

# Platelet-Rich Plasma in Plastic Surgery: A Systematic Review

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## Keywords

Autologous blood products · Healing · Therapy

## Abstract

**Introduction:** Platelet-rich plasma (PRP) is gaining popularity and is applied in a variety of clinical settings. This review aims to present and evaluate available evidence regarding the use of PRP in various applications in plastic surgery.

**Methods:** PubMed, Web of Science, Medline, and Embase were searched using predefined MeSH terms to identify studies concerning the application of PRP alone or in combination with fat grafting for plastic surgery. The search was limited to articles in English or German. Animal studies, in vitro studies, case reports, and case series were excluded.

**Results:** Of 50 studies included in this review, eleven studies used PRP for reconstruction or wound treatment, eleven for cosmetic procedures, four for hand surgery, two for burn injuries, five for craniofacial disorders, and 17 as an adjuvant to fat grafting. Individual study characteristics were summarized. Considerable variation in preparation protocols and treatment strategies were observed. Even though several beneficial effects of PRP therapy were described, significance was not always demonstrated, and some studies yielded conflicting results. Efficacy of PRP was not universally proven in every field of application. **Conclusion:** This study presents an overview of current PRP treatment options and outcomes in plastic surgery. PRP may be beneficial for some indications explored in this review; however, currently available data are insufficient and systematic evaluation is limited

due to high heterogeneity in PRP preparation and treatment regimens. Further randomized controlled trials employing standardized protocols are warranted.

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## Introduction

Over the past years, autologous platelet-rich plasma (PRP) has gained significant attention among various medical specialties, including, but not limited to, orthopedics, dermatology, gynecology, oro-maxillofacial surgery, and plastic surgery. PRP has been applied in a variety of clinical settings based on the assumption that it stimulates tissue regeneration, among other postulated positive effects, due to the presence of growth factors and cytokines [1].

The anticipated impact on tissue repair drives increased consideration for use of PRP in treating chronic wounds, burn injuries, and scars, hence establishing a promising supplemental approach in reconstructive plastic surgery. The application of PRP has also become more frequent in aesthetic surgery, i.e., in facial rejuvenation or in treatment of alopecia [2]. As a carrier-containing anti-inflammatory mediator, PRP is believed suppress inflammation in osteoarthritis, thereby promoting cartilage repair and temporizing pain [3]. In addition, PRP is used in bone grafting to support osseointegration and increase the odds of graft survival [4]. PRP is also introduced as an adjuvant to lipofilling since it is theorized to increase fat

graft survival rates [5]. In addition to its beneficial therapeutic effects, it is easily obtained and cost-effective.

Despite increasing clinical popularity, the efficacy of PRP remains controversial due to the lack of consistent data and discord among researchers concerning the classification of PRP. Even though PRP is employed in a variety of medical fields, such as the different pillars of plastic surgery, current studies show notable inhomogeneity concerning the preparation process, control groups (CGs), and objective outcomes [6]. The purpose of this study was to demonstrate the current role of PRP and its application in plastic surgery, identify different techniques of preparation, and present current evidence for the use of PRP.

## Background

PRP is defined as the portion of the plasma fraction of blood with a platelet count above baseline [7]. Platelets carry secretory alpha granules, which release a high number of biologically active proteins including platelet-derived growth factor (PDGF), epidermal growth factor, basic fibroblastic growth factor, vascular growth factor, transforming growth factor, and fibroblast growth factor. As a result, tissue regeneration and remodeling, angiogenesis, re-epithelialization, and collagen formation are promoted [6].

The preparation process for PRP varies since no standardized protocol has been established so far. The procedure involves drawing venous blood – in most cases a small volume between 5 and 50 mL – followed by centrifugation. The duration, force, and number of centrifugation cycles depend on the device. This step separates the blood in the tube into three different layers: red and white blood cells (bottom), PRP (middle), and platelet-poor plasma (PPP, top). After extracting the platelet-rich component, platelets can be activated by adding thrombin (Thrb) and calcium chloride (CaCl). However, some authors argue that this step is not a requirement [2]. Anticoagulation is necessary to stabilize the platelets and prevent clotting. In most cases, the tube used for the venipuncture already contains an anticoagulant coat [5].

Various classification systems for different types of PRP and platelet-rich concentrations in general have been proposed, but there is still no consensus on which classification system is the most suitable. One of the most common classification systems was established by Dohan Ehrenfest et al. [65]. The authors suggested dividing PRP into four main groups, depending on the presence of white blood cells (leucocyte rich or poor) and the density of the fibrin network (high or low density). The classification system according to Mishra et al. [66] separates PRP in four different categories as well. The most important

factors for this classification are the platelet concentration and the absence or presence of leucocytes [8]. The DEPA classification by Magalon et al. [67] which was introduced in 2016 is based on the dose of platelets injected, as well as the efficiency, purity, and activation of PRP [2]. Recently, Lana et al. [8] proposed a new classification system called “MARSPILL,” which is based on eight parameters concerning the preparation and application of PRP: method (automated or handmade), activation, red blood cells (rich or poor), spin (one or two spins), platelet number, image guidance, leucocyte concentration, and light activation.

The hypothesis that the growth factors and cytokines provided by PRP support tissue regeneration, thereby restoring structure and function, has been confirmed in various in vitro studies and animal models. These effects may provide a major advantage in clinical settings of plastic surgery, since effective union of damaged tissue is crucial for satisfactory clinical outcome in this field. PRP has emerged as a promising treatment approach in various areas and subdomains of plastic surgery; however, the extent of its clinical efficacy remains uncertain due to lack of standardized research [9]. We performed a systematic review in order to present the currently available studies on PRP therapy within all branches of plastic surgery, evaluate evidentiary support for the efficacy of PRP treatment, and discuss preparation methods.

## Materials and Methods

### *Literature Search*

The databases PubMed, Web of Science (core collection), Embase, and Medline (via Ovid) were queried for studies concerning the therapeutic use of PRP in plastic surgery. A systematic search was performed until the December 1, 2021. To cover all pillars of plastic surgery, the following subject headings were used:

“Plastic surgery” OR “aesthetic surgery” OR “reconstructive surgery” OR “hand surgery” OR “breast surgery” OR “burns”) AND (“platelet-rich plasma” OR “PRP”).

Depending on the database, further search restrictions (article type, search category, language, studied species) were predefined to optimize the results and exclude nonrelevant material by adjusting the search filter. The added limitations are portrayed in Table 1.

### *Inclusion and Exclusion Criteria*

The search was limited to studies in English or German. Only clinical studies that investigated the treatment with autologous PRP alone or as an adjuvant in fat grafting (FG) in humans were included. All animal and in vitro studies were excluded, as well as case reports and case reviews. Trials were only included if the product they investigated was defined as “platelet-rich plasma” in their report. PRP-related products, for example, platelet-rich fibrin (PRF) or its derivatives (platelet-rich fibrin matrix), were not explored in this review.

All studies had to be conducted at a department for plastic surgery or by a physician who specializes in that field. Publications concerning medical specialties such as dermatology, orthopedics/

**Table 1.** Limitations added to query via refinement filters

	Search terms	Language	Species	Include article types	Exclude article types	Include category	Exclude category
OVID: Embase, Medline	(Plastic surgery, reconstructive surgery, aesthetic surgery, hand surgery, breast surgery) AND (platelet-rich plasma, PRP); burns AND platelet-rich plasma	x	Human	x	x	x	x
Web of Science Core collection	(Plastic surgery, reconstructive surgery, aesthetic surgery, hand surgery, breast surgery, burns) AND (platelet-rich plasma, PRP)	English German	Human	x	Letters, review articles, book reviews, notes	Surgery, transplantation, emergency medicine	Dermatology, dentistry/oral surgery, gynecology, nephrology/urology, ophthalmology, orthopedics Rheumatology Sports sciences, veterinary sciences, zoology
PubMed	(Plastic surgery, reconstructive surgery, aesthetic surgery, hand surgery, breast surgery, burns) AND (platelet-rich plasma, PRP)	English, German	Human	Clinical study, clinical trials and protocols, comparative study, controlled study, evaluation study, observational study, RCT	x	x	x

x, not applied/not possible for this database.

trauma, oro-maxillofacial surgery, ophthalmology, periodontology, or any other center that was not defined as a division or subdivision of plastic surgery were eliminated.

#### Data Extraction

Following the assembly of the findings of all databases, duplicates were manually removed. First, all titles and abstracts were screened for eligibility, followed by a full-text review of the remaining studies. The study selection process has been highlighted in the flowchart shown in Figure 1.

## Results

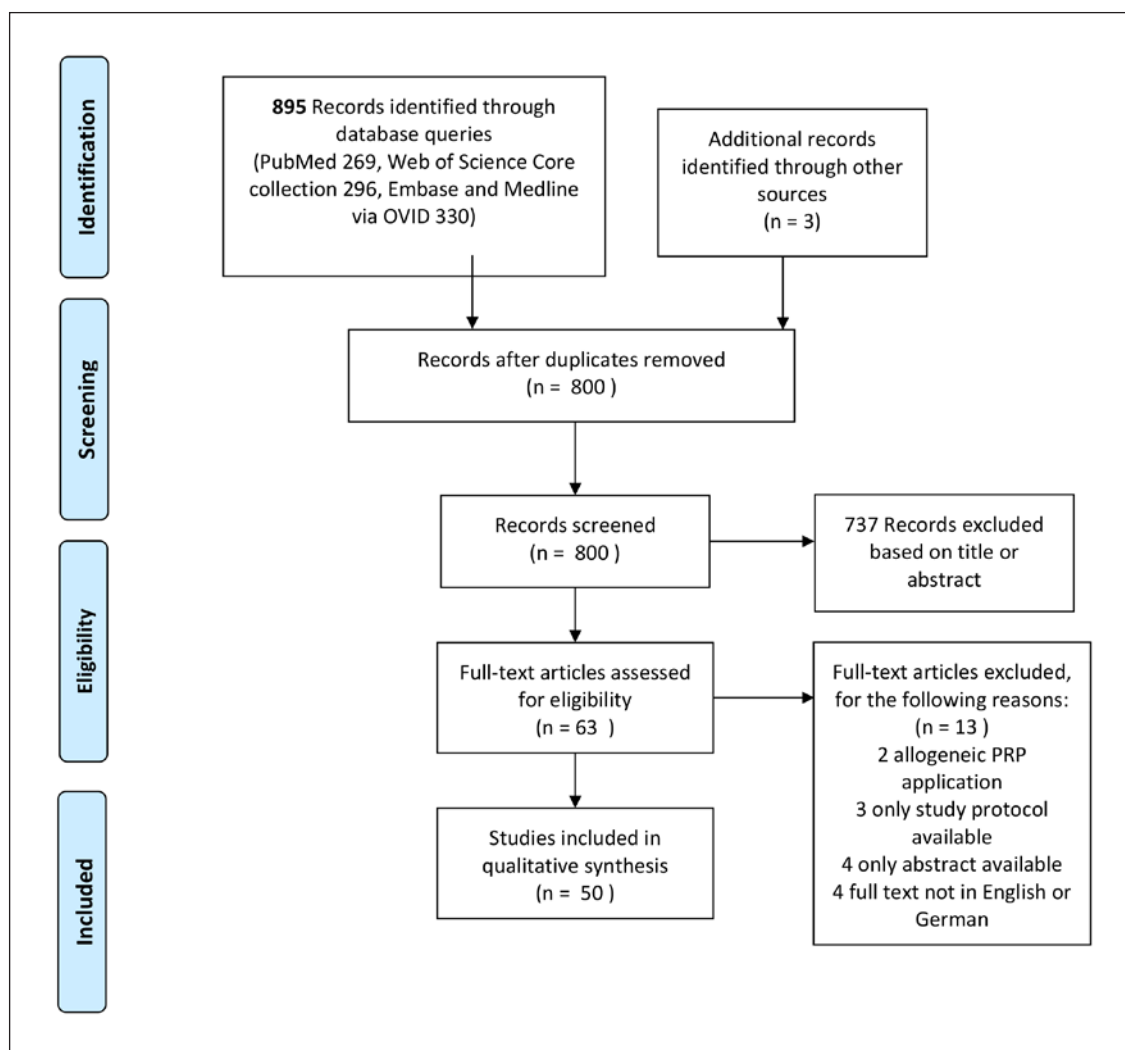
A total of 895 results were obtained through literature search. Three records were identified through other sources. After deduplication, 800 articles remained and were screened thoroughly. Fifty papers met the previously described inclusion criteria and were included in this review.

These studies were divided into sections according to their field of application in plastic surgery, namely: *reconstructive surgery*, *aesthetic surgery*, *hand surgery*, *craniofacial surgery*, and *burn injury treatment*. The use of PRP in *FG* was classified as an independent segment.

Eleven studies investigating the application of PRP in reconstructive plastic surgery were included. Five of them treated chronic wounds or ulcers with PRP injections or gel application [10–14]. Two randomized controlled trials (RCTs) compared PRP application to conventional

fixation with split-thickness skin grafts (STSGs) [15, 16]. In 1 case, PRP was applied to the donor site to accelerate wound healing [17]. Two studies aimed to reduce postoperative complications after breast reconstruction with PRP application [18, 19]. Another study investigated the effects of PRP injections in keloid scars with the objective to improve scar quality and reduce pain [20].

In total, eleven studies reported the use of PRP in aesthetic plastic surgery, which was further subcategorized into “facial” and “hair growth” interventions. The most common indications were androgenetic alopecia (AGA) and alopecia areata. One paper described the use of PRP as a preservation solution for hair transplantation [21]. Three studies had a PRP and a placebo group, whereas one compared different types of PRP (activated vs. non-activated autologous vs. homologous PRP) without a CG in AGA therapy [22–25]. In one study, plasma was enhanced with dalteparin and protamine microparticles to evaluate if these growth factor carriers would result in better hair growth than conventional PRP, and one author explored the effects of the plant derivative QR678 in contrast to intradermal PRP injections in a randomized controlled study [26, 27]. The bioengineered formulation of QR678 was introduced by Kapoor and Shome in 2018. It contains a variety of biomimetic peptides, as well as vitamins, minerals, and amino acids and has been proven to be an efficient therapeutic approach for AGA for both male and female patients [26].



**Fig. 1.** Flowchart describing the review process.

Two studies injected PRP to achieve facial rejuvenation [28, 29]. PRP gel was applied in two trials: one of them performed blepharoplasty, and the second one used it to improve face lifting outcome [30, 31].

The field of hand surgery is considered a sub-specialty that is shared between plastic, orthopedic, and general surgeons. Therefore, all studies concerning PRP therapy for procedures that are of interest for the plastic hand surgeon were included, regardless of the main medical specialty of the investigator. In total, four articles concerning plastic surgery of the hand were retrieved [32–35]. In a comparative study (CS), patients with mild carpal tunnel syndrome (CTS) were treated with either PRP or corticosteroid injections. Three authors performed intra-articular PRP injections as a treatment for carpometacarpal arthritis of the thumb joint. Two RCTs focused on the treatment of severe burns with PRP-enhanced skin grafts (SGs) [36, 37].

Craniofacial procedures fall under the scope of oromaxillofacial surgery, as well as plastic surgery. A total of five studies conducted by plastic surgeons investigated the efficacy of PRP in bone grafting for alveolar cleft treatment, temporomandibular joint (TMJ) disorders, or other maxillofacial conditions [38–42]. All these studies were either CS or case-control (CC) study, and no RCTs were found.

Seventeen studies concerning to combination of PRP application and fat grafts were found, and three of those were RCTs [43–59]. Eight articles fell under the category “reconstruction,” focusing on chronic ulcers and wounds (three), scars (three), or breast reconstruction (two). Another eight studies administered PRP and autologous fat to improve the aesthetic outcome of lipofilling to the face and hand (six), the calf region (one), or the gluteal area (one). One study explored the effects of PRP mixed-microfat in 3 patients with wrist osteoarthritis. For a better overview, analysis and detailed descriptions of the included trials are presented in tabular form in Table 2.

**Table 2.** Study details

Author	Design	N	Intervention	Objective	Results	AEs
<b>Reconstruction, wounds</b>						
Dhava et al. [15]	RCT	40	PRP versus mechanical fixation for STSG in wound bed	Graft loss, graft discharge, morbidity (hematoma, edema, pain), duration of stay, frequency of dressings, costs	PRP: instant graft take*; less graft loss, and morbidity* Lower costs and duration of stay	Related to PRP nm
Harper et al. [18]	RCT	12	L-PRP spray versus control for latissimus dorsi breast reconstruction	Reduction of drain burden (drain output volume, time to drain removal) and seroma formation	No benefit with L-PRP; 1 hematoma, 1 seroma reported (both in TG)	Hematoma (1) seroma (1)
Helmy et al. [10]	RCT	80	PRP versus conventional treatment for chronic venous leg ulcers	Rate of healing, reduction in ulcer size (%), recurrence, side effects	PRP: better healing results*; shorter healing time*; higher % in reduction*; no recurrence (11 in CG), no AEs, pain decrease	None
Hersant et al. [19]	Pro-study	54	PRP gel in breast reduction and weight loss sequelae surgery	Postoperative complications (seroma and hematoma) formation, wound healing/scar quality (POSAS)	Less complications in TG for limb lifting and breast reduction*; no difference in scar quality for all procedures	nm
Hersant et al. [20]	Pro-pilot study	17	PRP injection for keloid scar treatment	Remission of scars, VSS (including pruritus severity), pain (VAS)	53% healed, 29% complete relapse (difference between groups*); decrease in VSS (pruritus)*	None
Moghazy et al. [11]	-	40	PRP gel versus VAC in complex wound management	Wound grading, change in wound surface, wound exudate, pain (VAS)	Decrease in wound size in both groups*; less pain in PRP group*; higher reduction rate in VAC group*	Wound sinus
Rainys et al. [12]	RCT	69	PRP gel versus control in chronic leg ulcers	Wound size, granulation tissue, microbiological wound bed changes, safety	PRP: Higher wound size reduction* and granulation tissue formation*; higher wound contamination	No serious AEs
Saad Setta et al. [13]	CS	24	PRP versus PPP for chronic diabetic foot ulcers	Healing rate (measured length and width of ulcer), wound characteristics (exudation, necrosis, infection, granulation)	PRP: shorter healing time*; no significant differences in clinical signs between groups	nm
Slaninka et al. [17]	RCT	24	PRP versus control in healing SG donor sites	Healing quality (% of healed area assessed visually) and time	PRP: median healing time shorter*; accelerated healing	nm
Waiker and Shivalingappa [16]	RCT	200	PRP versus conventional fixation for STSG	Graft uptake or loss, hematoma or discharge, edema, frequency of dressing change, duration of hospital stay	Favorable results for all outcome parameters in PRP group*; high rate in instant graft take	nm
Xie et al. [14]	RCT	25	Platelet gel versus conventional dressing for diabetic sinus tract wounds	Sinus tract closure time, ulcer healing rate, hospitalization time and costs	APG: lower costs*, shorter stay*, higher healing rate, closure rate higher* until week 4, not at week 8	None
<b>Aesthetic</b>						
<i>Hair growth</i>						
Abdelkader et al. [21]	RCT	30	PRP versus saline as a preservation solution for hair transplantation	Hair graft uptake, hair follicular density, patient satisfaction	Higher hair thickness and graft uptake (after 1 year) in PRP group*; more rapid hair growth	-
Gentile et al. [22]	RCT	23	PRP versus placebo for hair growth	Hair regrowth, hair dystrophy, cell proliferation, itching sensation	Increase in hair count, total hair density, epidermal thickness, and epidermal cell proliferation*	None
Ince et al. [23]	-	46	aPRP versus nPRP versus hPRP injection for AGA	Hair density, average platelet number, complications	Higher hair density in all groups*; most of all in hPRP; highest platelet count and lowest preparation time for hPRP	None
Kapoor et al. [26]	Pro-CS	50	PRP versus QR678 injection for AGA	Hair fall rate, hair density, terminal hair, vellus hair, shaft diameter	Higher density and shaft diameter in non-PRP group*	Itchy scalp, light-headedness during injection
Kumar et al. [24]	Pro-CS	40	PRP versus placebo for AGA	Hair count, density, diameter, anagen/telogen, and terminal/vellus ratio	Higher increase in hair count, density, telogen/anagen ratio	Slight pain during injection, no major AEs
Singh [25]	Pro-study	20	PRP for chronic alopecia areata	Efficacy of PRP	Improved hair growth, no side effects; only 1 relapse	None
Takikawa et al. [27]	Clinical trial	26	PRP + D/P MPs versus PRP + saline for hair growth		Increase in hair growth and thickness in both groups	Discomfort during injection, no major AEs
<i>Face</i>						
Davis and Augenstein [28]	CS	8	PRP versus amniotic allograft for midface aging correction	Aesthetic result, patient downtime, level of comfort, office time	Improvement in both groups; quicker results and less downtime in non-PRP group	Hematoma, slight burn upon injection
Hersant et al. [29]	RCT	93	a-PRP or HA or PRP + HA injection for facial rejuvenation	Facial appearance Skin elasticity	Improvement in PRP + HA group compared to PRP or HA alone*; gross elasticity improved in all 3 groups	Mild bruising
Powell et al. [31]	RCT	8	Unilateral treatment with PRP gel versus control side for deep-plane rhytidectomy	Response to treatment; judged by occurrence of edema and ecchymosis in buccal, preauricular, and cervical region of the face	Response to effect of PRP: ecchymosis – 13 positive, 9 equal, 3 negative; edema – 8 positive, 11 equal, 6 negative; no significance	None
Vick et al. [30]	RCT	33	PRP gel versus control for blepharoplasty	Postoperative occurrence of edema and ecchymosis, post-op discomfort	No significant difference in discomfort or ecchymosis; less edema in TG at day 1 and 30*	nm



**Table 2** (continued)

Author	Design	N	Intervention	Objective	Results	AEs
<i>Hand</i>						
Loibl et al. [33]	Pilot study	10	Leucocyte-poor PRP for thumb joint arthritis	Changes in VAS, DASH, mayo wrist score, strength	Pain decrease*, improvement in mayo wrist score*	Palmar wrist ganglion (1)
Malalias et al. [34]	RCT	33	PRP versus corticosteroids for thumb joint arthritis	Changes in VAS, quick-DASH, patient satisfaction	Better results for all parameters in PRP group after 12 months*	nm
Abdelsabor Sabah et al. [35]	RCT	45	PRP versus HA versus corticosteroids for thumb joint arthritis	Changes in VAS, strength, AUSCAN score, tenderness grading	Overall improvement for all groups after 4 weeks*, only maintained for HA group after 12 week*	nm
Uzun et al. [32]	C-C	40	PRP versus corticosteroid injection for CTS	Change in NCS and BCTQ	No significant difference in NCS; higher BCTQ in PRP group at 3 months*	None
<i>Burns</i>						
Gupta et al. [36]	RCT	200	PRP versus control as preparation for STSG	Graft adherence, complication rate	Better graft uptake in PRP group*; less hematomas in PRP group	nm
Marck et al. [37]	RCT	52	PRP versus control for deep dermal burns with SSG	Graft uptake and re-epithelialization; pain, complications, scar quality	No significant differences	Hematoma
<i>Craniofacial</i>						
Chen et al. [38]	Pro-CS	20	PRP versus control for bone grafting for unilateral alveolar cleft	Newly formed bone volume, bone formation (BF) after PRP	No statistical difference in BF; faster recovery and less graft failure in PRP group	None
Gentile et al. [39]	C-C	25	PRP gel versus control for maxillofacial surgery	Bone regeneration of the jaw, morbidity	Less pain and infection in PRP group*; higher bone regeneration (54% in TG vs. 38% in CG)	No major AEs
Hanci et al. [40]	Pro-CS	20	PRP injection versus arthrocentesis for TMJ disorder	ROM, relief of functional pain, noise with joint movement	Less pain and joint sound in PRP group*; increase in mouth opening	No major AEs
Oyama et al. [41]	C-C	23	PRP versus control for iliac bone graft in alveolar cleft patients	Regenerated bone volume in CT	Higher rate of bone regeneration* in TG	None
Sakio et al. [42]	C-C	29	PRP versus control for alveolar bone grafting for unilateral cleft lip	Bone volume	No significant difference	Temporary wound dehiscence
<i>Lipofilling + PRP</i>						
Bilkay et al. [43]	CS	52	FG with or without PRP for calf augmentation	Number of sessions needed for satisfactory result	Lower mean n of sessions in PRP group (2.0*) versus without PRP (2.95)	Infection (1)
Cervelli et al. [44]	-	20 (vs. 10)	PRP gel + FG for lower extremity ulcers (vs. HA + collagen)	Re-epithelialization time	16 ulcers restored at 9.7 weeks in PRP group (2 out of 10 in CG)	nm
Fontdevila et al. [45]	Clinical trial	49	PDGF + FG versus FG alone for facial lipoplasty	Safety of treatments; improvement in facial structure/volume gain (clinical and via CT)	Improvement in facial atrophy and increase in volume in both groups*, no difference in volume gain between TG and CG, no serious AEs	No serious AEs
Gentile et al. [46]	CS	23	PRP + FG versus SVF + FG versus control for breast reconstruction	Maintenance of contour restoring and 3D volume	69% maintenance with PRP* and 63% with SVF* versus 39% control after 1 year overall satisfaction	No major AEs
Gentile et al. [47]	C-C	20	PRP + FG versus SVF + FG versus control for facial scars	Tissue regeneration (assessed visually by doctors and patients, MRI, US)	69% maintenance with PRP* and 63% with SVF* versus 39% control after 1 year; overall satisfaction with PRP	None
Majani and Majani [48]	-	28	PRP before FG versus PRP + FG simultaneously versus FG alone for scar correction	FG improvement, aesthetic outcome, scar elasticity, dyschromia	Improvement in all groups at 30 d; more durable results with PRP	nm
Mayoly et al. [49]	Clinical trial	3	PRP mixed-microfat injection for radio-carpal osteoarthritis	Safety, complications, pain (VAS), function (DASH, PRWE), ROM, wrist strength, patient satisfaction	No serious AEs, pain decrease >50%, improvement in DASH and PRWE	None
Rigotti et al. [50]	CS	13	PRP + FG (vs. SVF + FG vs. adipose-derived stem cells vs. control) for facial rejuvenation	To determine the best approach for facial skin regeneration	Greater vascular reactivity in PRP group, no significant advantages in regeneration compared to other groups	nm
Salgarello et al. [51]	CS	42	PRP + FG versus conventional Coleman technique for breast FG	Clinical outcome (according to patient and doctor), liponecrosis rate (US), need for revision	No superiority of PRP group proven	nm
Sasaki [52]	Pro-C-C	236	PRP versus SVF versus PRP + SVF versus control for midface FG	Volume retention	Higher graft retention for all TG at 1 year*; PRP and SVF equally effective	No serious AEs
Sasaki [53]	-	10	FG for face or dorsal hand with or without PRP	Retention of fat volume and improvement in skin elasticity	Higher, but non-s volume restoration in PRP group	None
Segreto et al. [54]	Pro-study	14	nL-PRP + nanofat for infected chronic wounds	Pain reduction (VAS), wound depth, re-epithelialization (%)	53.8% healed completely (re-epithelialization in 9.1 week, VAS 0); 30% improvement (wound depth reduction of 57.5%, VAS decrease of 42%)	nm
Smith et al. [55]	RCT	18	PRP + FG versus FG versus control for diabetic foot ulcers	Feasibility of trial, HRQoL, clinical outcome (wound size, healing, PUSH score, costs, AEs)	Feasibility proven, no differences in clinical outcomes, no serious AEs	Infection (3)
Tenna et al. [56]	CS	30	PRP + FG with or without fractional CO2 laser for atrophic acne scars	Patient satisfaction and aesthetic perception via FACE questionnaire, thickness of subcutaneous tissue	Improvement of tissue thickness and FACE-Q in both groups, nonsignificant	nm

**Table 2** (continued)

Author	Design	N	Intervention	Objective	Results	AEs
van Dongen et al. [57]	RCT	28	SVF + PRP + FG versus PRP + FG + saline for facial lipofilling	Improvement in skin elasticity, transdermal water loss, skin appearance (wrinkles, pigmentation, etc.), patient satisfaction (FACE-Q), recovery, AEs	No overall benefit with SVF; no improvement in skin quality in TG or CG; FACE-Q improvement in CG No major AEs	None
Willemsen et al. [58]	-	21	Gluteal augmentation with PRP + FG	Patient satisfaction and clinical results	Increased but subjective patient satisfaction, consistent results, safe procedure, low complication rate	Infection (1)
Willemsen et al. [59]	RCT	32	PRP versus control for facial lipofilling	Skin elasticity improvement, changes in skin, recovery time, and satisfaction according to patient	Faster recovery in PRP group*, otherwise no significant differences between groups	None

Asterisk means significant. AEs, adverse events; Pro, prospective study; RCT, randomized controlled trial; C-C, case-control study; CS, comparative study; TG, treatment group; STSG, split-thickness skin graft; SG, skin graft; HA, hyaluronic acid; FG, fat grafting; SVF, stromal vascular fraction; PPP, platelet-poor plasma; a-PRP/n-PRP/h-PRP, activated/nonactivated/homologous PRP; PDGF, platelet-derived growth factors; VAS, visual analogue scale; POSAS, patient and observer scar assessment scale; HRQoL, health-related quality of life; PUSH score, pressure ulcer scale for healing (quick); DASH (shortened), disability of shoulder and hand questionnaire; AUSCAN, score for pain, disability, joint stiffness in hand osteoarthritis; ROWE, range of motion; PRWE, patient-rated wrist evaluation; NCS, nerve conduction studies; BCTQ, Boston Carpal Tunnel Questionnaire.

### Complications

Overall, little to no side effects were observed. Only three out of 50 studies reported isolated occurrences of hematomas [18, 28, 37]. One patient developed a palmar wrist ganglion, which receded quickly and without need for intervention [33]. The most common side effect of PRP injections to the scalp or to the face was mild discomfort or light-headedness during the injection, which subsided shortly after the procedure [24, 26–28]. The 5 patients that exhibited signs of infection had all been treated with PRP-enhanced FG; therefore, one cannot be certain whether the PRP or the lipofilling itself was responsible for these side effects [43, 55, 58]. However, most patients did not experience any negative effects related to PRP application. No serious adverse event (AE) occurred in any of the studies. All authors concurred that the therapeutic use of PRP is safe.

### PRP Preparation

The studies included in this review showed notable heterogeneity in terms of PRP preparation methods. Many factors had to be considered, such as differences in number of PRP applications or the use of activators. In seventeen studies [10, 11, 13–15, 21, 24, 27, 31, 34, 35, 38, 40–42, 50, 53], double spin centrifugation was performed, 21 studies used a single spin protocol [16, 17, 19–23, 29, 30, 32, 33, 36, 37, 43–49, 51, 58], and twelve authors merely disclosed the name of the device used, or no information about this process at all [12, 18, 25, 26, 28, 39, 52, 54–57, 59]. Twenty-two authors reported the use of CaCl and/or Thrb for platelet activation [11, 13–15, 18, 19, 21, 24, 28, 30, 31, 37, 39, 42–47, 50, 51, 58]. Nonactivated PRP (na-PRP) was applied in 6 cases [34, 52–55, 57], and two authors reported the use of both na-PRP and a-PRP [22, 23]. One author applied photo-activated PRP [40]. The remaining studies did not mention this step of the process [10, 12, 16, 17, 20, 25–27, 29, 32, 33, 35, 36, 38, 41, 48, 49, 56, 59]. High variation was seen in the number of PRP treatments and in the volume of obtained/applied PRP. The reporting of PRP protocols showed inconsistencies, especially in terms of platelet count or platelet concentrate. Merely, a few studies included these details when describing the PRP preparation and treatment process [19, 20, 22, 23, 27, 29, 31–33, 37, 42, 50, 52, 53]. PRP preparation methods of each included study are portrayed in Table 3.

### Discussion

#### Reconstructive Surgery

According to Dhua et al. [15] and Waiker and Shivalingappa [16], PRP showed significantly better results in skin grafting when compared to conventional mechanical

**Table 3.** Preparation methods for PRP

Authors	Vol	N	PRP	Centrifugation	A/A	FORM
<b>Reconstruction and wounds</b>						
Dhua et al. [15]	nm	1	nm	1 × 20 min (3,000 rpm) 1 × 10 min (1,000 rpm)	CaCl	Topical
Harper et al. [18]	52 mL	1	nm	nm	Ca, Thrb	Gel
Helmy et al. [10]	nm	4–6	nm	1 × soft spin 1 × hard spin	nm	Injection
Hersant et al. [19]	24–48 mL	1	4–5 mL	1 × 5 min (1,500 g)	Thrb	Glue
Hersant et al. [20]	8 mL	4	4.5 mL	1 × 5 min (1,500 g)	nm	Injection
Moghazy et al. [11]	One unit	1	5–10 mL	Twice	Thrb	Gel
Rainys et al. [12]	8 mL	Mult	nm	RegenKit BCT	nm	Gel
Saad Setta et al. [13]	10 mL	nm	nm	1 × soft spin (1,007 g) 1 × hard spin (447.5 g)	CaCl, Thrb	Gel
Slaninka et al. [17]	10 mL	1	2–3 mL	1 × 10 min (3,600 rpm)	nm	Gel
Waiker and Shivalingappa [16]	20 mL	1	4–5 mL	1 × 5 min (1,000 rpm)	nm	Topical
Xie et al. [14]	20 mL	nm	3 mL	1 × 4 min (2,000 rpm) 1 × 6 min (4,000 rpm)	CaCl, Thrb	Gel
<b>Aesthetic</b>						
<i>Hair growth</i>						
Abdelkader et al. [21]	20 mL	–	2 mL PRP	1 × 5 min (101 g) 1 × 5 min (280 g)	Yes	Solution
Gentile et al. [22] (used two different systems)	18 mL/60 mL	3	0.1 mL/cm <sup>2</sup>	Cascade-Esforax/P.R.L. system 1 × 10 min (1,100 g/1 × 10 min 1,200 rpm)	Ca2+/no	Injection
Ince et al. [23]	40 mL nPRP 10 mL aPRP	nm	4–5 mL nPRP 4–5 mL aPRP	nPRP: 1 × 15 min (3,000 rpm) aPRP 1 × 5 min (200 rpm)	aPRP: CaCl	Injection
Kapoor et al. [26]	nm	8	1.5 mL	nm	nm	Injection
Kumar et al. [24]	20 mL	5	2–4 mL	1 × 5 min (2,000 rpm) 1 × 10 min (2,500 rpm)	CaCl	Injection
Singh [25]	25 mL	6	nm	nm	nm	Injection
Takikawa et al. [27]	15 mL	5	3 mL	1 × 15 min (1,700 rpm) 1 × 5 min (3,000 rpm)	nm	Injection
<i>Face</i>						
Davis and Augenstein [28]	30 mL	1	1 mL	nm	CaCl	Injection
Hersant et al. [29]	8 mL	3	4 mL	1 × 5 min (1,500 g)	nm	Injection
Powell et al. [31]	450 mL	1	7–8 mL	1 × 5,600 rpm 1 × 2,400 rpm	CaCl, Thrb	Gel
Vick et al. [30]	20 mL	1	nm	1 × 14 min	CaCl, Thrb	Gel
<i>Hand surgery</i>						
Loibl et al. [33]	15 mL	2	1–2 mL	1 × 4 min (1,500 rpm)	nm	Injection
Malahias et al. [34]	20 mL	2	2 mL	2 × (10 min and 3,100 rounds in total)	No	Injection
Abdelsabor Sabah et al. [35]	20 mL	1	1 mL	1 × 15 min (1,500 rpm) 1 × 10 min (3,500 rpm)	nm	Injection
Uzun et al. [32]	15 mL	1	2 mL	1 × 4 min (4,000 rpm)	nm	Injection
<i>Burns</i>						
Gupta et al. [36]	nm	1	5 mL/100 cm <sup>2</sup>	1 × 10 min (3,500 rpm)	nm	Film
Marck et al. [37]	54 mL	1	nm	1 × 15 min (3,200 rpm)	Thrb	Topical
<i>Craniofacial plastic surgery</i>						
Chen et al. [38]	30 mL	1	3 mL	1 × 10 min (2,000 rpm) 1 × 10 min (2,200 rpm)	nm	
Gentile et al. [39]	18 mL	1	nm	Cascade-Esforax system	Ca2+	nm
Hanci et al. [40]	8 cm <sup>3</sup>	1	0.6 mL	1 × 20 min (1,000 g) 1 × 10 min (1,500 g)	Photo-activated	Injection
Oyama et al. [41]	40 mL	1	nm	1 × 20 min (160 g) 1 × 15 min (400 g)	nm	nm
Sakio et al. [42]	34 mL	1	3 mL	1 × 5 min (2,650 g) 1 × 10 min (90 g)	CaCl	nm
<i>Lipofilling + PRP</i>						
Bilkay et al. [43]	20 mL	2 (m)	nm	1 × 10 min (1,100 g)	CaCl	FG



**Table 3** (continued)

Authors	Vol	N	PRP	Centrifugation	A/A	FORM
Cervelli et al. [44]	18 mL	1–2	nm	1 × 10 min (1,100 g)	CaCl	FG
Fontdevila et al. [45]	4–5 mL	1	nm	1 × 8 min (1,800 rpm)	CaCl	FG
Gentile et al. [46]	18 mL	1	0.5 mL	1 × 10 min (1,500 g)	Ca2+	FG
Gentile et al. [47]	18 mL	1–2	0.5 mL	1 × 10 min (3,300 rpm)	Ca2+	FG
Majani and Majani [48]	nm	1	1–8 mL	1 × 8 min (1,800 rpm)	nm	FG
Mayoly et al. [49]	18 mL	1	2 mL	1 × 10 min (3,200 rpm)	nm	FG
Rigotti et al. [50]	nm	nm	1 mL	1 × 5 min (300 g) 1 × 17 min (700 g)	CaCl, Thrb	FG
Salgarello et al. [51]	16–40 mL	1–3	0.3 mL	1 × 5 min (3,500 rpm)	CaCl	FG
Sasaki [52]	54 mL	1	2–2.5 mL	nm	No	FG
Sasaki [53]	54 mL	1	6–7 mL	Double spin	No	FG
Segreto et al. [54]	nm	4	4 mL	nm	No	FG
Smith et al. [55]	52 mL	1	2.6 mL (m)	Angel PRP processing device	No	FG
Tenna et al. [56]	nm	2	3 mL	RegenLab THT tube	nm	FG
van Dongen et al. [57]	62 mL	1	6 mL	nm	No	FG
Willemsen et al. [58]	2 × 54 mL	1	6 mL	1 × 15 min (3,500 rpm)	Thrb	FG
Willemsen et al. [59]	30 mL	1	3 mL	Biomet GPS 3 device	nm	FG

V, volume of whole blood drawn; N, number of PRP treatments; PRP, volume of PRP; A/A, activation/added components; FG, PRP added to fat graft for application; rpm, rounds per minute; g, relative centrifugal/g force; CaCl, calcium chloride; Thrb, thrombin; Ca2+, calcium; m, mean; nm, not mentioned.

fixation. Graft loss, morbidity, and time of hospitalization were reduced. A particularly beneficial outcome was the occurrence of instant graft uptake in the PRP group.

PRP showed positive effects in wound treatment in all studies. Healing time and overall results in chronic leg ulcers were significantly better when treated with PRP, according to Helmy et al. [10]; furthermore, there was no reoccurrence in the treatment group (TG) in contrast to the eleven cases in the CG. Similar results were presented by Xie et al. [14] and Rainys et al. [12]. According to these studies, PRP can reduce wound size, induce granulation tissue formation, and shorten hospital stay, which leads to reduced costs for both patients and hospitals. PRP may also decrease pain in wounds, as described by Moghazy et al. [11]. They treated 40 patients suffering from “complex wounds” – defined as acute or chronic wounds that challenge medical teams in terms of treatment and healing – with either PRP gel or vacuum-assisted closure (VAC). The patients included in this study had suffered from pressure sores, burn injuries, venous ulcers, diabetic ulcers, surgical wounds, or traumatic wounds. The authors reported significantly lower VAS scores and shorter, but nonsignificant, duration of hospital stays in the PRP group. However, the PRP group showed inferior results in reduction rates concerning the amount of wound exudate when compared to VAC treatment.

The effects of PRP in scar treatment and breast reconstructive surgery were not as conclusive. Hersant et al. [20] reported complete remission in 53% of keloids treated with PRP; however, 29% showed complete relapse.

PRP seemed to have a significant beneficial effect on pruritus severity and the Vancouver Scar Scale (VSS) score, which may indicate that PRP is an effective method in scar treatment. The same authors described the efficacy of PRP in breast reduction and limb lifting surgery [19]. Patients treated with PRP showed significantly less hematoma and seroma than the CG; however, this effect was not observed in abdominoplasty patients. The scar quality did not improve in the TG. In contrast, PRP did not show any favorable results in breast reconstruction with a latissimus dorsi flap performed by Harper et al. [18], and no reduction of hematoma or seroma formation was reported compared to the CG.

### *Aesthetic Surgery*

#### *Hair Growth*

PRP appears to be a safe and suitable alternative in managing hair loss, according to all studies collected for this review. The most relevant factors were hair regrowth, hair density, and hair count. Gentile et al. [22], Kumar et al. [24], and Singh [25] findings showed improvement in all mentioned parameters. However, the results were not always statistically significant and superiority over other therapeutic approaches, such as the plant derivate QR678 applied in the CS by Kapoor et al. [26], was not proven. In fact, intradermal QR678 injections resulted in higher hair density and shaft diameter. Adding growth factor carriers to PRP yielded similar yet not better results than injecting PRP alone. PRP may also serve as a preservation solution for hair transplantation, since Abdelkader et al.

[21] reported higher hair graft uptake and accelerated hair growth in their RCT. No AEs occurred in connection with PRP injections in any of the studies, suggesting it is a safe treatment.

#### Face Lifting and Skin Rejuvenation

The outcomes of three studies by Davis and Augenstein [28], Hersant et al. [29], and Powell et al. [31] did not show significant results after applying PRP in rhytidectomy or facial rejuvenation. Hersant et al. [29] reported a major benefit for facial appearance and skin elasticity when combining PRP and hyaluronic acid (HA) as opposed to PRP or HA alone. These findings are consistent with a prospective study the authors published in 2017, indicating a positive synergistic effect of HA combined with PRP in cosmetic surgery [60]. Powell et al. [31] let three blinded surgeons evaluate the effects of the PRP application in rhytidectomy. Each facial side treated with PRP gel that showed less edema or ecchymosis than the control side was interpreted as a “positive” response; an “equal” response correlated with no noticeable difference and a “negative” response indicated the non-PRP side showed a better outcome. The treatment did receive some positive feedback from the judges, but no clinically significant difference compared to the control side was observed. Vick et al. [30] provided data suggesting PRP may reduce edema in blepharoplasty, since patients presented with less edema at day one and day thirty in the PRP group, but no significant clinical effects were reported. Similar to the findings of Powell et al. [31], ecchymosis was not reduced significantly, neither was postoperative discomfort. Overall, PRP alone does not seem to have major beneficial effects on aging correction or face lifts; however, further investigation of the combination of PRP and HA may yield more promising results. The studies showed that PRP therapy is safe, and any complications that occurred were minor and temporary. This corresponds to the results of a systematic review on PRP treatment for stria distensae performed by Sawetz et al. [61] in 2021. Their findings demonstrated that (multiple) PRP injections are a safe treatment option for stretch marks; however, the lack of comparability among the included reports made it impossible to draw clear conclusions about the efficacy of PRP in that field. This was due to a variety of limiting factors, a major one being the broad range of PRP preparation protocols, an issue we have come across in this review as well.

#### Hand Surgery

In a CS, Uzun et al. [32] reported the application of PRP in plastic surgery of the hand. Their research demonstrated that PRP is an effective method to reduce symptom severity and improve hand function in patients with mild CTS, judged by the Boston Carpal Tunnel Questionnaire (BCTQ). Three months after the procedure, BCTQ scores were significantly improved in the PRP group compared to the group that had received cortisone; however, this significance was no longer maintained after 6 months. The treatments showed equal improvements in sensory nerve conduction.

Recently, PRP has sparked interest in treating carpo-metacarpal arthritis of the thumb joint (CMC-1 arthritis). To our knowledge, only three studies have published studies investigating PRP injections for CMC-1 arthritis so far. PRP shows promising results in terms of pain decrease, according to Loibl et al. [33], Malahias et al. [34], and Abdelsabor Sabah et al. [35]. Intra-articular PRP injections can also result in improved function (measured via quick-disability of shoulder and hand questionnaire [DASH] or AUSCAN questionnaire), higher patient satisfaction, and more grip and pinch strength, as demonstrated by Malahias et al. [34] and Abdelsabor Sabah et al. [35]. The latter reported that these effects were no longer present at the second follow-up examination (3 months post-intervention), which does not correspond to the findings of Malahias et al. [34], who reported satisfactory result even after 1 year. This may be owed to the fact that Abdelsabor Sabah et al. [35] only performed one injection of 1 mL, whereas Malahias et al. [34] performed two intra-articular injections of 2 mL each. More extensive research in that field may yield further insight into the efficacy of PRP therapy for this condition and provide data to optimize frequency and volume of intra-articular PRP injections.

#### Burn Injuries

Similar to hand surgery, little evidence for PRP application in burn treatment is available. The randomized controlled studies by Gupta et al. [36] and Marck et al. [37] both investigated the addition of PRP to skin grafting for the treatment of burn wounds. Gupta et al. [36] demonstrated a significantly higher graft take and a lower complication rate, respectively, hematomas, compared to the CG. Marck et al. [37], conversely, did not report any significant benefit to graft adherence, re-epithelization rate, or scar quality in patients treated with PRP, and all observed effects were minor. However, the inhomogeneity of the study population may have been responsible for these findings. No serious complications were observed. Enhanced graft survival with PRP application in burn treatment was recently demonstrated by Zheng et al. [62] and published in the Chinese journal of burns. They recommend the use of PRP in skin grafting for burn injuries since their trial showed improved survival and fusion rates.

#### Burn Injuries

Due to the scarcity of current data in that field, no clear statement on the efficacy of PRP in burn treatment can be made. Further research in that area needs to be provided.

## Craniofacial Surgery

PRP appears to be more efficient than arthrocentesis in treating TMJ disorders, as demonstrated by Hanci et al. [40]. Their results showed significantly better pain relief and decrease in pathological joint movement sounds, as well as improved range of motion (ROM). Gentile et al. [39] observed high patient satisfaction and low morbidity rate in patients undergoing maxillofacial surgery and PRP gel application. Pain levels and infection rates were reduced significantly. Also, applying platelet gel resulted in a 16% higher bone regeneration rate. PRP is believed to promote bone growth and soft tissue healing. This effect was observed a study by Oyama et al. [41]: CT imaging showed higher rate in regenerated bone volume after additional PRP treatment for alveolar bone grafting compared to the CG, indicating PRP in fact induces osteogenesis. These findings were not confirmed by Chen et al. [38] and Sakio et al. [42], who conducted similar studies, but did not report statistically significant benefits of adding PRP to the graft regarding newly formed bone volume. However, Chen et al. [38] did show less graft failure and a faster recovery in patients receiving the PRP-enhanced bone graft. Overall, the results presented no clear evidence about the effect of PRP in alveolar cleft surgery. Larger studies in a randomized controlled study design are necessary to evaluate the potential of PRP in craniofacial plastic surgery.

## PRP as an Adjuvant to FG

The combination of PRP and lipofilling is based on the assumption that pro-angiogenic and anti-inflammatory effects of PRP enhance fat grafts [63]. The vascular component of PRP was demonstrated by Rigotti et al. [50], who observed higher vascular reactivity when adding PRP to facial lipofilling. It is also theorized that the growth factors released from the platelets induce proliferation and differentiation of adipose-derived stem cells), thereby further improving the graft outcome [63].

Cervelli et al. [44], Segreto et al. [54], and Smith et al. [55] evaluated the combination of PRP and FG for wound healing purposes, proving feasibility and safety. Pain reduction and over 50% complete healing rate were reported by Segreto et al. [54]; however, there was no CG to compare these results to. PRP-enhanced lipofilling appears to accelerate the re-epithelization process in ulcers compared to HA and collagen, according to Cervelli et al. [44]. Although Smith et al. [55] did not report any significant clinical improvement in their RCT, the authors concluded that the procedure was safe and recommended conducting larger randomized controlled studies to further evaluate the efficacy of PRP-enhanced FG in wound treatment.

PRP improves aesthetic perception and skin quality in scar treatment as demonstrated by Tenna et al. [56] and

Majani and Majani [48]. Significant superiority over fat graft alone was not observed by the latter, but results were more durable with PRP.

The outcome of PRP-enhanced fat grafts in facial lipofilling procedures does not differ significantly from FG alone, according to Fontdevila et al. [45], Sasaki [52], and Willemsen et al. [59]. Nevertheless, PRP may still be of interest for cosmetic surgery since the RCT of Willemsen et al. [59] reported significantly shorter recovery in the PRP group. This may be attributed to the effect of PRP on fibroblast growth and differentiation. PRP-enhanced lipofilling is a safe procedure for gluteal augmentation, according to Willemsen et al. [58], and may even, as described in “PRP-enhanced fat graft augmentation of the calf region” by Bilkay et al. [43], reduce the number of sessions necessary to achieve satisfactory results. This effect was not observed in breast reconstructive surgery performed by Salgarello et al. [51], neither was a better clinical outcome in the PRP group when compared to the conventional Coleman technique, questioning the role of PRP in this field.

A few authors compared the effects of PRP in lipofilling to those of stromal vascular fraction (SVF) as an adjuvant to FG. van Dongen et al. [57] and Sasaki [53] provided data suggesting PRP is equally effective in facial lipofilling compared to SVF. The outcome of two studies by Gentile et al. [46, 47] demonstrates significantly higher graft maintenance in breast reconstruction and scar therapy for both PRP- and SVF-enhanced lipofilling; however, PRP showed slightly better results in both studies. These findings support PRP efficacy in lipofilling and may indicate superior effects of PRP over SVF as an adjuvant in FG.

As previously mentioned, the application of PRP in plastic surgery of the hand is a relatively unexplored field. Mayoly et al. [49] performed intra-articular injection PRP and microfat on 3 patients with radio-carpal osteoarthritis and proved feasibility and safety for this procedure. Preliminary results showed positive short-term outcomes, indicating a potential efficacy which should be explored on a greater scale (more patients, longer follow-up periods).

## Limitations

There are some limitations to this review. Many studies had different endpoints or different evaluation approaches, and in some cases, the primary and secondary endpoints were not clearly defined. This posed a challenge in comparing and analyzing results. The previously mentioned (nm) heterogeneity in PRP preparation and application must be taken into account as well. The considerable variations in PRP extraction, activation, and frequency of application can lead to significant discrepancies between study results and diminish comparability. Furthermore, the vast majority of the authors did not dis-

close the final platelet concentration and the platelet count in their report.

The issue of high variation in PRP preparation protocols has been addressed on several occasions [3–5]. One of the contributing factors is the broad range of suggested classification systems. Historically, Dohan Ehrenfest et al. [65] provided the first classification system in 2009. They suggested dividing platelet-rich preparations according to their contents – whether they contain leucocytes or not – and the density of the fibrin network: [2]

- P-PRP: leucocyte-poor, low-density fibrin network (pure PRP).
- L-PRP: leucocyte-rich, low-density fibrin network (leucocyte-rich PRP).
- P-PRF: leucocyte-poor, high-density fibrin network (pure PRF).
- L-PRF: leucocyte-rich, high-density fibrin network (leucocyte-rich PRF).

Other authors support labeling different PRP products according to the DEPA classification by Magalon et al. [67] which is based on the dose of injected platelets, the efficiency of the production (percentage of platelets retrieved from blood), the purity of PRP (ratio of platelets compared to red and white blood cells), and the activation process [2].

Mishra's classification, which has mainly gained recognition in sports medicine, separates PRP into four groups, mainly focusing on the platelet concentration and the presence of leucocytes [8]. In 2017, Lana et al. [8] proposed a new classification system called MARSPILL – an acronym for *Method, Activation, Red blood cells, Spin, Platelet number, Image guidance, Leucocytes, Light activation* – which provides a precise description of the most important steps in PRP preparation and pays special attention to the peripheral blood mononuclear cell component of PRP preparation. The authors argued that the presence of peripheral blood mononuclear cells has a crucial impact on the regenerative potential of PRP and that its quantity should therefore be the main focus in labeling PRP products [8]. The issue of confusing terminology and varying PRP preparation methods has been addressed by many authors, such as Everts et al. [64]. The authors pointed out that the magnitude of PRP products and the lack of detailed bioformulation descriptions contribute to inconsistent patient outcomes [64].

The different approaches and the lack of a categorization standard pose a problem in interpreting and comparing data. Standardized terminology, guidelines for the preparation protocols of PRP and other platelet products, and consistent and detailed reporting of said protocols would facilitate conducting – and analyzing – research in this field [2].

## Conclusion

PRP therapy is widely used in plastic surgery, and numerous trials have investigated its effects in reconstruction, cosmetic surgery, burn treatment, hand surgery, and bone or FG. The majority of the literature focuses on the benefits of PRP in reconstructive and aesthetic surgery. Its use in hand surgery or burn treatment has only been reported by a small number of studies. Particularly good outcomes of PRP treatment can be achieved in wound healing and pain reduction. Since no serious complications or side effects are associated with PRP application, PRP presents a safe treatment option in the field of autologous blood products.

Even though several beneficial effects of PRP were identified, the evidence presented in current studies is conflicting and treatment regimens and evaluation methods show considerable heterogeneity. Moreover, PRP preparation protocols differ between one another and are often only partially disclosed.

The use of PRP shows promising results and is certainly justified in some areas, but its efficacy has not been proven in all fields of application. Further prospective randomized controlled studies with standardized preparation protocols and treatment regimens should be conducted to determine the efficacy of PRP in plastic surgery.

## Statement of Ethics

An ethics statement is not applicable because this study is based exclusively on published literature.

## Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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## Author Contributions

All authors provided meaningful input in the development and design of this work, or the analysis and interpretation of data for the work and the drafting of the work or revising the intellectual content.

## Data Availability Statement

The data that support the findings of this study were obtained from online databases (PubMed, Ovid, Web of Science), journal websites, or other research platforms where restrictions or charges may apply. Such dataset may be requested from the respective journals or by contacting the authors directly.



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