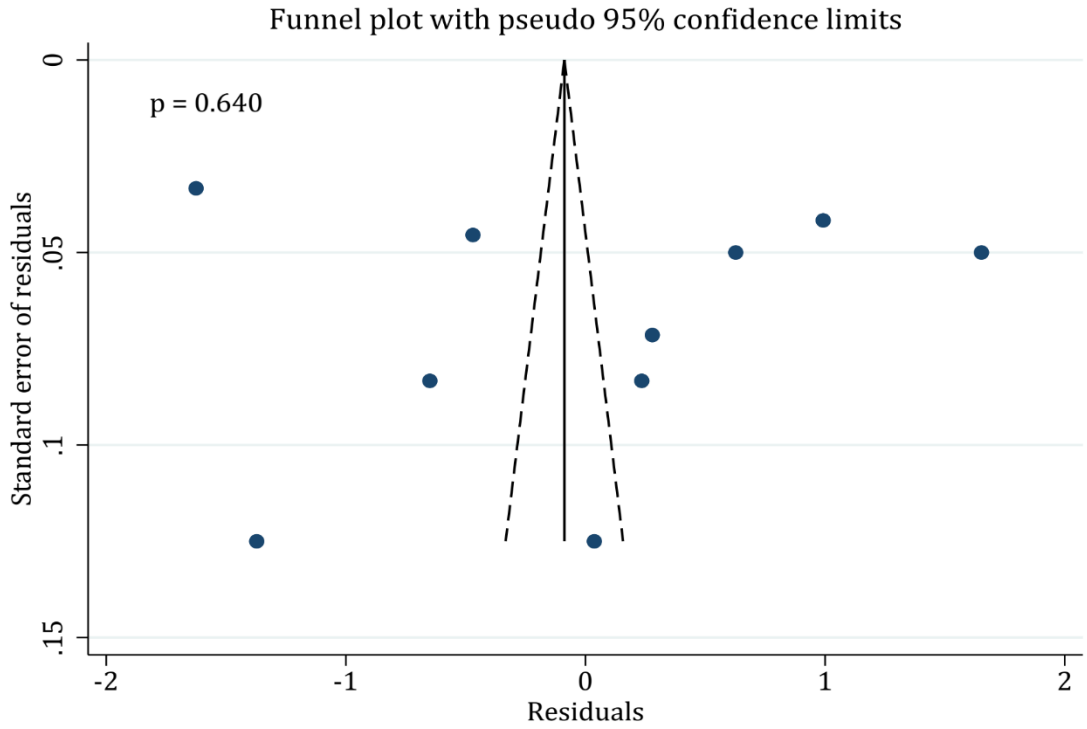


**Figure 4**: Funnel plot with pseudo 95% confidence interval in the assessment of publication bias

**Table 1**: Characteristics of the included studies

| Study | Injury level | Injury model | Severity | Antibiotics | Species | Strain | Sex | Origin of PRP | Days to injection | Site of injection | Total volume | Platelet number (*$10^6$) | Follow-up (weeks) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Behroozi, 2021 | T12-T13 | Compression | Moderate | Tetracycline | Rat | Wistar | M | hUCB | 2, 14 | Intra-spinal | 6 µl | 1000 | 6 |
| Behroozi, 2022 | T12-T13 | Compression | Moderate | Tetracycline | Rat | Wistar | M | hUCB | 2, 14 | Intra-spinal | 6 µl | 1000 | 6 |
| Chen, 2018 | T10 | Contusion | Severe | Cephalosporine | Rat | Wistar | F | Peripheral blood | 0 | Intra-thecal | 10 µl | 4800, 9600 | 4 |
| Hu, 2022 | T10 | Contusion | Severe | Penicillin | Rat | SD | M | Peripheral blood | 3 | Intra-spinal | 10 µl | NR | 4 |
| Lam, 2016 | T8-T10 | Transection | Severe | Penicillin | Mice | NR | NR | hUCB | 7 | Intra-spinal | 20 µl | NR | 5 |
| Salarinia, 2017 | T10 | Contusion | Severe | Cefazolin | Rat | Wistar | M | Peripheral blood | 1, 7 | Intra-spinal | 5 µl | NR | 5 |
| Salarinia, 2020 | T10 | Contusion | Severe | Cefazolin | Rat | Wistar | M | Peripheral blood | 7 | Intra-spinal | 10 µl | NR | 5 |
| Seddawy, 2020 | T9 | Compression | Moderate | Gentamicin | Rat | SD | F | Peripheral blood | 0 | Intra-spinal | 100 µl | 4800 | 4 |
| Zhao, 2013 | T10 | Hemi-section | Severe | Penicillin | Rat | SD | F | Peripheral blood | 0 | Intra-spinal | 15 µl | 3000 | 8 |

T: Thoracic vertebrae; SD: Sprague-Dawley; M: Male; F: Female; hUCB: human Umbilical-Cord Blood

**Table 2**: Sub-group analysis to investigate the relationship between different variables in functional recovery

| Variable | Subgroups | No. of analyses | SMD [95% CI] | p | Heterogeneity | Meta-regression coefficient | p |
|---|---|---|---|---|---|---|---|
| **Severity** | | | | | | | |
| | Severe | 8 | 1.22 [0.64 – 1.79] | <0.0001 | 56.35% | -1.39 [-2.68 - -0.098] | 0.035 |
| | Moderate | 2 | 2.59 [1.59 – 3.59] | <0.0001 | 30.22% | | |
| **Origin of PRP** | | | | | | | |
| | Peripheral blood | 7 | 1.30 [0.62 – 1.97] | <0.0001 | 58.99% | 0.62 [-0.69 to 1.94] | 0.354 |
| | Human umbilical-cord blood | 3 | 1.97 [0.63 – 3.30] | 0.004 | 80.74% | | |
| **Type of graft** | | | | | | | |
| | Allograft/Autograft | 7 | 1.30 [0.62 – 1.97] | <0.0001 | 58.99% | 0.62 [-0.69 to 1.94] | 0.354 |
| | Xenograft | 3 | 1.97 [0.63 – 3.30] | 0.004 | 80.74% | | |
| **Injury to intervention** | | | | | | | |
| | ≤ 24 hours | 4 | 0.86 [0.17 to 1.56] | 0.015 | 32.36% | 0.96 [-0.16 to 2.09] | 0.093 |
| | > 24 hours | 6 | 1.87 [1.11 to 2.64] | <0.0001 | 67.93% | | |
| **Follow-up duration** | | | | | | | |
| | ≤ 4 weeks | 3 | 1.26 [-0.08 to 2.61] | 0.066 | 68.92% | 0.33 [-1.07 to 1.74] | 0.64 |
| | > 4 weeks | 7 | 1.59 [0.88 to 2.29] | <0.0001 | 70.30% | | |

**Table 3**: Quality control of the included articles

| No. | Study | Item 1 | Item 2 | Item 3 | Item 4 | Item 5 | Item 6 | Item 7 | Item 8 | Item 9 | Item 10 | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Behroozi, 2021 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **2** | Behroozi, 2022 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **3** | Chen, 2018 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **4** | Hu, 2022 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **5** | Lam, 2016 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **6** | Salarinia, 2017 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **7** | Salarinia, 2020 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **8** | Seddawy, 2020 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |
| **9** | Zhao, 2013 | Low | Low | Low | Unclear | Low | Unclear | Low | Low | Low | Low | Fair |

Low: Low risk of bias

Item 1. Was the allocation sequence adequately generated and applied?

Item 2. Were the groups similar at baseline or were they adjusted for confounders in the analysis?

Item 3. Was the allocation adequately concealed?

Item 4. Were the animals randomly housed during the experiment?

Item 5. Were the caregivers and/or investigators blinded from knowledge which intervention each animal received during the experiment?

Item 6. Were animals selected at random for outcome assessment?

Item 7. Was the outcome assessor blinded?

Item 8. Were incomplete outcome data adequately addressed?

Item 9. Are reports of the study free of selective outcome reporting?

Item 10. Was the study apparently free of other problems that could result in high risk of bias?

**Appendix 1**: Search strategy in the Medline database

1- Spinal Cord Injuries[mh] OR Spinal Cord Compression[mh] OR Central Cord Syndrome[mh] OR Spinal Cord Injuries[tiab] OR Spinal Cord Compression[tiab] OR Central Cord Syndrome[tiab] OR Spinal Cord Trauma[tiab] OR Cord Trauma, Spinal[tiab] OR Cord Traumas, Spinal[tiab] OR Spinal Cord Traumas[tiab] OR Trauma, Spinal Cord[tiab] OR Traumas, Spinal Cord[tiab] OR Myelopathy, Traumatic[tiab] OR Myelopathies, Traumatic[tiab] OR Traumatic Myelopathies[tiab] OR Traumatic Myelopathy[tiab] OR Injuries, Spinal Cord[tiab] OR Cord Injuries, Spinal[tiab] OR Cord Injury, Spinal[tiab] OR Injury, Spinal Cord[tiab] OR Spinal Cord Injury[tiab] OR Spinal Cord Transection[tiab] OR Cord Transection, Spinal[tiab] OR Cord Transections, Spinal[tiab] OR Spinal Cord Transections[tiab] OR Transection, Spinal Cord[tiab] OR Transections, Spinal Cord[tiab] OR Spinal Cord Laceration[tiab] OR Cord Laceration, Spinal[tiab] OR Cord Lacerations, Spinal[tiab] OR Laceration, Spinal Cord[tiab] OR Lacerations, Spinal Cord[tiab] OR Spinal Cord Lacerations[tiab] OR Post-Traumatic Myelopathy[tiab] OR Myelopathies, Post-Traumatic[tiab] OR Myelopathy, Post-Traumatic[tiab] OR Post Traumatic Myelopathy[tiab] OR Post-Traumatic Myelopathies[tiab] OR Spinal Cord Contusion[tiab] OR Contusion, Spinal Cord[tiab] OR Contusions, Spinal Cord[tiab] OR Cord Contusion, Spinal[tiab] OR Cord Contusions, Spinal[tiab] OR Spinal Cord Contusions[tiab] OR Compression, Spinal Cord[tiab] OR Compressions, Spinal Cord[tiab] OR Spinal Cord Compressions[tiab] OR Myelopathy, Compressive[tiab] OR Compressive Myelopathy[tiab] OR Spinal Cord Compression, Extramedullary[tiab] OR Extramedullary Spinal Cord Compression[tiab] OR Conus Medullaris Syndrome[tiab] OR Conus Medullaris Syndromes[tiab] OR Syndrome, Conus Medullaris[tiab] OR Syndromes, Conus Medullaris[tiab] OR Central Spinal Cord Syndrome[tiab] OR Central Cord Injury Syndrome[tiab]

2- Platelet-rich plasma[mh] OR Platelet-rich plasma[tiab] OR Plasma, Platelet-Rich[tiab] OR Platelet Rich Plasma[tiab]

3- #1 AND #2