



ROLE OF BLOOD VITAMIN C LEVELS IN POST-OPERATIVE WOUND HEALING

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ABSTRACT

Background: Management of post-operative wounds is very challenging now a days as there are many factors which interfere in the normal physiology of wound healing. Vitamin C, a water-soluble vitamin, facilitates wound healing by enhancing the protective mechanism of the immune system and accelerates healing process through the synthesis of collagen. **Methods:** In this prospective study, we seek to determine the role of Vitamin C in wound healing by determining its blood levels in 60 post-operative in-patients who had had elective or emergency surgery including those with co-morbid conditions like diabetes, hypertension and chronic kidney disease. All of them had their blood Vitamin C levels assayed and those with Vitamin C deficiency were supplemented with Vitamin C tablets and their wound status assessed over their recovery period. Data are expressed as percentages and Pearson Chi-square test was used compare the frequency between the groups and $p < 0.005$ was considered statistically significant. **Results:** 22 patients had vitamin C deficiency of whom 20 patients had post-operative wound improvement with high dose vitamin C supplementation and 2 had poor wound healing ($p < 0.001$). **Conclusion:** We conclude that supplementation of high dose vitamin C (1000mg/day) to patients with deficiency significantly hastened wound healing with improved final outcomes.

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INTRODUCTION

Wound healing is a normal biological process of repairing insults to the integumentary system in human body. Factors that interfere with one or more phases of healing process cause improper or impaired wound healing. The process starts immediately after an injury and may continue for months or years, and is essentially the same for all types of wounds. Management of post-operative wounds is challenging now a days as many factors are involved in it such as co-morbidities, risk factors etc. While advances have been made in infection control practices, including improved operating room ventilation, sterilization methods, barriers, surgical techniques and availability of antimicrobial prophylaxis, surgical site infections remain a substantial cause of morbidity and mortality among hospitalized patients. In some cases, the post-operative wounds do not readily heal in spite of antibiotics and conventional wound management.

In such cases, improvement of the patient's general condition is key. Micro-nutrients aid in healing wounds by providing the essential building blocks and enzyme co-factors needed by the cells to maintain all their normal tasks. Vitamin C, a water-soluble vitamin is critical in wound healing by enhancing the protective mechanism of the immune system and accelerates healing process through the synthesis of collagen. In addition, if blood vitamin C levels of the patients are assessed and if it is found to be deficient and the same is supplemented, it plays a vital role in accentuating the healing process of the post-operative wounds. This study purports to determine the role of vitamin C in the healing process of all post-operative wounds.

MATERIALS AND METHODS

This prospective analytical study was carried out in the Department of General Surgery, Thanjavur Medical College over a period of one year (January 2018 to December 2018) on 60 subjects.

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Post-operative patients who have had both elective and emergency surgery and post-operative patients with comorbid conditions like diabetes mellitus, hypertension and chronic kidney disease have been included in this study. Post-operative patients with traumatic wounds, patients with preoperative diabetic wounds and those who were previously undergoing chronic treatment for any ailments other than diabetes mellitus, hypertension or chronic kidney disease and patients with collagen vascular disease were excluded from the study. The post-operative wound status was studied and this included the assessment of the wound bed, the wound edges and the wound measurements. Biochemical parameters included blood vitamin C levels, haemoglobin, serum albumin levels, blood glucose levels and renal function tests. Vitamin C levels were assessed by commercially manufactured assay kits (Elabscience) using the calorimetric method. The most obvious chemical activity of Vitamin C is that it reduces ferric (Fe³⁺) to ferrous (Fe²⁺) which reacts with phenanthroline and the colour-changing reaction occurs. We measured the optical density (OD) values from spectrophotometry (536 nm) and deduced the Vitamin C levels indirectly.

RESULTS

Of the 60 post-operative patients included in this study, 37 were male and 23 were female. Age of the patients studied ranged from 30 to 85 years. In this study, 22 patients were found to be deficient of vitamin C which included 16 male and 6 female patients.

Statistical Analysis

Mean age of patients: 57.08 years

Mean vitamin C level: 7.11 micrograms/deciliter

Mean of vitamin C level in Vitamin C deficient patients: 3.36 micrograms/deciliter

Percentage of patients with vitamin C deficiency: 36.67%

Mean age of patients with vitamin C deficiency: 57.63 years

Percentage of patients with wound improvement after high dose vitamin C supplementation in the study group: 90.91%

Percentage of patients with poor response after high dose Vitamin C supplementation in the study group: 9.09%

Percentage of patients with wound improvement with normal value of vitamin C levels in control group after two weeks of regular dose of Vitamin C supplementation: 93.75%

Percentage of patients with poor wound improvement with normal value of vitamin C levels in control group after two weeks of regular dose of vitamin C supplementation: 6.25%

Of the 12 patients with Diabetes mellitus (DM) included in this study, 6 had vitamin C deficiency and 4 out of the 10 hypertensive patients had vitamin C deficiency. 8 patients had both Diabetes mellitus and hypertension and 3 of them had vitamin C deficiency. Patients with risk factors such as alcohol addiction, smoking, anaemia, chronic kidney disease (CKD) and hypoalbuminemia were also included in this study. In this

study, of the 6 alcoholics 1 had vitamin C deficiency, among the 17 smokers 11 had vitamin C deficiency, 4 out of 5 patients who both had alcoholic addiction and smoking were found to be deficient in vitamin C. 6 out of 17 anaemic patients, 2 out of 5 CKD patients and 4 out of 7 patients with hypoalbuminemia were found to have vitamin C deficiency. In this study, 50 patients underwent emergency surgeries and 10 patients underwent elective surgeries. Of this, 21 patients in the emergency surgery category and 1 patient in elective surgery category were found to be Vitamin C deficient. All the 22 patients with vitamin C deficiency were supplemented with high dose vitamin C (1000 mg/day) and the post-operative wound healing was assessed over the next few weeks and months. It was found that 20 patients had considerable wound improvement (90.91%). The level of significance $t(3) = 30.454$, $p < 0.001$.

DISCUSSION

Vitamin C, a water-soluble vitamin is essential to the formation of collagen in a healing wound. The enzymes critical to forming collagen cannot function without their co-factor Vitamin C. Various clinical studies provide evidence that wound healing in subjects judged not deficient in Vitamin C can be significantly accelerated with supplements of this nutrient above the recommended daily allowance. The researchers administered daily doses of 500 to 3000 mg which is roughly 8 to 50 times the RDA of 60 mg to subjects recovering from surgery, other injuries, decubitus ulcers and leg ulcers induced by haemolytic anaemias. The severity and healing of post-operative wound depends upon various factors such as the general condition of the patient, comorbidities like Diabetes mellitus, systemic hypertension and chronic kidney disease and risk factors like age, anaemia, hypoalbuminemia, smoking, alcohol, pre and post-operative infection, surroundings and environment etc. In the present study we found the role of vitamin C in post-operative wound healing and how important it is to decrease the morbidity in these patients by enhancing the healing process. Normal vitamin C value ranges from 6 – 20 microgram per decilitre. Blood samples were taken from all the patients who were included in this study and vitamin C levels were assessed. For those patients who had vitamin C deficiency, vitamin C was supplemented and after 2 weeks again vitamin C levels were studied and post-operative wounds were reassessed and accordingly the percentage of patients with wound improvement after vitamin C supplementation and those with no improvement were calculated. Subjects selected for the study included those who had undergone different surgeries and were treated with antibiotics and other supportive measures from the first post-operative day. All subjects in the study had their blood Vitamin C levels estimated post operatively by the colorimetric method. Regular dose of Vitamin C was administered to patients who had normal levels of blood Vitamin C while high doses were given to patients whose blood Vitamin C levels were suboptimal, with those patients who had undergone bowel resections receiving parenteral forms of Vitamin C. A section of patients with risk factors for delayed wound healing and those with poor wound status in the second and third post-operative week were picked up and their wounds assessed in terms of dimension, wound bed and wound edges along with the blood Vitamin C levels. Of the 60 patients in this study, 22 patients were found to have vitamin C deficiency post-operatively and were supplemented

Table 1. Patients with co-morbid conditions and other adverse risk factors

S.No.	Comorbid conditions and other risk factors	Frequency	Patients with Vitamin C deficiency	% with Vitamin C deficiency
1.	Diabetes mellitus (DM)	12	06	50.00
2.	Hypertension	10	04	40.00
3.	Both DM and Hypertension	08	03	37.50
4.	Chronic Kidney Disease	05	02	40.00
5.	Alcohol	06	01	16.66
6.	Smoking	17	11	64.70
7.	Alcohol and Smoking	05	04	80.00
8.	Anaemia	17	06	35.29
9.	Hypoalbuminemia	07	04	57.14
10	Patients over 60 years	15	05	33.33

Table 2. Vitamin C deficiency across different surgeries

S.No.	Type of Surgery	Number of patients	% of patients	Number of Vitamin C deficient patients	% of Vitamin C deficiency
1.	Laparotomy	46	76.66	17	36.95
2.	Incisional Hernia	03	05.00	00	00.00
3.	Obstructed Hernia	03	05.00	03	100.00
4.	Appendicular Perforation	05	08.33	01	20.00
5.	Modified Radical Mastectomy	02	03.33	01	50.00
6.	Paraumbilical Hernia	01	01.66	00	00.00
	Total	60		22	

Table 3. Total patients supplemented with Vitamin C

S. No	High dose vitamin C received	Frequency	Wound improvement seen	% of wound improvement	Poor wound healing	% of poor healing
1.	Yes	22	20	90.90	2	09.10
2.	No	38	35	92.10	3	07.90
	Total	60	55		5	

Table 4. Chi-square test

	Value	df	Asymptotic significance (2-sided)
Pearson Chi-square	30.545	3	0.000

p value <0.005 is significant.

with high doses of vitamin C in oral or parenteral forms. After two weeks, blood Vitamin C levels were rechecked in the deficient group and the wounds of all the subjects were assessed for the same physical parameters. After supplementation with vitamin C, 20 patients were found to have improvement in post-operative wounds and 2 with no improvement.

The unsatisfactory improvement is these two patients as well as the three patients in the group with normal Vitamin C levels was attributed to uncontrolled local infection and the existent co-morbid factors which impeded wound healing. The study of role of vitamin C level in wound healing in post-operative patients helps in early intervention in the treatment of wound management and in improving the general condition and wellbeing of the patient. While treating post-operative wounds, the general condition, co-morbidities, risk factors are usually considered. But, in addition to these, if vitamin C levels were assessed and their supplementation in deficient patients is carried out, better and quicker wound healing may follow. Vitamin C is crucial for the synthesis and maturation of collagen, the primary constituent of granulation tissue that heals a wound and the key component in blood vessel walls. Theoretical considerations regarding wound healing, overall safety and low cost have supported its use in surgical patients. Blood samples were taken from 60 patients who had post-operative wounds. In this study group 22 patients had vitamin C deficiency. 20 patients had post-operative wound improvement with high dose vitamin C supplementation and 2 with poor improvement.

We conclude that supplementation of high dose vitamin C (1000mg/day) to patients with pre-existing deficiency improved wound healing considerably as other patients in the study group treated with regular dose of vitamin C showed similar outcomes.

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Key points

- Ascorbic acid supplementation is not harmful to patients due to tight control of absorption and urinary excretion thereby justifying its use in all post-operative patients.
- We are led to understand that Vitamin C supplementation is a simple step in post-operative wound management, nonetheless it plays a significant role in accentuating wound healing in patients with and without co-morbid medical illnesses alike without any detrimental effects.

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