We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

4,800
Open access books available

122,000
International authors and editors

135M
Downloads

Our authors are among the

154
Countries delivered to

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS BOOK CITATION INDEX INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

6

Risk Factor Analysis and Management of Cerebrovascular Accidents in Japanese Patients Supported by Left Ventricular Assist Device

Tomoko S. Kato, Kazuo Komamura, Ikutaro Nakajima, Ayako Takahashi, Noboru Oda and Masafumi Kitakaze
National Cerebral and Cardiovascular Center
Japan

1. Introduction

Heart transplantation provides considerable survival benefits for patients with end-stage heart failure, but it is available for only a small fraction of these patients due to donor shortage. Especially in Japan, domestic legal issues had severely limited the number of heart transplantation until the Revised Organ Transplant Law was launched in 2010. The mean waiting period of Japanese heart transplant candidates after left ventricular assist device (LVAD) surgery had exceeded 2 years and occasionally reached 4 years until recently (Sasaoka T et al., 2010).

The long-term LVAD support can result in serious complications such as cerebrovascular accident (CVA), the most common cause of death following LVAD surgery (Rose EA et al., 2001; Holman WL, 2009; Saito S, et al. 2010). CVA is the leading cause of death and the primary reason for elimination from transplant eligibility. In addition, transplant recipients with a history of CVA face tremendous difficulties in being reintegrated into society, often for years after transplant (Nakajima I et al., 2011).

Therefore, we investigated factors associated with CVA after LVAD surgery in Japanese patients, as well as we reviewed our treatment strategies for CVA and the outcome of these patients after developing CVA.

2. Special circumstance surrounding transplant and LVAD issues in Japan

Until recently, brain-death tests, conducted on the premise of organ donation, were only for possible donors aged over 15 with formally signed donor cards indicating a willingness to donate his or her organs. The cardiac donation rate per million population in Japan is only 0.08 or less than 10 cases in the nation, whereas it is 7.3 in the United States, 5.3 in Spain, and 0.97 in South Korea in 2007 (Fukushima N et al., 2009; Hashimoto S et al., 2011).

Furthermore, only one pulsatile extracorporeal left ventricular assist device (LVAD) (Toyobo-LVAS®, Nipro Corp., Tokyo, Japan, Figure 1) was covered by the National Health

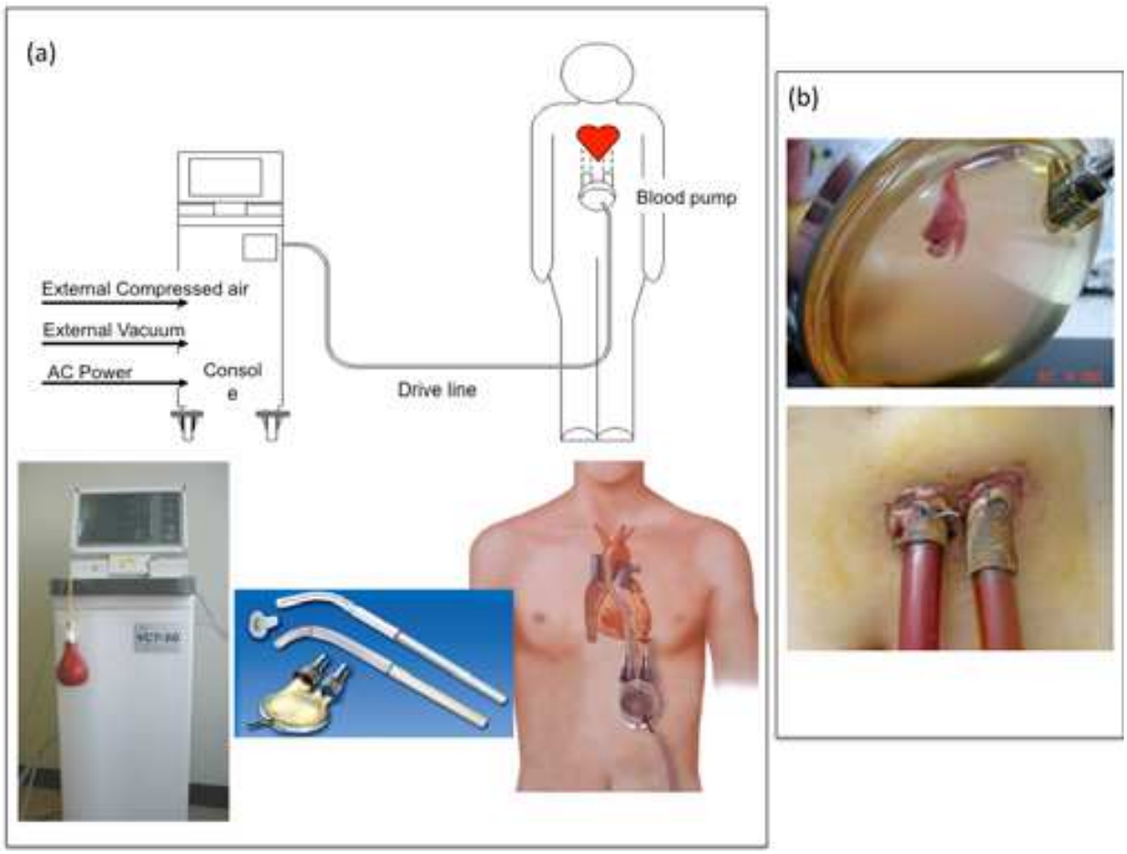


Fig. 1. (a) Outline of the Toyobo-LVAS® system with device console (left lower panel), blood pumps and inflow/ outflow cannula (middle lower panel) and the chart of the LVAD system (right lower panel). The blood pump consisted of a diaphragm with a pulsatile flow through two mechanical valves, operated by a pneumatically driven system. The maximum stroke volume was 70 mL per beat when testing with water. The blood contacting surface is covered by segmented polyurethane approved for medical use. (b) Representative pictures of the blood pump with mobile thrombi (upper panel) and a granulating wound at the penetration sites of the inflow/ outflow cannula in the abdominal skin

Insurance System as of November 2010 (Sasaoka T et al., 2010). Some implantable LVAD were used for Japanese patients for the purpose of clinical trail, or when medical expense was paid individually. Therefore, as improbable as it may sound, Japanese patients with advanced heart failure were being maintained mainly by pulsatile extracorporeal Toyobo-LVAS® as a "bridge-to-transplant" treatment for 2 to 4 years until being transplanted. Needless to say, some of them died while on the device. Given these circumstances, our long-term management skills for overcoming LVAD–related complications have improved over time, with the 1-year survival now being 82% (Sasaoka T et al., 2010). However, even with this success rate of survival, CVA still remains the leading cause of death.

The Toyobo-LVAS® was actually designed for "short-term" support, but the lack of alternatives resulted in it becoming a "long-term" support device in Japan. The Toyobo-LVAS® also requires an intensive anti-coagulation therapy, such as a target prothrombin time-international normalized ratio of 3.0-4.0. The 3-month and 1-year CVA-free survival rate for a patient with Toyobo-LVAS® is 56.1% and 36.8%, respectively (Sasaoka T et al.,

2010; Nakajima et al., 2011). The overall incidence of CVA for Toyobo-LVAS® patients was reported as 57.3 % at a mean observation period of 224 days, and a report from another institution indicated a CVA incidence of 53.6% at a mean of 505 days (Nakajima et al., 2011; Saito et al., 2009).

In spite of such a high frequency of CVA development after Toyobo-LVAS® surgery, we could achieve a reasonably high survival rate after the device placement thanks to the use of prothrombin complex concentrate (PCC) for rapid reversal of warfarin-induced anticoagulation in this population (Takahashi A et al., 2010). We here describe (i) factors associated with CVA after LVAD surgery in Japanese patients in order to distinguish patients with high risks for CVA, and (ii) the effects of PCC for rapid reversal of warfarin-induced anticoagulation in patients developing hemorrhagic stroke who were supported by LVAD, based on our experience.

3. Pre- and post-operative risk factors associated with CVA developments in Japanese patients supported by left ventricular assist device

3.1 Risk factors for CVA at any time after LVAD surgery

Nakajima et al. reviewed a total of 118 adult Japanese patients who were supported by LVAD between 1994 and 2009 (Nakajima et al., 2011). A CVA was defined as an ischemic or hemorrhagic intracranial event that persisted beyond 24 hours or less than 24 hours with infarction on an image study, based on the Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) adverse events definitions of stroke. Clinical characteristics, hemodynamic data, and laboratory indexes associated with CVA after LVAD surgery were analyzed.

In total, 57 (48.3%) patients developed CVA 133.5±184.7 days after surgery. Patients who developed CVA revealed to have longer duration of heart failure ($p=0.0039$), more frequency of cardiomyopathy as a baseline heart disease vs myocarditis/ acute coronary syndrome ($p=0.039$), more frequency of undergoing surgery with inflow cannula site at the left atrium ($p=0.011$), and longer duration of inotropic requirement after surgery ($p<0.0001$) than those who did not develop CVA. In addition, patients with CVA had higher pre-LVAD mean right atrial pressure (mRA) ($p=0.001$), higher pre-LVAD total bilirubin (T-Bil) concentration ($p=0.024$), lower lymphocyte subset percentage ($p=0.019$), lower pre-LVAD total protein (TP) concentration ($p=0.001$) and larger pre-LVAD right ventricular end-diastolic dimension (RVEDD) on echocardiogram ($p=0.0003$). This combination could discriminate patients developing CVA from those not developing CVA at any time after surgery with a predictive accuracy of 71.8%, which the following formula;

$$z=-0.507566 + (1.5664\times [\text{baseline heart disease; 1=cardiomyopathy, 0=other diseases}]) + (3.49143\times [\text{type of LVAD; 1=left atrium drainage Toyobo®, 0=other type of LVAD}] + (0.123626\times \text{mRA}) + (0.185355\times \text{T-Bil}) - (1.04891\times \text{TP}) + (0.153542\times \text{RVEDD}).$$

where $Z > 0$ indicates patients developing CVA and $Z < 0$ indicates patients not developing CVA after LVAD surgery.

The above finding could be implicated that patients with longstanding heart failure associated with malnutrition as well as accompanied right heart failure would be at higher risk for CVA development after LVAD surgery.

Hierarchical multiple regression analysis for the interactions between CVA associated factors revealed that duration of heart failure and pre-LVAD lymphocyte subset influenced the duration of inotropic support after surgery, which in turn influenced CVA development.

Accordingly, both duration of heart failure and lymphocyte subset before surgery were indirectly associated with CVA. In addition, right ventricular size had an effect on the duration of inotropic support in addition to its direct effect on CVA development (Figure 2a).

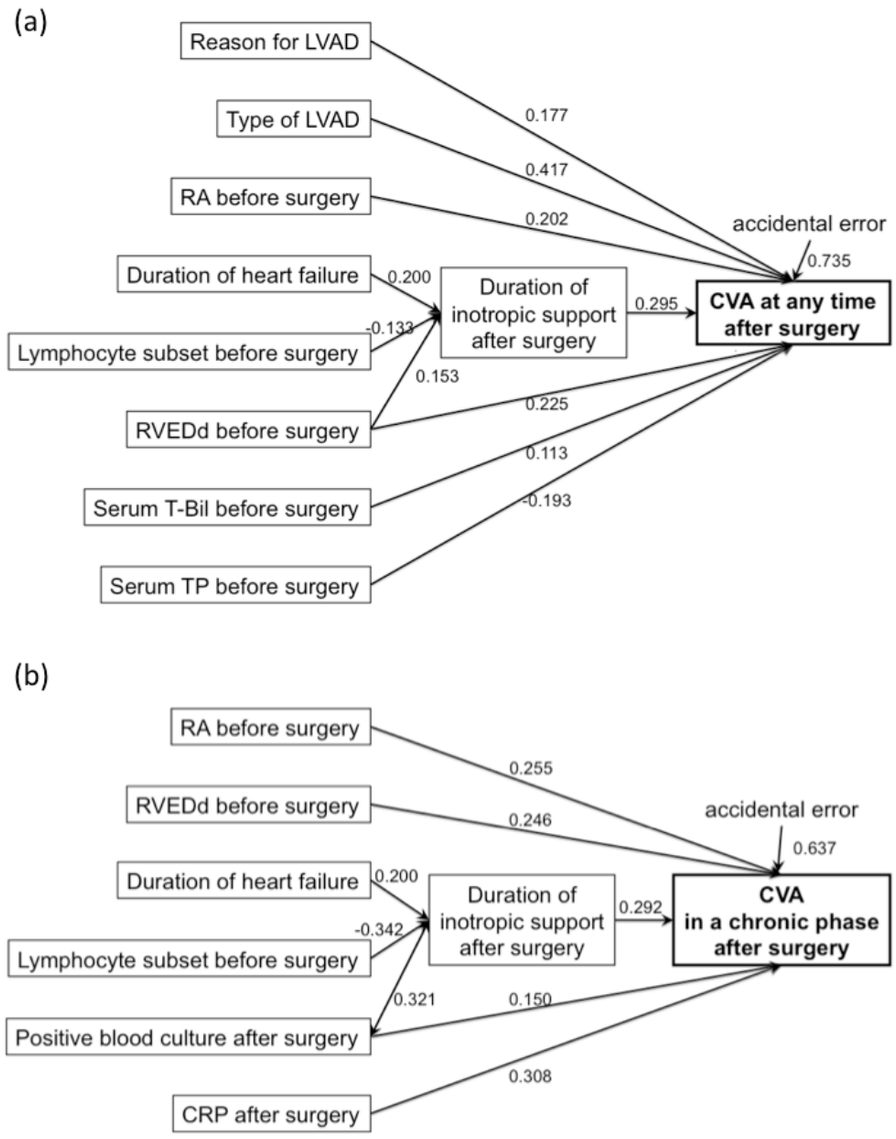


Fig. 2. (a) A path diagram based on the hierarchical multiple regression analysis for all studied patients. Observed variables are delineated by squares. Unidirectional arrows indicate cause-and-effect relationships. The number next to each arrow indicates the path coefficient of the standard partial regression coefficient. The regression error is added without delineation. (b)The path diagram based on the hierarchical multiple regression analysis for patients survived longer than 3 months without CVA. Observed variables are delineated by squares. Unidirectional arrows indicate cause-and-effect relationships. Bidirectional arrows indicate reciprocal cause-and-effect relationships. The number next to each arrow indicates the path coefficient of the standard partial regression coefficient. The regression error is added without delineation. (Adopted from Nakajima et al. Circ J)

3.2 Risk factors for CVA in a chronic phase after LVAD surgery

Because of the long waiting period supported by LVAD for transplant such as beyond 2 years in Japan, a certain amount of patients develop CVA in a chronic phase after LVAD surgery. Therefore, Nakajima et al. also performed the analysis to find factors associated with CVA in the chronic phase after surgery by excluding patients who had CVA in an acute phase or who had died within 3 months after surgery.

For this sub-analysis, duration of heart failure was longer ($p=0.012$), myocardial fibrosis was severer ($p=0.034$), duration of post-LVAD inotropic requirement was longer ($p<0.0001$), mRA was higher ($p=0.0005$), the pre-LVAD lymphocyte subset of peripheral blood was lower ($p=0.008$), and pre-LVAD RVEDD was larger ($p=0.0006$) in patients with CVA later than 3 months from the surgery compared to those who never developed CVA after surgery. In addition, the proportion of patients who had positive blood cultures was higher ($p=0.0002$) in patients who developed CVA in a chronic phase. The post-LVAD serum creatinine concentration ($p=0.011$) and C-reactive protein level (CRP) ($p<0.0001$) were higher in patients who developed CVA in a chronic phase than who never developed CVA after surgery.

A discriminant function test revealed that a discriminant score (Z) defined using the following equation yielded the discriminant probability of 85.9 %:

$$z=-10.0754 + (0.212146\times \text{mRA}) + (0.179936\times \text{RVEDd}) + (2.03552\times [\text{blood culture positivity after surgery; 1=positive, 0=negative}]) + (0.787837\times \text{CRP})$$

where $Z > 0$ indicates 3 months survivors after LVAD surgery developing CVA subsequently and $Z < 0$ indicates patients would never develop CVA.

The hierarchical analysis for evaluating interactions of factors associated with chronic phase CVA again revealed that both duration of heart failure and lymphocyte subset before surgery were indirectly associated with CVA through their effect on duration of inotropic support after surgery (Figure 2b). Here again, patients with longstanding heart failure associated with accompanied right heart failure and those with post-operative infection would be at higher risk for developing CVA in a chronic phase after LVAD surgery.

Multivariate regression analysis for CVA at any time after surgery and CVA in a chronic phase after surgery were shown in Table 1.

Although the population of the above study was different from heart failure patients in the US or European countries, the combination of pre-LVAD right heart failure and post-LVAD infection contribute to chronic phase CVA after surgery is worthwhile information.

4. Prothrombin complex concentrate for rapid reversal of warfarin-induced anticoagulation in patients with hemorrhagic stroke supported by left ventricular assist device

4.1 Prothrombin complex concentrate

Development of hemorrhagic stroke is one of the most serious complications in patients supported by LVAD, who require extensive oral anticoagulant therapy (Leitz K et al. , 2007). Hemorrhagic stroke associated with anticoagulation has a high mortality, and more than 50% of patients die within 30 days (Sjöblom L et al., 2001). Thus, warfarin-related hemorrhagic stroke is considered a medical emergency especially for patients supported by LVAD. Nevertheless, there are no guidelines for reversal of anticoagulation for such patients.

Parameter	OR (95% CI)	Discriminant score (95% CI)	*p* value
Associated factors for overall CVA development at any time after surgery			
cardiomyopathy	4.79 (1.31-17.4)	1.56 (0.28-2.86)	0.018
left atrium drainage Toyobo®	32.8 (8.39-128.4)	3.49 (2.12-4.86)	<0.0001
Mean RA before surgery (mmHg)	1.13 (1.04-1.23)	0.12 (0.04-0.21)	0.005
T-Bil before surgery (mg/ dL)	1.20 (0.95-1.52)	0.18 (-0.05-0.41)	0.12
TP before surgery (mg/ dL)	0.35 (0.17-0.74)	-1.05 [-1.80-(-0.30)]	0.006
RVEDd before surgery (mm)	1.17 (1.07-1.28)	0.15(0.06-0.24)	0.001
Associated factors for chronic phase CVA development			
Mean RA before surgery (mmHg)	1.24 (1. 07-1.42)	0.21 (0.07-0.35)	0.004
RVEDd before surgery (mm)	1.20 (1.06-1.34)	0.18 (0.05-0.31)	0.006
blood culture positive after surgery	7.66 (1.50-39.0)	2.04 (0.41-3.66)	0.015
CRP after surgery (mg/ dL)	2.19 (1.47-3.25)	0.78 (0.39-1.18)	0.0002

Table 1. Multivariate stepwise forward selection analysis of associated factors for CVA. (Adopted from Nakajima et al. Circ J2011)

The anticoagulation effect of warfarin is related to its ability to inhibit synthesis of the vitamin K-dependent clotting factors II, VII, IX, and X. The appropriate way to reverse the anticoagulation effect of warfarin depends on the clinical situation. Minor or asymptomatic bleeding needs a less aggressive reversal, whereas serious bleeding requires rapid reversal to avoid succeeding fatal events, regardless of the reason for anticoagulation. For major bleeding, guidelines recommend the administration of vitamin K (5 mg i.v. or oral), and/ or PCC (50 U/ kg), and/ or FFP (15 ml/ kg) (British Committee for Standards in Haematology. 1998; Ansell Jet al., 2001).

However, reversing warfarin-induced anticoagulation by vitamin K is time consuming (Aguilar MI et al., 2007). Reversing anticoagulation with vitamin K requires 4 to 24 hours, then might cause a fatal situation after hemorrhagic events, and also its persistent effect may promote clot formation. Thus, vitamin K administration is not an adequate treatment as an emergent treatment to stop further bleeding for patients with intracranial haemorrhages supported by LVAD.

The administration of fresh frozen plasma (FFP) requires substantial intravenous volume (Aguilar MI et al., 2007), which is not adequate for patients with heart failure. Prothrombin complex concentrate (PCC), which contains a high concentration of the vitamin K-dependent coagulation factors II, VII, IX, and X, has been reported to be effective for rapid reversal of warfarin-induced anticoagulation. The PCC promotes a much more rapid reversal of (PT)- international normalized ratio (INR) than FFP or/ and vitamin K (Steiner T et al., 2006; Aguilar MI et al., 2007) which is explained by its higher concentration of coagulation factors than FFP. The PCC product (PPSB-HT®; Nihon Pharmaceuticals, Tokyo, Japan) became available at our institution since 2001, and it has been used for emergency reversal of warfarin-induced anticoagulation such as hemorrhagic stroke, intraabdominal haemorrhage and cardiac tamponade.

4.2 Our experience of using prothrombin complex concentrate

Takahashi et al. reviewed 38 consecutive hemorrhagic stroke events occurred in patients supported by LVAD for bridge-to-transplantation between 1996 and 2007 at National Cerebrovascular Center, Osaka, Japan (Takahashi A et al., 2010). Fourteen hemorrhagic strokes were treated by FFP and 24 hemorrhagic strokes were treated by PCC. The FFP was initially administrated after the evens at the dosage of body weight (kg) × 0.08 × (100-hematocrit/ 100) × 0.3 × 0.2 × 1000 (ml). If the PT-INR was still greater than 2 after the initial FFP administration, additional FFP was administrated. In patients who were treated with PCC, the initial dosage of 500 to 1000 units were administered for 30 to 60 minutes, and if the INR was greater than 2 after the initial PCC administration, additional PCC was administrated. The proportion of patients' survival after the hemorrhagic stroke was significantly smaller in those treated with FFP administration than those who were treated with PCC (35.7% vs. 75.0%, $p < 0.05$). Only 18% of patients who were treated with FFP could be back on the transplant waiting list, while 58% of patients treated with PCC could be back on the waiting list. None of the patients who were only treated with FFP and not received PCC were able to undergo heart transplantation, whereas 21.4% patients who were treated with PCC successfully underwent heart transplantation.

Representative computed tomography scans from a patient treated with FFP and a patients receiving PCC were shown in Figure 3.

Several studies demonstrated the effect of recombinant activated factor VII on warfarin reversal and reported successful results treating hemorrhagic stroke events (Deveras RAE et al., 2002). Further studies are required to establish the difference of the effect of warfarin reversal between PCCs and recombinant activated factor VII.

5. Conclusion

Patients' general condition including malnutrition, in addition to device selection, would contribute to overall CVA development after surgery. In the chronic phase after surgery, pre-LVAD right heart failure and post-LVAD systemic infection were highly associated with CVA development. It was noteworthy that post-operative infection was selected as discriminating factors for CVA development in a chronic phase. An association of right heart dysfunction with a high mortality rate after LVAD surgery has been reported, although the association between pre-LVAD right heart failure and post-LVAD CVA was not fully evaluated. The longstanding heart failure might cause not only biventricular failure but also systemic vascular dysfunction including cerebral blood vessel. In addition, patients with biventricular failure required a long duration of inotropic support after LVAD. Long-term inotropic dependency due to right heart failure might cause line infections leading to systemic infection.

This unique situation surrounding LVAD issues in Japan may have influenced the results of this study, especially with respect to early postoperative outcome. The number of patients on devices as a 'destination therapy' has been increasing worldwide. Even in the era of new generation devices, CVA remains to be important complication. In that sense, we believe that the information described in this chapter are helpful in the long-term management strategies from the perspective of CVA risk stratification in patients on destination therapy devices.

Administration of PCC can result in a prompt reversal of warfarin-induced anticoagulation, and could be of importance for the survival of patients supported by LVAD, who require intensified anticoagulation therapy and who are at high risk for hemorrhagic stroke.

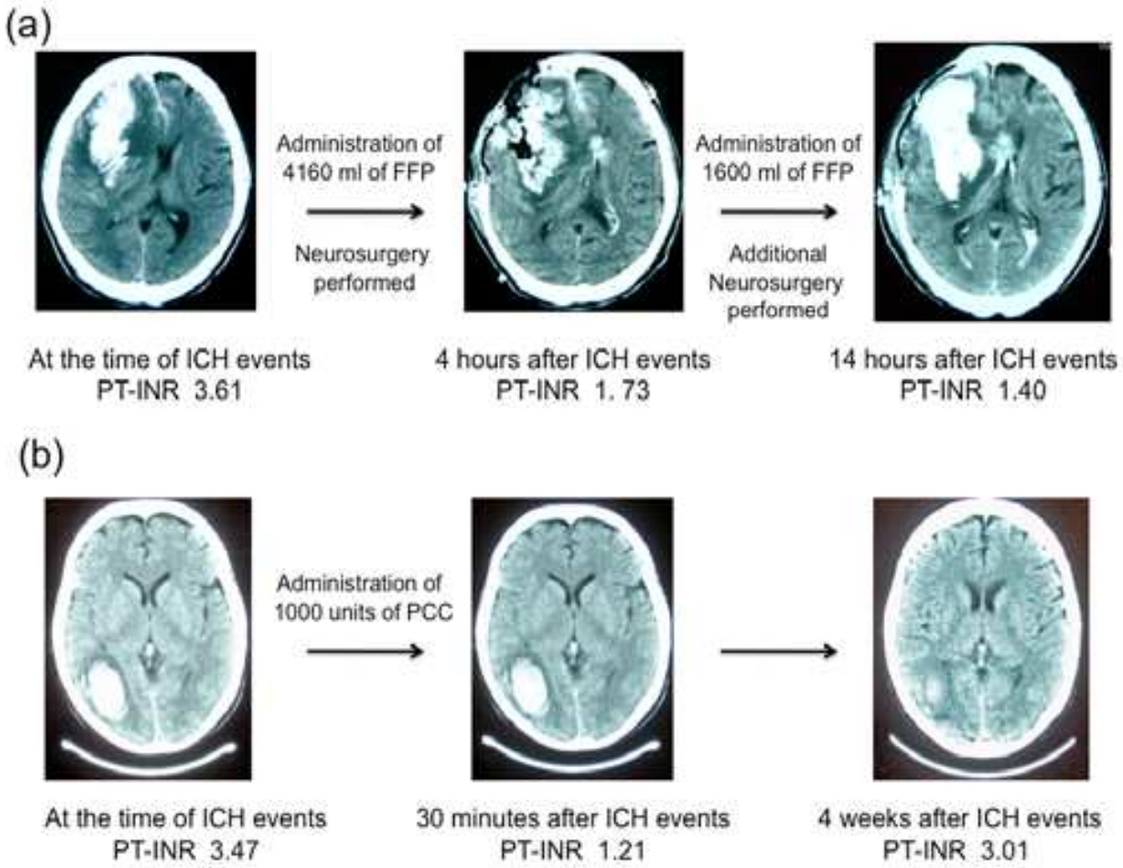


Fig. 3. Representative images of computed tomography head scan from patients in Group FFP (a) and in Group PCC (b). (a) A 50-year-old male developed ICH in the right frontal lobe with a PT-INR of 3.61. After 4160 ml of FFP administration resulting in PT-INR of 1.73, the patients required neurosurgery. Due to residual ICH, the patient required additional neurosurgery but eventually died. (b) A 41-year-old female developed ICH in the right posterior lobe with a PT-INR of 3.47. The immediate administration of 1000 units of PCC resulted in the PT-INR of 1.21 within 20 minutes. The patient underwent heart transplantation 2.8 years after the ICH event without neurological after-effects

6. Acknowledgement

The year 2010 was the dawn of a new era of LVAD/ transplant issues in Japan. In December 2010, implantable continuous-flow LVADs [Evaheart™ (Sun Medical Corp, Nagano, Japan) and DuraHeart™ (Terumo Heart Inc, Tokyo, Japan)] finally obtained Manufacture and Sales approval from the Ministry of Health, Labor, and Welfare. The Revised Organ Transplant Law went into effect in July 2010, allowing both adults and children to have a chance to be donors as well as recipients. The number of transplants has dramatically increased since then. Until the revision of the Organ Transplant Law, a number of Japanese patients chose to undergo transplantation abroad, mostly in the US or Europe. We all Japanese would like to express our deep appreciation to the entire European/ US populations for accepting Japanese patients as their transplant recipients to date.

7. References

Aguilar MI, Hart RG, Kase CS, et al. Treatment of warfarin-associated intracerebral haemorrhage: literature review and expert opinion. Mayo Clin Proc 2007; 82:82–92.

Ansell J, Hirsh J, Dalen J, Bussey H, et al. Managing Oral Anticoagulant Therapy. Chest 2001; 119:22S–38S

British Committee for Standards in Haematology. Guidelines on oral anticoagulation: third edition. Br J Haematol 1998; 101:374–87.

Deveras RAE, Kessler CM. Reversal of Warfarin-Induced Excessive Anticoagulation with Recombinant Human Factor VIIa Concentrate. Ann Intern Med. 2002. 137: 884-888.

Fukushima N, Ono M, Nakatani T, Minami M, Konaka S, Ashikari J. Strategies for maximizing heart and lung transplantation opportunities in Japan. Transplant Proc. 2009; 41: 273-6.

Hashimoto S, Kato TS, Komamura K, Hanatani A, Niwaya K, Funatsu T, Nakatani T, Kobayashi J, Sumita Y, Tanaka N, Hashimura K, Asakura M, Kanzaki H, Kitakaze M. J Cardiology. 2011 Jan; 57:215-22.

Holman WL, Kormos RL, Naftel DC, Miller MA, Pagani FD, Blume E, Cleeton T, Koenig SC, Edwards L, Kirklin JK. Predictors of death and transplant in patients with a mechanical circulatory support device: a multi-institutional study. J Heart Lung Transplant 2009; 28:44-50.

Lietz K, Long JW, Kfoury AG, et al. Outcome of LVAS as Destination Therapy. Outcomes of left ventricular assist device implantation as destination therapy in the post-REMATCH era: implications for patient selection. Circulation 2007; 116:497–505.

Nakajima I, Kato TS, Komamura K, Takahashi A, Oda N, Sasaoka T, Asakura M, Hashimura K, Kitakaze M. Pre- and Post-Operative Risk Factors Associated With Cerebrovascular Accidents in Patients Supported by Left Ventricular Assist Device. Circ J 2011; 75: 1138 – 1146.

Oda N, Kato TS, Komamura K, Hanatani A, Mano A, Hashimura K, Asakura M, Niwaya K, Funatsu T, Kobayashi J, Wada K, Hashimoto S, Ishibashi-Ueda H, Nakano Y, Kihara Y, Kitakaze M. Clinical course and outcome of heart transplant recipients: single center experience at the National Cardiovascular Center in Japan. Int Heart J. 2010; 51:264-71.

Oda N, Kato TS, Komamura K, Patel J, Kobashigawa JA. Retrospective review of Japanese patients undergoing heart transplantation in Japan compared with those undergoing transplantation in the United States. J Heart Lung Transplant. 2010; 29:1076-8.

Rose EA, Gelijns AC, Moskowitz AJ, Heitjan DF, Stevenson LW, Dembitsky W, et al.; Randomized Evaluation of Mechanical Assistance for the Treatment of Congestive Heart Failure (REMATCH) Study Group. Long-term mechanical left ventricular assistance for end-stage heart failure. N Engl J Med 2001; 15; 345:1435-43.

Saito S, Matsumiya G, Sakaguchi T, Miyagawa S, Yoshikawa Y, Yamauchi T, Kuratani T, Sawa Y. Risk factor analysis of long-term support with left ventricular assist system. Circ J. 2010 25; 74:715-22.

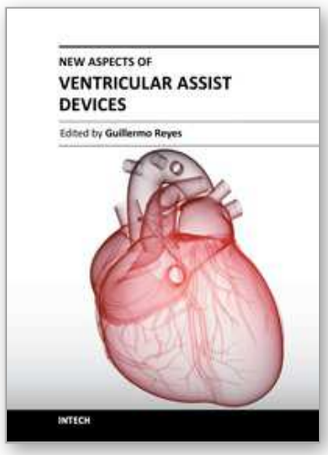
Saito S, Matsumiya G, Sakaguchi T, Fujita T, Kuratani T, Ichikawa H, et al. Fifteen-year experience with Toyobo paracorporeal left ventricular assist system. J Artif Organs. 2009; 12:27-34.

Sasaoka T, Kato TS (corresponding), Komamura K, Takahashi A, Nakajima I, Oda N, Hanatani A, Mano A, Asakura M, Hashimura K, Niwaya K, Funatsu T, Kobayashi J, Kitamura S, Shishido T, Wada K, Miyata S, Nakatani T, Isobe M, Kitakaze M. Improved Long-Term Performance of Pulsatile Extracorporeal Left Ventricular Assist Device. JCardiology 2010; 56: 220-228.

Sjöblom L, Hårdemark HG, Lindgren A, et al. Management and prognostic features of intracerebral haemorrhage during anticoagulant therapy: a Swedish multicenter study. Stroke 2001; 32:2567–74.

Steiner T, Rosand J, Diringer M. Intracerebral haemorrhage associated with oral anticoagulant therapy: current practices and unresolved questions. Stroke 2006; 37:256–62.

Takahashi A, Kato TS, Oda N, Komamura K, Kanzaki H, Asakura M, Hashimura K, Niwaya K, Funatsu T, Nakatani T, Kobaashi J, Kitamura S, Shishido T, Miyata S, Takahashi J, Iihara K, Kitakaze M. Prothrombin Complex Concentrate for Rapid Reversal of Warfarin-Induced Anticoagulation in Patients with Intracerebral Haemorrhages Supported by Left Ventricular Assist Device. International Journal of Gerontology 2010; 4: 143–147.



New Aspects of Ventricular Assist Devices
Edited by Dr. Guillermo Reyes

ISBN 978-953-307-676-8
Hard cover, 134 pages
Publisher InTech
Published online 29, August, 2011
Published in print edition August, 2011

Ventricular assist device has become one of the standard therapies for the support and the management of the failing heart. Updating our knowledge about these devices is mandatory in order to improve patient outcomes. In this book we can read the efforts made by many physicians concerned with the treatment of heart failure with mechanical devices. We all hope that the information compiled by experts in ventricle assist devices in this book will help us all to do better our main task - heal patients.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Tomoko S. Kato, Kazuo Komamura, Ikutaro Nakajima, Ayako Takahashi, Noboru Oda and Masafumi Kitakaze (2011). Risk Factor Analysis and Management of Cerebrovascular Accidents in Japanese Patients Supported by Left Ventricular Assist Device, New Aspects of Ventricular Assist Devices, Dr. Guillermo Reyes (Ed.), ISBN: 978-953-307-676-8, InTech, Available from: http://www.intechopen.com/books/new-aspects-of-ventricular-assist-devices/risk-factor-analysis-and-management-of-cerebrovascular-accidents-in-japanese-patients-supported-by-l

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen