Retropubic Radical Prostatectomy: Associated Blood Loss And Transfusion Requirements – A Two-Decade Perspective Review

Kobi Stav MD[1], Naomi Rahimi-Levene MD[2], Arie Lindner MD[1], Yoram I. Siegel MD[1] and Amnon Zisman MD[1]

[1]Department of Urology, and [2]Blood Bank and Hematology Institute, Assaf Harofeh Medical Center, Zerifin, Israel
Affiliated to Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel

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Abstract

Bleeding during retropubic radical prostatectomy arises from venous structures in the majority of cases. Since its introduction two decades ago, the nerve-sparing procedure with surgical control of the dorsal venous complex has led to a reduction in blood loss and blood transfusion rate. The reduction in blood loss is a result of better understanding of the prostatic blood vessel anatomy, extensive surgical experience over time, and reduction in transfusion triggers with an acceptance of lower postoperative hemoglobin values. Increased blood loss during RRP is associated with poorer outcomes most probably due to surgical difficulties. But as for now, there are no decisive risk factors for clinically significant bleeding during RRP although newer technologies for hemostasis of the dorsal vein complex are being utilized.

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The prostate remains the leading site of malignancy and the second most common cause of cancer death in men [1]. Many prostate cancers are not indolent; they pose a threat to quality of life and impair life expectancy and, therefore, justify intent for cure. Radical prostatectomy, first described by Young in 1901 [2], is considered one of the most effective therapeutic options for localized prostate cancer. The retropubic approach gained acceptance due to urologists' greater familiarity with pelvic anatomy and the ability to perform staging pelvic lymphadenectomy and radical prostatectomy in one session through a single incision.

Bleeding is the most common early complication of retropubic radical prostatectomy [3]. To investigate the incidence, time trends and risk factors for blood loss and transfusion requirements in men undergoing RRP we conducted a comprehensive Medline literature review. A total of 322 publications were located using the key words radical prostatectomy, blood loss, blood transfusion and surgical complications. Of these, 39 full-length English language manuscripts were identified.

Etiology

Arterial supply to the prostate is derived mainly from branches of the internal iliac (hypogastric) artery – the inferior vesical and middle rectal arteries. The dorsal vein of the penis passes between the inferior pubic arch and the striated urinary sphincter to reach the pelvis, where it trifurcates into a central superficial branch and two lateral plexuses. The superficial branch pierces the endopelvic fascia between the puboprostatic ligaments and drains the retropubic fat, anterior bladder, and the anterior prostate. The lateral plexuses sweep down the sides of the prostate, receiving drainage from it and the rectum, and communicate with the vesical plexuses on the lower part of the bladder. All these plexuses eventually drain into the internal iliac veins.

Bleeding usually arises from venous structures. It may also occur during pelvic lymphadenectomy if the external iliac vein or branches of the hypogastric vein are violated inadvertently [4,5]. Hemorrhage may arise from the dorsal vein complex during incision of the endopelvic fascia, during division of the puboprostatic ligaments and during exposure of the prostate apex. It may also occur when extending the incision in the endopelvic fascia towards the puboprostatic ligaments where small arterial and venous tributaries of pudendal origin may be encountered while perforating the pelvic floor [5]. Blood loss may also evolve from perforating capsular arteries and veins originating along the neurovascular bundle as well as from the arteries to the seminal vesicles during their dissection out of the Denonvilier fascia [6].

RRP estimated blood loss

Blood loss is reported to range from 215 to 7,700 ml [Table 1]. The nerve-sparing RRP with control of the dorsal venous complex that was introduced two decades ago resulted in a marked trend in which RRP-associated blood loss declined significantly (<1,000 ml). Since the year 2000 the literature has focused on the emergent new modality – laparoscopic radical prostatectomy. Consequently, data on the estimated blood loss during open retropubic radical prostatectomy in more recent years are scarce.

Intraoperative management

Venous injury to the external iliac or hypogastric veins can often be controlled by temporary packing. If this is not successful, it can be repaired with fine cardiovascular sutures [10]. Bleeding from the dorsal vein complex is usually satisfactorily controlled once the dorsal vein has been ligated and divided so that the apex of the prostate is approached anatomically [6].

Postoperative bleeding

The reported incidence of hemodynamically significant bleeding is 0.5 to 1.2% [11,12]. The mean blood product requirements for patients who undergo exploration for bleeding did not differ from

RRP = retropubic radical prostatectomy

Table 1. Estimated blood loss during RRP – a time trend

Reference	Estimated blood loss (ml)	No. of patients	Time range
Catalona and Dresner 1985 [7]	500–7,700	52	1980-1984
Oefelein et al. 1995 [30]	2,266	241	1980-1990
Kavoussi et al. 1991 [4]	1,420–1,605	130	1985-1988
Rainwater and Segura 1990 [5]	1,020–1,262	641	1984-1989
Lerner et al. 1995 [8]	994	1000	1989-1992
Muto et al. 2001 [36]	400–850	296	1990–98
Koch and Smith 1996 [10]	579–983	124	1993–95
Nuttall et al. 2002 [15]	984	276	1999
Hsu et al. 2003 [9]	813	971	1994–2000
Barre et al. 2002 [34]	650	197	1999–2001
Sengupta and Webb 2001 [35]	529–642	25	2000
Nagai et al. 2001 [37]	215–329	24	2000

those managed conservatively (13.8 versus 14.7). However, in patients managed conservatively, the hospital stay was longer (14.5 vs. 21 days) and the incidence of symptomatic bladder neck stricture and long-term incontinence higher (67 vs. 25%) [12]. These findings suggest that in patients requiring acute transfusions for hypotension after RRP, evacuation of pelvic hematoma may be indicated in an effort to decrease the likelihood of bladder neck stricture and incontinence.

Transfusion requirements

Until the late 1980s the blood transfusion rate in patients undergoing RRP was 62–89%, with a mean administration of 2.5–3.5 units of blood per patient [13,14]. Between 1989 and 1991 the transfusion rate declined to 37%, a further decline to 4–11% was noted between 1991 and 1992 [11] and in the late 1990s to 1–3.5% [10].

The reduced blood loss is a result of better understanding of the pelvic anatomy and extensive surgical experience gained over time [14], combined with acceptance of lower postoperative hemoglobin level (from 12 to 9–10 g/dl) [15]. This trend is consistent with changes in transfusion practice in surgical patients at large [16]. In a study of 181 patients undergoing RRP, hematocrit level below 28% was independently associated with risk for myocardial ischemia during and after RRP [17]. Data from the trial on transfusion requirements in critically ill patients [18] randomized to a blood transfusion policy that was restrictive (hemoglobin <7 g/dl) or liberal (Hb <10 g/dl) reveal that a restrictive blood transfusion strategy is safe and possibly superior to a more liberal approach. Thus, it is reasonable to consider a perioperative blood transfusion in a hemodynamically stable patient when the hemoglobin concentration drops below 7 g/dl and below 8–9 g/dl in patients with an ischemic heart disease [17].

Numerous strategies have been utilized to minimize the risks of transfusion, including preoperative erythropoietin therapy, acute normovolemic hemodilution, intraoperative cell salvage with autotransfusion, and preoperative autologous donation [13,15,19–21]. However, the use of these techniques has been questioned due to low utilization rate. Of 200 consecutive patients undergoing RRP, 189 (95%) did not require blood transfusion. Of the 64 patients who had donated autologous blood, only 17 (27%) required transfusion and none of them received allogeneic blood transfusion. Of the 136 non-donors, 11 (8%) received blood transfusion [22]. Autologous blood pooling is not without risk. There is a 2–5% incidence of vasovagal reaction at donation [23], and clerical errors do occur and may cause blood mislabeling or incorrect patient identification.

Various studies questioned the cost-effectiveness of preoperative autologous donation. Two- to threefold higher costs are associated with collecting and storing autologous blood [25]. RRP is preferably performed in men with a life expectancy greater than 10 years, without significant co-morbidity. Therefore, most patients tolerate well a mild degree of blood loss [25].

In conclusion, autologous donation is an option but not a default practice. It may be indicated for patients at high risk of allogeneic blood transfusion, such as those with a history of alloimmunization, febrile or allergic reactions, known alloantibodies to common antigens, and increased risk for transfusion-associated graft versus host disease [26].

Transfusions and outcome

Perioperative blood transfusion is reported to be associated with an adverse effect on the survival of patients with solid tumors [27], including prostate cancer [28]. An immunosuppressive mechanism has been proposed. The mechanisms of the blood transfusion-associated immunosuppressive effect remain ill defined, although evidence indicates that such effects are probably due to the infusion of allogeneic donor leukocytes or their products present in the cellular blood products used for the transfusion [29].

In a study of 251 consecutive men who underwent RRP for clinically localized carcinoma, the intraoperative blood loss was inversely associated with progression-free survival (1.08 risk ratio for every 100 ml of operative blood loss). The blood group type (autologous versus allogeneic) does not serve as a negative predictor for disease progression [30], suggesting that the need to manage more extensive disease is potentially more significant than the allo-immunologic effects of blood transfusion and may be related to tumor characteristics (stage, grade, vascularity), making resection more challenging and therefore resulting in more blood loss [13,30]. Whether the relationship between blood transfusion and outcome is causative or coincidental remains obscure.

Risk factors for bleeding

In a study on surgical outcomes after RRP in 1,024 patients, estimated blood loss (mean 813 ml, range 100–3,000 ml) and

transfusion rate were significantly related to prostate volume. Estimated blood loss and transfusion rate were 1.2 and 2.5 times greater in prostates larger than 50 cm^3 compared with prostates smaller than 26 cm^3, respectively [9].

A recent study of 1,123 RRP cases demonstrated on multivariate analysis that prostate size greater than 50 g ($P < 0.0001$, odds ratio 1.74), use of general anesthesia ($P = 0.01$, OR 2.22), use of neoadjuvant hormonal therapy ($P = 0.006$, OR 3.35), and surgeon expertise ($P < 0.0001$, OR 8.63) were independently associated with the probability that a patient would require blood transfusion [31]. The most influential factor, surgical expertise, clustered among surgeons who performed more than 15 RRPs annually, because these surgeons had lower transfusion rates and lower estimate blood losses more consistently than did surgeons who performed fewer RRPs annually.

A marked prominence of the apical periprostatic veins on preoperative endorectal magnetic resonance imaging was found to be associated with greater intraoperative blood loss during RRP ($P < 0.01$, correlation coefficient = 0.22) [32].

In a recent study [33] of 436 consecutive patients who underwent RRP, body mass index correlated significantly to estimated blood loss. There was a significantly lower EBL in patients with an acceptable BMI (< 25) as compared to overweight (25–30) and obese (> 30) patients ($P = 0.021$). Likewise, the rate of transfusion was significantly higher in the overweight (6.9%) and obese (5.6%) groups as compared to the normal BMI group (1.9%) ($P = 0.009$).

Prevention of bleeding

Surgical aspects

Surgical technique is a contributor to the amount of intraoperative blood loss. Precise anatomic dissection and preemptive control of the dorsal vein complex and prostatic pedicle are essential [8,14,15].

In an effort to decrease blood loss during RRP, Peters and Walsh [14] reported their experience with temporary occlusion of the hypogastric arteries. This retrospective, non-randomized study of patients operated with or without temporary hypogastric artery occlusion demonstrated a 40% decrease in blood transfusion requirement for patients in whom the hypogastric arteries were occluded. A more recent, prospective, randomized study of 130 patients showed no advantage to intraoperative occlusion of the hypogastric artery [4]. The failure of hypogastric occlusion to decrease blood loss may be attributed to extensive collateral arterial blood supply and to venous bleeding not directly controlled by the proposed maneuver [4].

Patient positioning might also affect blood loss during RRP. Among 187 patients who underwent RRP in the Trendelenburg position with flexion of the hips, the mean intraoperative blood loss (290 ml) decreased by 80% compared to 40 patients operated in the supine position, while the transfusion rate was 0.5% [34].

OR = odds ratio
EBL = estimated blood loss
BMI = body mass index

Technical modifications

Ligasure® – a new hemostatic system – has been experimentally used in RRP. Ligasure is a computer-controlled bipolar diathermy system, designed to optimally seal vessels in diameter of 7 mm or less, based on tissue collagen precipitation [35]. Its use reduced blood loss (mean 529 vs. 642 ml) in 25 radical prostatectomies, and no intraoperative or postoperative blood transfusions were required [35].

Using an endoscopic gastrointestinal anastomosis stapler for hemostasis of the dorsal vein complex during RRP reduces blood loss from 850 to 400 ml, but anastomotic strictures were more prevalent [36].

The high power ultrasonic coagulating and cutting device is in widespread use for both open and laparoscopic operations and is generally perceived to carry a low risk of collateral damage. Experience on 24 prostate cancer patients undergoing RRP showed a minimal mean amount of blood loss during the operation (215 114 ml) [37].

Non-surgical considerations

Several measures other than surgical technique have been described to prevent, control or decrease blood loss during RRP. Preoperative dilution of blood volume has been used to decrease transfusion requirements [39]. Since regional anesthesia causes vasodilation, it is believed to decrease the pressure within blood vessels regionally, and thus decrease intraoperative bleeding [14]. Not all studies could demonstrate decreased intraoperative blood loss with regional anesthesia [4,36].

Laparoscopic versus open surgery

Laparoscopic radical prostatectomy offers improved visualization of the anatomy, reduced blood loss, and perhaps better preservation of anatomic structures. The mean blood loss in LRP is 185–800 ml and the reported transfusion rate 2–9.6% [34,39]. A comparison between open RRP with LRP (219 patients in each group) revealed that the mean blood loss (1,550 vs. 800 ml) and transfusion rates (55.7 vs. 9.6%) favors the laparoscopic group [40].

Conclusions

During the last two decades the blood transfusion rate associated with RRP has sharply decreased, and currently only a minority of patients require blood transfusions. Improvements in surgical technique and acceptance of lower postoperative hemoglobin values have led to a decreased need for blood transfusion over time.

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LRF = laparoscopic radical prostatectomy

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Correspondence: Dr. A. Zisman, Dept. of Urology, Assaf Harofeh Medical Center, Zerifin 70300, Israel.
Phone: (8-972) 977-9409
Fax: (8-972) 977-9402
email: zismana@asaf.health.gov.il

Put your hand on a hot stove for a minute, and it seems like an hour. Sit with a pretty girl for an hour, and it seems like a minute. THAT's relativity.

Albert Einstein