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Editorial

"In My Experience...15 Data Points To Better Evaluate Platelet Rich Plasma Kits And Protocols"

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Introduction

Platelet rich plasma (PRP) use in orthopedics is growing. Clinical research documenting effective outcomes for various conditions is fueling interest in PRP as a safe intervention for many soft tissue and joint pathologies in orthopedics. However, clinicians do not have a consistent means to evaluate PRP as a biologic drug and as a result interpreting clinical reports can be challenging. Additionally, clinicians often do not have the necessary information to fully evaluate PRP kits and protocols when deciding on how to best integrate this therapy into their practice.

Purpose

This paper defines 15 different metrics that can be used to quantify PRP and to compare PRP kits and protocols. Our goal is to provide a comprehensive framework that allows for the unbiased evaluation of PRP regardless of the kit or protocol used. By using these PRP metrics routinely, we can improve characterization PRP for research and clinical purposes.

It is difficult to compare the various platelet rich plasma (PRP) kits sold because of the lack of industry standardization and quantification of the PRP output. Incomplete evaluation of the hematology input and the PRP output makes kit comparison challenging. With published research, clinical significance is difficult to interpret when the platelet rich plasma used is not adequately described. PRP can be an effective biologic drug for many orthopedic conditions (Janocha et al. 2024). Ongoing research to determine how PRP dosing relates to specific clinical outcomes relies on understanding the techniques used to make the PRP and a

a Dr. Buford is a board Certified Orthopedic Surgeon who specializes in sports Medicine And Regenerative Medicine Don Buford, MD founded Texas Orthobiologics as a clinic where patients can get an unbiased orthopedic diagnosis and a complete discussion of their nonsurgical and surgical treatment options including orthobiologics or orthopedic surgery. The most common conditions treated are arthritis pain, back pain, tendon injuries, and sports injuries.

Our goal is to maximize our patients' quality of life and minimize their disability from any musculoskeletal condition in the safest, least invasive, most successful and most cost effective way. For many patients, we can successfully get them back in play with therapy, medications or office based orthobiologic injections. In some cases, we use PRP and bone marrow concentrate/cellular injections to assist, accelerate or augment the healing response in conjunction with a surgical procedure. Orthopedic surgery is reserved for those patients with the most serious injuries.

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quantification of the PRP used (Murphy, Terrazas, and Buford 2015).

There is no single specific metric that allows universal comparison of PRP kits. Perhaps the closest such metric that includes an evaluation of the efficiency of PRP production and the cost is the Cost/Billion Platelets ($/Billion) which is a calculated number requiring knowledge of the kit cost and the platelet dose created for that cost. Unfortunately, no commercially available kits are currently promoted or marketed with this information.

Typically, PRP kits are marketed with limited metrics that make an accurate evaluation challenging for the clinician end user. Because of the lack of complete data, the clinician could make a purchase decision based on inaccurate or incomplete information. In this article, we detail processes that can be used to assess PRP kits and PRP literature. The goal is to make clinical decisions based on as complete a data set and as accurate a description of the biologic drug as possible. We believe that clinicians should use the highest level, peer reviewed, unbiased clinical data available when making clinical recommendations for PRP use.

A quantification of PRP can be done on any commercially available hematology analyzer with at least a 3-part differential capability. Some hematology analyzers may require dilution of the PRP for proper evaluation of a very elevated platelet count, but there are many hematology analyzers with a range that allows evaluation of the platelet count in PRP without the need for dilution. Recent classification systems account for the many PRP parameters that can only be obtained with a hematology 3 part or 5 part differential analysis (Magalon et al. 2016). The standard of care for reporting results of PRP procedures now demands the full quantification of this biologic drug (Murray et al. 2017). Similarly, the standard for publication of peer-reviewed research detailing the effects of a drug, especially a biologic drug like PRP, should require the full evaluation of drug dosing. It is not enough for researchers to only report which PRP kit or protocol was used for a clinical intervention. To properly evaluate a clinical outcome based on a biologic drug intervention, the clinician needs to accurately define the drug intervention as precisely as possible because we have clear clinical evidence that PRP dosing relates to clinical outcomes for many, if not all indications for which PRP is currently used (Bansal et al. 2021; Berrigan et al. 2024; Patel et al. 2024; Hohmann, in press; Zhuang et al. 2024; Nunes et al. 2024; Hamid et al. 2014; Tuakli-Wosornu et al. 2016; Everts et al. 2023; Chu et al. 2022).

For PRP, there are many metrics that define the drug. Some of the most basic PRP parameters include the platelet count, the white blood cell count, the red blood cell count, the hematocrit, the hemoglobin, the neutrophil count, the lymphocyte count, and the monocyte count. One metric that allows comparison of PRP therapies is the platelet dose which is defined as the PRP platelet concentration multiplied by the PRP volume. The PRP platelet reading on a typical analyzer is converted to billions/cc because a hematology analyzer reports its platelet reading per microliters and PRP is usually delivered per cc. The calculated platelet dose metric is typically in the billions although with some low efficiency PRP kits the platelet dose could be less than 1 billion.

Due to the multitude of possible metrics used to describe PRP, it can be difficult to evaluate the output from different clinical machines. Commercially available PRP kits have differences in blood volume input, PRP volume output, and centrifuge protocols, all of which can create confusion in trying to compare the PRP produced. Furthermore, there is substantial intrasubject and intersubject variability in PRP output when utilizing the same techniques on repeated blood draws (Mazzocca et al. 2012).

A commonly used metric by manufacturers in describing their PRP is the platelet concentrating factor, which is easy to manipulate by varying the blood volume or the PRP volume or both. With the end PRP volume held the same, increasing the blood draw input will lead to a higher platelet concentration being reported. In a similar way, starting with the same blood draw volume but decreasing the PRP output should also report in a higher platelet concentrating factor. The best way to account for these differences is to standardize evaluation by using the same blood draw volume, anti-coagulant volume, and PRP output volume. By standardizing these factors, the actual differences in the PRP kits and centrifuging protocols can be more accurately assessed by clinicians trying to optimize clinical outcomes.

How can we start to better evaluate PRP research and kits? The first step is to collect all basic data from the whole blood analysis. If there is no reported whole blood analysis, then any further analysis is incomplete at best and misleading at worst.

The minimum 10 data points to be collected are as follows:

1. Blood draw volume (cc)
2. Anti-coagulant volume (cc)
3. WBC count
4. RBC count
5. Hemoglobin
6. Hematocrit
7. Platelet count
8. Lymphocyte % and #
9. Monocyte % and #
10. Neutrophil/Granulocyte % and #

We have identified the following 15 collected or calculated data points that give a complete understanding of PRP kits and protocols:

1. PRP volume (cc)
2. WBC count
3. RBC count
4. Hemoglobin
5. Hematocrit
6. Platelet count
7. Lymphocyte % and #
8. Monocyte % and #
9. Neutrophil/Granulocyte % and #
10. Platelet concentration factor (over baseline platelet count)
11. Platelet recovery %

12. PRP volume output consistency (ie. the % of time a protocol makes the same PRP volume from the same whole blood input)
13. PRP protocol time (ie. centrifuge time to make PRP)
14. PRP kit cost ($)
15. PRP kit cost/billion platelets ($/billion platelets)

The first nine PRP data points are directly measured (i.e. volume) or are provided by a hematology analyzer. The last six data points are measures of the reproducibility, efficiency, and true cost of a PRP kit and should be noted and calculated anytime a clinician wants to fully assess a PRP kit.

The 15 PRP data points listed are rarely calculated by the makers of PRP kits, so it is currently up to the individual clinician to collect this data and make the calculations. However, standardized reporting by manufacturers to include such measures of reproducibility, efficiency, and cost is recommended.

There are many ways to manipulate the PRP output data that may be misleading to the clinician end user. Here are just 9 of the more common ways that PRP kit comparisons can be flawed or misleading:

1. Not accounting for a difference in starting blood volume.
2. Not accounting for a difference in anti-coagulant volume.
3. Not accounting for a difference in PRP end volume when starting from the same whole blood input.
4. Not reporting the PRP platelet count and instead reporting a platelet concentration factor which can be manipulated multiple ways.
5. Using PRP concentration as a comparison metric between kits instead of platelet recovery percentage or platelet dosing.
6. Not accounting for differences in time to create PRP. The time to make PRP can vary from 90 seconds to more than 20 minutes.
7. Not accounting for significant variability in the end PRP product. Some kits may inconsistently produce anywhere from 2cc to 6 cc from the same blood volume input.
8. Not calculating the platelet dose produced by a kit from a standardized blood volume input.
9. Not calculating the cost ($) per billion platelets based on the average cost of a PRP kit and the average platelet dose output for a set blood volume input.

Sample calculations:

Platelet Concentration Factor

Platelet Concentration = (PRP platelet count) / (Blood platelet count)

Example:

> Hematology on blood draw gives platelet count of 180,000 platelets per µL
> Hematology on PRP gives platelet count of 1,186,000 platelets per µL
> 1,186,000 platelets per µL / 180,000 platelets per µL = 6.6X (platelet concentration factor)

Starting Total Platelets (TP)

TP = (Blood draw volume) x (Blood platelet concentration)

Example:

> 60cc syringe with 8cc of ACD-A preloaded to which 52cc of blood is drawn.
> Blood platelet count is 200,000 platelets per µL
> TP = 52cc (blood draw) x 200,000 platelets per µL (blood platelet count) = (10,400,000 platelets x cc) / µL
> 1000µL = 1cc
> TP = (10,400,000 platelets x cc) / µL) x (1000 µL / cc) = 10.4 billion platelets

PLATELET DOSE

Platelet Dose = (PRP platelet count) x (PRP volume)

Example:

> Hematology analyzer reports PRP platelet count as 1,186,000 platelets per µL
> Final PRP volume is 7 cc.
> 1000µL = 1cc
> Platelet dose = 1,186,000,000 platelets/cc (PRP platelet count) x 7cc(PRP volume) = 8.3 billion platelets

Platelet Recovery Percentage

Platelet Recovery Percentage = (Platelet Dose) x (Total Platelets)

Example:

> TP = 10.4 billion platelets
> Platelet Dose = 8.3 billion platelets
> 8.3 billion platelets / 10.4 billion platelets = 80% platelet recovery percentage

PRP Kit Cost/Billion Platelets (must use same starting blood volume to compare kits)

Example 1:

> 60cc PRP kit cost is $200.
> Average PRP dose produced is 10 billion platelets
> $200/10 billion platelets = $20/billion platelets

Example 2:

> 60cc PRP kit cost is $295
> Average PRP dose produced is 6 billion platelets
> $295/6 billion platelets = $49/billion platelets

There are other variables to consider that are not fully evaluated by the Cost/Billion Platelet metric, such as leukocyte content, platelet variability, and other factors not yet defined clinically. As a result, it will always remain up to the clinician's discretion to decide what parameters are clinically important in evaluating PRP kits and PRP publications.

Clinicians need as complete a description of PRP as a biologic drug as possible in order to evaluate its effectiveness in clinical use (Hurley et al. 2024). Our hope is that by recognizing the importance of PRP quantification, clinicians will receive more complete and unbiased information on the devices and protocols being used to make PRP. Clinicians can better assess the literature, plan future investiga-

tions, and provide PRP therapy when they have better PRP data.

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