

Profile of Thyroid Hormones following Burn Injury

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ABSTRACT

Burn injuries constitute a worldwide problem. Developments in burn management have decreased mortality rates in most technologically advanced countries. Such advances are not usually available in developing countries where the availability of the basic supplies, facilities and care-givers are the factors limiting adequate burn care. This coupled with lack of education; suspicion of Western medicine and hospitals makes burn care more challenging. Ninety burn patients (50 males and 40 females, aged 16-45 years, average 30 years) admitted to the Burn unit of a regional burn centre in Enugu, Nigeria, were Investigated for serum levels of Thyroxine (T_4), Triiodothyronine (T_3), Reverse Triiodothyronine (rT_3), Free thyroxine (FT_4), Free triiodothyronine (FT_3) and Thyroid Stimulating hormone (TSH). The patients were divided into 4 groups according to percent total body surface area (%TBSA) affected by the burn. Healthy individuals (16-45 years) who had no burn were used as control. Blood collection started on the third postburn day at 2-day intervals for 3 weeks at the first instance and weekly for the next 9 weeks. The results revealed some biochemical Imbalance following burn Injuries. Serum concentrations of T_4 , T_3 , FT_3 and FT_4 were significantly decreased ($P < 0.05$) while serum levels of rT_3 were markedly elevated. Both FT_4 and FT_3 were significantly ($p < 0.05$) suppressed to levels indicative of biochemical hypothyroidism.

Keywords: Burns: Thyroid hormones: Imbalance

INTRODUCTION

Burns imply damage or destruction of the skin and /or its content by thermal, electrical and radiation energies, chemical reaction or their combination [1]. Burn Injuries have not only a high mortality rate but a very disturbing morbidity rate [2]. Burns are incurred through carelessness and are paid as the price of civilization [3, 4, 5]. Immediately following burning a series of pathological changes occurs and an untreated patient will pass into a state of shock [6, 7 and 2]. The liver cell is especially liable to injury because of its function of taking up and dealing with many toxic substances or chemicals [9, 10]. Burns remain a huge public health issue especially in developing

countries and from time immemorial there have been multiplicity of treatments suggested for burns and this is regarded as an index of our ignorance of the subject [11]. The difference between success and failure in treatment depends much on thorough clinical evaluation of the individual patient [12].

Rationale of Study

Burns result in fluid shift and loss, hypoxia and production of endotoxins which alter the liver, kidney and body metabolism [13, 14, 15]. Data characterizing endocrine response to burn injury are lacking [16, 17]. The sequence of biochemical events associated with burn injury are not all unraveled [18]. Little concrete literature dealing with 'measurables' exists in burn care [19, 20].

Thyroid hormones are biotransformed/metabolised in the liver and kidney and their function in the body is the maintenance of body metabolism [21, 22, 23]. Endocrine response to burns has become imperative since in the ebb or initial shock phase there are both fluid loss from the injured area and large fluid shifts between body fluid compartments [24, 25]. This study was aimed at evaluating the changes that occur in the levels of thyroid hormones in burn patients.

METHODOLOGY

The study was approved by the Research, Education and Training committee of the institution. Ninety burn patients (50 males and 40 females, aged 16 - 45 years) admitted to the Burn unit were investigated in a study period of seventeen months. Each patient was assessed using the Lund and Browder chart for estimating severity of burn wound. The patients were divided into four groups according to percent total body surface area (%TBSA) affected. Group A had 15-34 %TBSA affected; Group B, 35-54 % TBSA; Group C, 55-74% TBSA and Group D, 75% TBSA and above affected. Blood collection started on the third post burn day at 2-day intervals for the first three weeks post burn at the first instance and weekly for the following nine weeks. Serum was separated from the blood cells by centrifugation at a speed of 3000 revolutions per-minute for 5 minutes

using a temperature- regulated centrifuge (CRU-5000, Damon IIEC Division and London) and kept frozen until analyzed. Healthy individuals matched for age and sex were used as controls. Thyroid hormone levels, thyroxine [T_4], Triiodothyronine [T_3], Free triiodothyronine [FT_3], Free thyroxine [FT_4], Reverse triiodothyronine [rT_3] and Thyroid stimulating hormone (TSH) were determined by enzyme linked immunosorbent assay (ELISA MAT 300, Diagnostic Research company, Germany).

Statistical Analysis

The results obtained were expressed as mean \pm standard deviation and percentage. Statistical analysis was performed using analysis of variance (ANOVA) and correlation coefficient between the mean values of each group of patients and the control. Statistical significance was defined as $p < 0.05$.

RESULTS

During the acute phase of injury, mean serum T_4 value was $4.85 \pm 3.15 \mu\text{g/dl}$ compared with a control value of $9.0 \pm 4.0 \mu\text{g/dl}$. This showed 46% decrease. Significant suppression ($p < 0.05$) of serum concentration of T_3 was also observed. Serum T_3 level decreased from a control value of $1.35 \pm 0.5 \text{ ng/ml}$ to $0.75 \pm 0.4 \text{ ng/ml}$. The decreased serum concentrations of T_4 and T_3 (fig. 1 & 2) may probably reflect a fall in thyroid binding globulin capacity associated with severe trauma or illness. Serum levels of rT_3 were markedly elevated (fig.3). This shows a reciprocal alteration in the serum levels of T_3 and rT_3 . FT_3 decreased from a control value of $2.8 \pm 1.44 \text{ pg/ml}$ to $1.8 \pm 1.0 \text{ pg/ml}$ (35.7%) while FT_4 decreased from $1.4 \pm 0.6 \text{ ng/dl}$ to $0.75 \pm 0.35 \text{ ng/dl}$. Changes in TSH secretion were slight and variable but within the normal limits. We noted TSH elevations in eight patients. Serum T_4 and FT_4 were lower in females than in males while serum T_3 and FT_3 were about the same in both sexes.

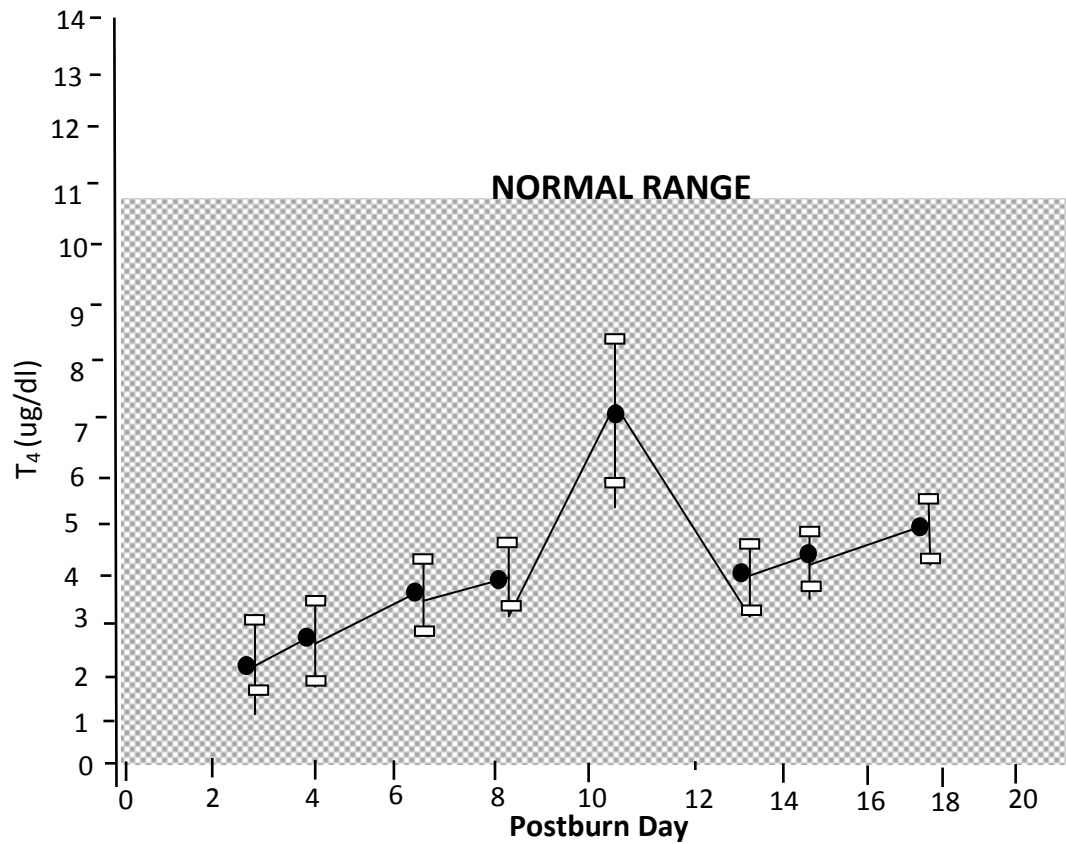


Fig.1: T₄ values during the first 3weeks after burn injury. Values were below the shaded normal range but with a rise to normal until day 14 when a fall was again observed

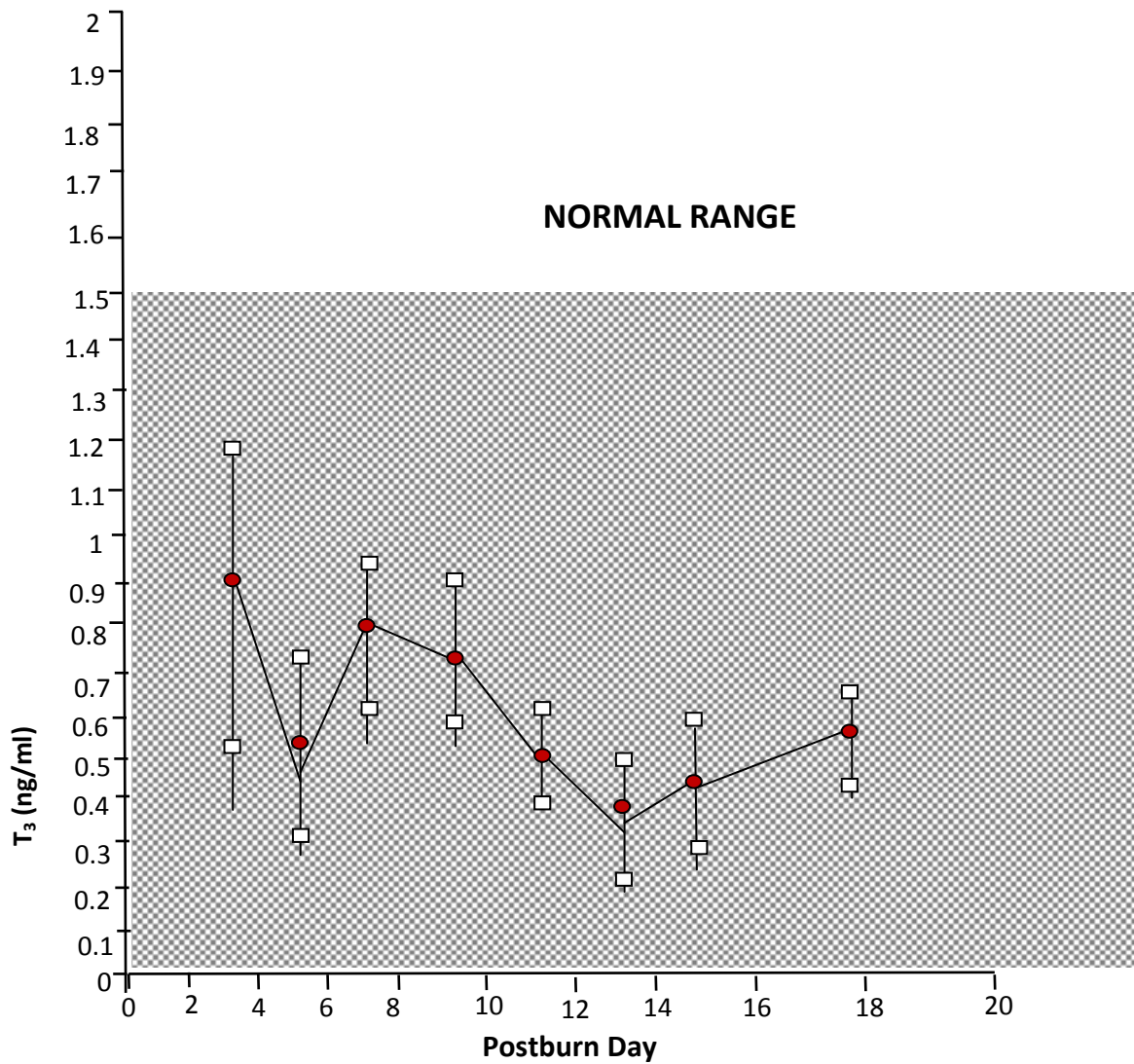


Fig.2: T₃ values during the first 3 weeks after burn injury. T₃ levels were low up to day 14 when there was an insignificant rise below normal range.

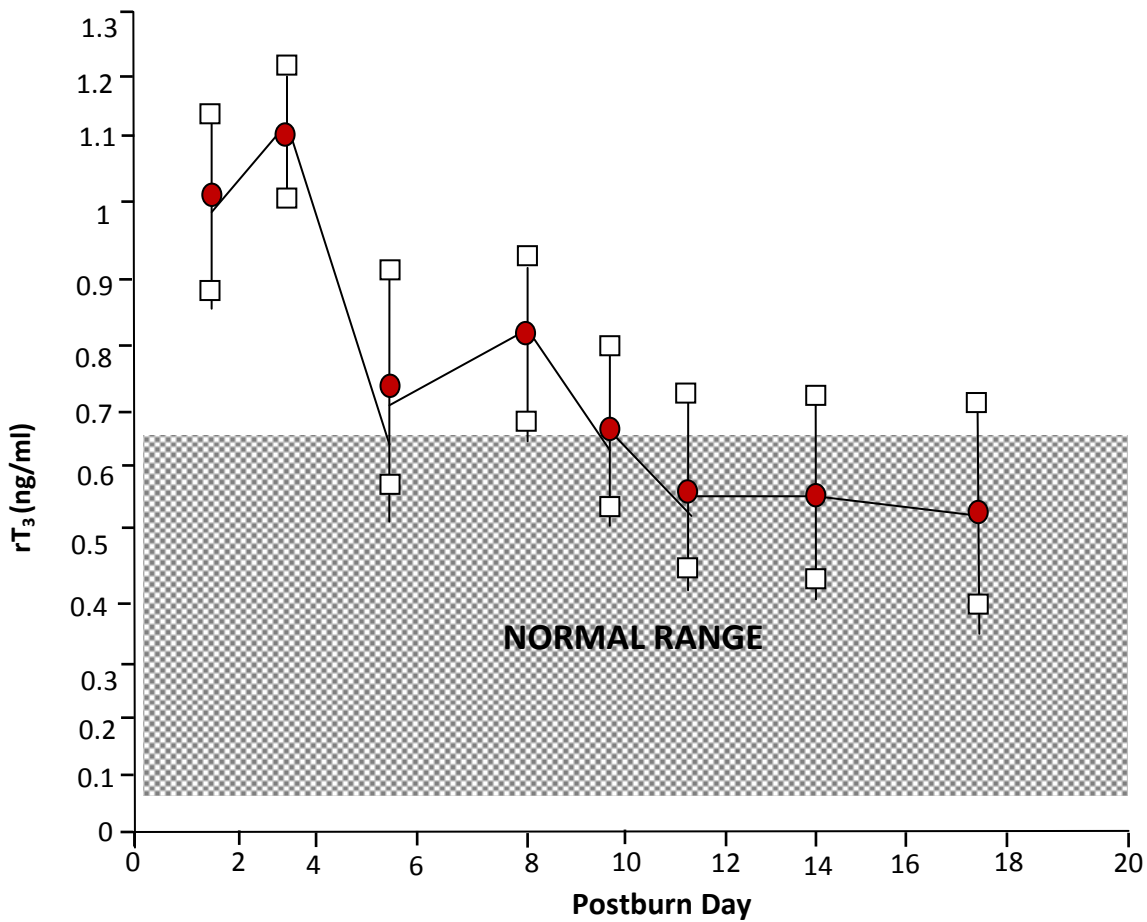


Fig. 3: rT_3 values during the first 3 weeks after burn injury. There was a sharp rise in rT_3 as early as Day 2.

DISCUSSION

The effect of the burn Injury and its clinical consequences are wide spread and long lasting. A study of burn patients revealed biochemical Imbalances in thyroid hormones concentrations especially in patients with severe burn. Serum concentration of T_4 , T_3 , rT_3 , FT_3 and FT_4 were significantly altered. Eight of the patients had only slight elevations of TSH suggesting that T_4 and especially FT_4 may have a significant role in feedback mechanism of the hypothalamic-pituitary axis. Significant decreases ($P < 0.05$) between control and burn patients were found in the serum levels of T_4 , T_3 , FT_3 and FT_4 from the first week post burn to the 9th week especially in the 75% TBSA burn and above affected. Elevations of serum

concentrations of rT_3 also followed the same pattern and imply that burn Injury has a direct Impact on thyroid hormone metabolism.

The alterations in serum concentrations of T_3 and rT_3 reflect a shift in the metabolism of T_4 from pathways which lead to the generation of T_3 to pathways which lead to the generation of rT_3 , a hormone with little biological activity. It has also been stated that a decrease in metabolic clearance rate of rT_3 without an increase in production rate accounts for the increase in serum concentration of rT_3 [26]. This is further explained by the fact that after the degradation from T_4 to rT_3 , there are further progressive deiodination and that unlike rT_3 , the di-iodo and mono-iodo products may actually act to inhibit the conversion of T_4 to T_3 and therefore produce an excess of inactive product [19].

The changes in peripheral thyroid hormone concentrations following burn Injury may be a reflection of altered peripheral hormone turnover, alteration in pool size or altered production or release of the hormones. Serum concentrations of T_3 , T_4 , FT_3 and FT_4 were significantly suppressed especially in the severely burned patients to levels indicative of biochemical aspects of hypothyroidism. The free thyroid hormones assess directly the metabolic impact of thyroid hormones on peripheral tissues and the low levels of these free hormones observed in burns may be of clinical importance since they reflect the amount of T_4 and T_3 available to the cell. Synthesis of cellular protein and rate of mitochondrial respiration might be on the decrease with decreased physiological concentration of thyroid hormones activity in plasma, partly due to greater proportion of free T_3 in plasma caused by its lower affinity for plasma binding proteins and partly due to T_3 having greater biological activity than T_4 [27].

The results of 6 patients who died during the first ten days following burn revealed that both total T_4 and T_3 were significantly suppressed. In the last seven days preceding, hormone levels were fatally low. T_4 concentration was in the range of 1.0ug/dl and T_3 in the range of 0.30ng/ml. In addition these patients had elevated TSH levels but the

TSH levels did not become elevated until very late in the course, that is within 2 days preceding death. This suggests that the pituitary did not recognize hypothyroidism until it had been exposed to very low serum concentrations of thyroid hormone for a sufficient period of time. It is important that clinicians collaborate with biochemistry department to monitor the severity of the initial disturbances and the effectiveness of the response to therapy.

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