Application of Platelet-Rich-Plasma in Spinal Fusion

+Hiroshi Nakamura; *Yukihiro Matsuyama; *Hisatake Yoshihara; *Yoshihito Sakai; *Yoshito Katayama; *Zanya Ito; *Jyunki Takamatsu; *Naoki Ishiguro
+Nagoya University School of Medicine, Aichi, Japan
hnaka@med.nagoya-u.ac.jp.

The use of platelet-rich plasma (hereinafter referred to as PRP) during surgery was proposed by oral surgeon Marx and others. PRP, a blood fraction rich in platelets obtained from patient blood, has been reported to promote bone formation by the action of PDGF and TGF released during platelet aggregation and degranulation. Although there are many reports of cases where PRP was clinically used with successful results for bone transplantation or implant surgery following tumor resection in the field of oral surgery, little data are available from basic experimental studies. In most oral surgery studies demonstrating the utility of PRP, assessments were based solely on visual ratings by scout radiography. In orthopedics, a few reports are available on surgical applications of PRP, including leg elongation, there are no prospective controlled studies. The objective of the present study was to determine whether bone formation potential was increased, and whether clinical results were influenced, when PRP was used for spinal fusion. Hence, we compared clinical outcomes of posterior lumbar interbody fusion (PLIF) surgery for reverse processes on both sides, with PRP added to bone autograft on one side, and without on the other side.

METHODS

Inclusion criteria were established to include patients who underwent PLIF for one or more interbody spaces at our hospital between September 2003 and September 2004, and who permitted follow-up for 6 months. Hence, 33 patients were enrolled in the study. Exclusion criteria were established to exclude patients who did not consent to participate in the study, or who experienced infection or required re-surgery within 6 months. Hence, the study population comprised 29 patients (11 males and 18 females) at 33 to 77 years of age (average age 63.3±8.6 years). The primary outcome measures determined were fusion mass area and mean density for spaces between reverse processes at 2 weeks, 3 months, and 6 months after surgery. The secondary outcome measures were preoperative fibrinogen and platelet levels, fibrinogen and platelet levels in the PRP prepared, and JOA score of lumbar vertebra; their effects on primary outcome were analyzed.

Preparation of PRP

On the day before surgery, 400 ml whole blood was drawn into a sterile bag containing CPD solution (2.51 g/L sodium dihydrogen phosphate, 26.30 g/L sodium citrate, 3.27 g/L citric acid, 23.30 g/L glucose). This blood sample was centrifuged at 200g for 15 minutes (KUBOTA 9800 Centrifuge, Kubota, Tokyo, Japan) to yield two separate layers: RBC and plasma. The plasma, along with theuffy coat between the two layers, was collected manually. This was centrifuged at 560g for 15 minutes to precipitate platelet pellets on the bag’s bottom; the supernatant was removed to yield a total of about 15 cc of platelet rich plasma. This fraction rich in platelets obtained from patient blood, has been reported to promote bone formation by the action of PDGF and TGF released during platelet aggregation and degranulation. Although there are many reports of cases where PRP was clinically used with successful results for bone transplantation or implant surgery following tumor resection in the field of oral surgery, little data are available from basic experimental studies. In most oral surgery studies demonstrating the utility of PRP, assessments were based solely on visual ratings by scout radiography. In orthopedics, a few reports are available on surgical applications of PRP, including leg elongation, there are no prospective controlled studies. The objective of the present study was to determine whether bone formation potential was increased, and whether clinical results were influenced, when PRP was used for spinal fusion. Hence, we compared clinical outcomes of posterior lumbar interbody fusion (PLIF) surgery for reverse processes on both sides, with PRP added to bone autograft on one side, and without on the other side.

RESULTS

During the six-month follow-up period, no complications such as infection were observed in any of the 29 subjects, who were all analyzed.

Regarding analysis set breakdown by operative site, 22 subjects underwent surgery for one interbody space and 7 for two interbody spaces. Mean JOA score improved by 79.2%, from 15.9 points preoperative to 26 points postoperative. Platelet and fibrinogen levels are shown on the slide, and the platelet concentration rate was 7.74 fold on average. Regarding fusion mass area, the percentage ratio of the PRP side to the control side is shown. Although the ratio decreased transiently, from 125% just after surgery to 99% at 3 months postoperative, it increased to 187% after 6 months (Table 1). As for fusion mass absorbance, the mean absorbance ratio was 101% at 2 weeks, 99% at 3 months, and 101% at 6 months, showing almost no time-related changes (Table 2). We correlated fusion mass area and mean density to JOA score, platelet count, and fibrinogen level, but no statistically significant relationship was found.

(Discussion)

Almost all currently available methods of assessing bone union between reverse processes are based on visual ratings, with no established method permitting quantitative assessments. Because pathological assessments as in animal experiments and assessments using the manual bending test and the like are impossible, however, ratings had to be based solely on imaging. We initially attempted to make assessments by scout radiography, but the data obtained were unreliable due to too wide a standard deviation, so we switched to multi-planner CT. As a result, fusion mass area tended to increase on the PRP side but the absorbance remained unchanged; the data obtained using this approach are considered to be more reliable than those obtained by scout radiography alone. It should be noted, however, that because no clear relationship was observed between platelet concentrations in blood and PRP and bone formation in the present study, it is impossible to demonstrate the increase in the bone formation area on the PRP side to serve as a platelet-derived trophic factor. A problem in our study resides in that the contents of the gel graft, which was transplanted only on one side, entered the opposite side because spaces between reverse processes were exposed on both sides using a single skin incision, and this is considered to represent a limitation on our study design. Because platelet degranulation activation time is very short, and also because PDGF and TGF activation times are very short, it remains questionable whether the present finding really arose from platelets, and fibrin might serve as a scaffold.

**Statistical Analysis**

Data obtained were statistically analyzed for significant differences between groups using the Statview 5.0 program (Windows); a p-value of less than 0.05 was considered to indicate statistical significance. Correlation between clinical findings and hematology data was analyzed using Pearson’s correlation coefficient.

**Image Analysis**

To minimize film scan and measurement errors, DICOM data were downloaded directly from the hospital’s server computer to a personal computer, with constant settings for window width and level.