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RECOVERY FOLLOWING ORTHOGNATHIC SURGERY

by

Herman Stewart Dickerson

A Thesis submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Science in the Department of Oral and Maxillofacial Surgery.

Chapel Hill

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HERMAN STEWART DICKERSON. Recovery Following Orthognathic Surgery.  
(Under the direction of Raymond P. White)

#### ABSTRACT

Thirty-eight patients undergoing orthognathic surgery between May 1989 and February 1993 reported their return to full activity and to work or school following surgery. Twenty-six patients had isolated bilateral sagittal split osteotomies (BSSO) and twelve had isolated Le Fort I osteotomies (LFI). Hemoglobin, hematocrit, weight and vital signs were determined preoperatively and for six weeks postoperatively. At 1-2 weeks post-operation, 50% of the BSSO group had returned to work or school while none of the LFI group had returned. By 3-4 weeks, 81% of the BSSO group had returned to work or school while nearly half of the LFI group still had not returned. More members of the BSSO group also returned to full activity sooner than the LFI group although the differences were not statistically significant. The LFI group had a larger mean estimated blood loss, length of operation and weight loss. None of the patients were transfused. There was no statistically significant difference between the two groups in the rate of return to preoperative hemoglobin levels.

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## LIST OF ABBREVIATIONS

ASA	American Society of Anesthesiologists
BSSO	Bilateral sagittal split osteotomy
LFI	Le Fort I osteotomy
POD	Postoperative day #1
POV1	Postoperative visit #1
POV2	Postoperative visit #2
POV3	Postoperative visit #3
PSD	Presurgery day

## INTRODUCTION

The bilateral sagittal split osteotomy (BSSO) and the Le Fort I osteotomy (LFI) are common operations for the surgical correction of dentofacial deformity. Many studies have investigated the results, stability and complications associated with these procedures. As a result, numerous modifications and improvements in techniques have been adopted by surgeons performing these procedures throughout the world. Recent advances in anesthetic and surgical techniques such as hypotensive anesthesia and rigid fixation have made the procedures safer, shortened the length of hospitalization and allowed more rapid recovery of function.<sup>1,2,3,4,5,6</sup> However, little data exist regarding patients' recovery of activity and return to school or work.

Neuwirth *et al* recently investigated patients' recovery from LFI operations alone or in combination with a BSSO.<sup>7</sup> Asymptomatic patients who were transfused postoperatively with predeposited autologous blood were compared to patients who were not transfused. Although a relationship between return to full activity and transfusion was observed, the investigators were surprised that nearly half of all the study patients did not return to their normal levels of activity for as long as twenty-eight days after their operations. No comparisons were made between types of operations.

Stewart *et al* investigated postoperative depression in six orthognathic surgery patients.<sup>8</sup> Patients were interviewed postoperatively and

were asked questions pertaining to symptoms of depression. One of the questions related to "energy." Four of the patients reported decreased energy which lasted from 3 to 6 weeks. Details of this fatigue were not presented but seemed to be associated with removal of maxillomandibular fixation at about 6 weeks in 2 patients. Types of surgical procedures were not specified.

Frost *et al* investigated psychological aspects of orthognathic surgery using questionnaires to collect subjective input from patients.<sup>9</sup> Two of the topics studied were "physical and/or psychological discomforts" and "length of time before discomforts abated", but the results of patient responses to these topics were not presented.

Lam *et al* questioned patients regarding changes in their patterns of recreational and social activities after orthognathic surgery.<sup>10</sup> Recreational and social activity was reduced after surgery and gradually increased to a level higher than before surgery at 4 months. At 9 months postoperation, both recreational and social activity had returned to preoperative levels. No data was collected from patients during the period from 3 weeks to 4 months after surgery.

Previous studies of orthognathic surgery patients have suggested that thorough preoperative education of the patient regarding the events following surgery results in fewer psychological problems and a more positive attitude toward the procedure.<sup>8,9,11,12</sup> Realistic expectations about postoperative physical activity and work or school therefore would seem to be beneficial. This study investigated the return to full activity and return to work or school in patients who underwent BSSO and LFI operations without any other procedures.

## REVIEW OF THE LITERATURE

Convalescence from orthognathic surgery as with other surgical procedures is a complex process that begins at the moment of surgical injury and involves more than wound repair. Kehlet described surgical convalescence as a process for restoring homeostasis, healing wounds and returning the organism to normal activity.<sup>13</sup> Convalescence is not only repair of the physical organism, but also restoration of a psychological sense of well-being, and a return to normal social functioning.<sup>14</sup> According to Powers convalescence terminates when the patient returns to the work which was interrupted when the patient entered the hospital for surgical treatment.<sup>15</sup> However, Sutherland observed that surgical convalescence continues until the patient has resumed his valued preoperative activities, a more diverse outcome than merely returning to work.<sup>16</sup>

Recovery after discharge from the hospital was studied by Baker who measured patients' progress through various stages from a sociological perspective.<sup>17</sup> Twenty-five patients recuperating from cholecystectomy were interviewed at intervals postoperatively. The major theme of the study emphasized recovery as a process of returning to normal. Three phases of recovery were identified: 1) the passivity phase during which the patient is highly dependent on others and engages only in self-care and sedentary activity, 2) the activity-resumption phase during which the patient gradually decreases reliance on others

and begins to resume pre-illness activities, and 3) the stabilization phase which is characterized by the resumption of normal activities, the support of others and normal social function.

Moore described four phases of recovery in more physiological terms.<sup>18</sup> An injury phase persisting usually from two to four days corresponds to the initial endocrine metabolic response to surgical trauma. Its duration is dependent upon the degree of trauma, and is accompanied by caloric starvation and catabolism of liver and muscle glycogen. This phase is followed by the "turning point" beginning from three to seven days after surgery and lasting one or two days. At this time ambulation increases, soft tissue wounds begin to acquire tensile strength and endogenous steroid levels return to normal. Reversal of catabolism to anabolism also occurs along with diuresis of salt and water. The muscular strength phase is next and occurs two to five weeks postoperation. It is marked by continued anabolism and positive nitrogen balance indicating resynthesis of muscle tissue and return of vigor. The final fat gain phase continues over several months. Normal strength returns, and soft tissue wounds mature.

These and other studies investigating recuperation from surgery, trauma and illness serve to illustrate a complex physiologic, psychologic and sociologic process occurring to restore the patient to the presurgical state. Numerous factors may affect the process and its ultimate outcome, but the complex process also presents opportunities to facilitate recovery. Several factors will be reviewed and these include postoperative fatigue syndrome, the endocrine metabolic response to surgery, nutrition, operative blood loss, immobilization, socioeconomic and psychologic factors.

### *Postoperative Fatigue Syndrome*

The postoperative fatigue syndrome is well known to surgeons.<sup>19,20,21</sup> After abdominal surgery, a pronounced feeling of fatigue has been observed in approximately one-third of the patients, persisting throughout the first month after surgery.<sup>13,21,22,23</sup> Although the exact etiology is unclear, it has been associated with a deterioration of the patient's postoperative nutritional status<sup>13,20,24</sup> and impaired cardiovascular response to submaximal work and orthostatic stress.<sup>19,21,22,24</sup> The magnitude of the surgical trauma is positively related to the development of postoperative fatigue since patients undergoing minor surgery such as middle ear surgery did not exhibit fatigue postoperatively.<sup>13,23</sup>

Christensen *et al* found a decreased capacity for skeletal muscle oxidative phosphorylation after surgery but could not correlate this finding to the development of postoperative fatigue.<sup>25</sup> They suggested that important factors in the pathogenesis of postoperative fatigue and the postoperative changes found in muscles could be the stress response to surgery, impaired nutrition intake during convalescence, and lack of exercise in the first month after surgery.<sup>25</sup> Postoperative fatigue is also related to other catabolic changes such as weight loss, decreased triceps skinfold thickness and decreased concentration of serum transferrin.<sup>22,24</sup>

Postoperative fatigue does not correlate with various preoperative and intraoperative factors such as age, gender, preoperative nutritional status and duration of surgery.<sup>13,22,23</sup> Postoperative fatigue cannot be predicted from the type and duration of anesthesia.<sup>22</sup> Regional anesthetic techniques may be capable of reducing the incidence of fatigue

probably by modulating the endocrine metabolic response to surgery.<sup>13</sup>  
Pain relief by itself does not affect the development of fatigue.<sup>26</sup>

### *Endocrine Metabolic Response*

The creation of a wound initiates a response in the body which at first seems to be biochemical chaos. The response is in fact a coordinated and determined attempt by the injured body to maintain homeostasis.<sup>24,27,28</sup> Wilmore *et al* described these events as a programmed response of the central nervous system to a variety of stimuli, all of which provoke the same response with only minor variations. The intensity of the response is dependent upon the magnitude of injury.<sup>28</sup> The centrally mediated response results in a hypermetabolic state characterized by weight loss, tissue catabolism, negative nitrogen balance, increased adrenergic activity and retention of sodium and water.<sup>24,27</sup> The process begins when afferent stimuli are conducted through various somatosensory and sympathetic pathways from the injured site and ultimately reach the hypothalamus.<sup>29</sup>

In addition to neural mechanisms initiating the endocrine metabolic response, circulating factors may also have an influence. For example, severe injury to a denervated limb may still result in an adrenocortical response. Potent humoral factors capable of producing proteolysis in rat muscle in vitro have been isolated from the plasma of seriously ill patients.<sup>29</sup> These substances also result in negative nitrogen balance and a sudden onset of increased gluconeogenesis. The exact nature of the humoral factors is unknown, but substances such as histamine, serotonin, prostaglandins, leukotrienes, bradykinins, substance-P, interleukin-1 and tumor necrosis factor could be participating.<sup>27,29</sup>

Once the signal is received by the hypothalamus, the response

proceeds on multiple fronts, both endocrine and neural in nature. The following summary is based on several excellent reviews of the subject.<sup>27,28,29,30,31</sup> Stimulation of the sympathetic nervous system results in increased catecholamine release from the adrenal medulla and sympathetic nerve endings with the resulting well-known adrenergic alterations of cardiovascular hemodynamics. There is an alteration in the hypothalamic setpoint for temperature regulation via the autonomic nervous system and body temperature rises. Corticotropin releasing factor from the hypothalamus results in increased secretion of adrenocorticotrophic hormone from the anterior pituitary and subsequent increase in circulating glucocorticosteroids of which cortisol is most prominent. Mineralocorticosteroids such as aldosterone are likewise increased in the circulation. Antidiuretic hormone, growth hormone and glucagon are increased while insulin and testosterone are decreased. Other endocrine responses such as increases in prolactin and melanocyte stimulating hormone are less well understood.

The aforementioned endocrine events lead to hyperglycemia, glucose intolerance, insulin resistance, skeletal muscle protein catabolism, lipolysis, retention of sodium and water and increased ureagenesis. A marked rise in urinary potassium, nitrogen, sulfur, phosphorous, magnesium, zinc and creatine accompanies the process. These disturbances are the signature of catabolism and mobilization of substrate for the mounting healing response.

It has been hypothesized that modification of the postoperative response to injury could result in reduced postoperative morbidity. However, no techniques to completely abolish the response to injury exist.<sup>29</sup> Anxiety and fear result in additional cortical stimulation of



hypothalamic centers which may augment the stress from surgery. Judicious use of anxiolytics could be beneficial in reducing this effect.<sup>28</sup> The effect of conventional systemic opiates on the endocrine metabolic response is inconclusive, and large doses of narcotic would be required to produce a meaningful response.<sup>29</sup>

Spinal or epidural anesthetic techniques can prevent a major part of the classical endocrine metabolic response to surgical procedures of the lower abdomen and lower extremity. Local anesthetics are more efficacious than opiates for spinal or epidural anesthesia.<sup>29</sup> However, these techniques are unsuitable for surgery above the low thoracic level. Also, spinal anesthesia that is clinically adequate by skin stimulation may not necessarily provide total neural blockade.<sup>29</sup> Shulze *et al* demonstrated that epidural local anesthetics and narcotics combined with a systemic non-steroidal anti-inflammatory drug produced complete pain relief but did not alter the catabolic response or the incidence of post-operative fatigue.<sup>26,32</sup>

Studies investigating epidural anesthesia combined with the administration of a prostaglandin-synthesis inhibitor, histamine antagonists, a serotonin receptor antagonist and a fibrinolysis inhibitor did not reduce the acute phase response in spite of adequate pain control.<sup>29,32</sup>

#### *Nutrition*

In general, patients who are well nourished convalesce better, have fewer complications, are able to ambulate and leave the hospital sooner.<sup>33</sup> Navia postulated that the duration of disability is shortened when the increased nutritional requirements of the injured patient are met adequately.<sup>34</sup> According to Gilder, malnutrition heralds a poor prognosis in patients undergoing severe trauma or surgical injury.<sup>27</sup>

Wilmore *et al* observed that although feeding the patient does not alter the endocrine metabolic response to injury, adequate caloric and nitrogen intake minimizes or prevents severe protein wasting which may in itself alter body function.<sup>28</sup> Kendell *et al* reported that orthognathic patients who received high caloric supplements with their blenderized diet exhibited increased nutrient intake and lost significantly less body weight during their fixation period when compared to the control group that did not receive the supplement.<sup>35</sup> Moore recommended resuming oral intake practically immediately after surgery if the surgery did not involve the gastrointestinal tract.<sup>18</sup>

Infusion of amino acids also does not alter the catabolic state induced by the endocrine metabolic response, but it does result in reduction of the negative nitrogen balance by supplying the liver with substrate for protein synthesis and by reducing the need for the breakdown of endogenous proteins.<sup>27</sup> Most healthy patients subjected to simple surgical procedures have enough nitrogen stores to meet basic requirements if they are provided with a small amount of glucose in intravenous fluids postoperatively. As little as 15 grams of glucose will reduce lipolysis and ketoacid production by fifty percent.<sup>34</sup>

#### *Operative Blood Loss*

Christensen *et al* pondered the influence of operative blood loss on postoperative fatigue and speculated that some of the observed effects may be attributable to a postoperative decrease in hematocrit.<sup>21</sup> Christensen and his colleagues had already observed that the loss of one liter of blood over two days in phlebotomy subjects resulted in a marked decrease of maximal oxygen uptake and maximal work capacity.<sup>36</sup> These effects disappeared during the twenty-five days after bleeding

and were closely correlated with the changes in hematocrit. Yet in a later study of surgical patients, they were unable to demonstrate any relationship between the development of postoperative fatigue and changes in hematocrit.<sup>21</sup>

Marciani and Dickson proposed that patients benefit from a higher postoperative hematocrit by transfusion of predeposited autologous blood following surgery. This should produce a smoother postoperative course since the patient's energy and feeling of well-being would be enhanced.<sup>37</sup> Mandel studied patients undergoing reduction mammaloplasty and compared patients who received transfusions of predeposited autologous blood after surgery to those who did not. The length of hospital stay for the group that was not transfused was longer and associated with postoperative weakness and decreased hemoglobin. Patients who received autologous blood were able to return to work sooner than patients who were not transfused.<sup>38</sup> These findings are consistent with those cited from Neuwirth *et al.*<sup>7</sup>

Saltzstein and Linker reported that correcting preoperative anemia and replacing blood lost during operative procedures is associated with a decreased incidence of postoperative complications such as wound infections, wound rupture, obstructions, adhesions and major pulmonary complications. They suggested that operative blood losses of as little as three hundred milliliters may retard convalescence.<sup>39</sup>

#### *Immobilization*

According to Wilmore *et al*, prolonged bedrest and muscle inactivity cause profound circulatory disturbances and add to the increased catabolism of skeletal muscle protein after injury.<sup>28</sup> Powers adds that early ambulation favorably influences many postoperative complications

and results in accelerated convalescence and earlier return to normal activity.<sup>15</sup> Gold also conducted studies of early ambulation and demonstrated faster recovery from various surgical procedures when early ambulation was encouraged.<sup>40</sup>

#### *Socioeconomic Factors*

Brown and Rawlinson identified five factors particularly important in determining the tendency of the patient to relinquish the sick role after surgery: depression, preoperative tendency to reject the sick role, duration of illness prior to surgery, age and gender.<sup>41</sup> Kasl *et al* credits Parsons with coining the phrase "sick role" and defined it as a variety of dependent behaviors by people who consider themselves ill, which to some degree, result in neglect of their usual duties.<sup>14</sup>

For most people, assuming the sick role is more difficult than relinquishing it; people who are more reluctant to assume the sick role before surgery are more eager to exit from it afterwards.<sup>41,42</sup> Men and younger persons have been described as being more likely to abandon the sick role after surgery than are women and older individuals.<sup>41</sup> Baker identified role responsibilities, not gender, as the reason for these differences in relinquishing the sick role.<sup>17</sup>

The rehabilitation literature is somewhat divided on the effect of socioeconomic status on abandoning the sick role. However, Brown and Rawlinson found no difference between socioeconomic groups.<sup>41</sup> Saffier found no relationship between the duration of convalescence from surgery and amount of weekly wage or the amount of weekly disability income.<sup>43</sup>

#### *Psychologic Factors*

A number of psychological issues may have considerable impact on

the patient's recovery from surgery. For example, Sutherland described depression from whatever cause as a potent inhibitor of convalescence.<sup>16</sup> Patients who are less depressed relinquish the sick role more readily.<sup>41</sup> Postoperative depression after orthognathic surgery occurs often in the first six weeks after surgery and may be related to medications such as steroids and analgesics or the emotional impact of a low calorie diet for four to six weeks.<sup>8</sup> Frost and Peterson reported that most of the respondents in their study experienced postoperative depression, usually after hospital discharge.<sup>9</sup> Stewart *et al* postulated that fixation techniques that minimize the period of jaw immobilization may reduce postoperative depression since a return to normal mood occurred after jaw release.<sup>8</sup> They also propose that forewarning the patient of a postoperative depressive period can reduce the impact of this response to orthognathic surgery on patients and their families.

The psychological factors affecting surgical recovery might be some of the easiest ones to influence in a positive way, improving convalescence from surgery. For example, Johnson and colleagues suggest that preparatory information on the sensory elements of the surgical experience is associated with indicators suggesting a more rapid resumption of usual activities.<sup>44,45</sup> Similar conclusions were reached by Devine and Cook after a meta-analysis of 102 studies dealing with psychoeducational interventions for coping with surgery.<sup>46</sup> Kiyak adds that it is essential to prepare patients thoroughly before surgery by explaining not only the physical discomfort to come, but also the psychological changes that occur which may continue for as long as two years.<sup>47</sup> Sutherland suggested that investing a small amount of time preoperatively to deal with the patient's misconceptions and fears will greatly

benefit the patient after surgery.<sup>16</sup>

Another psychological consideration is the effect of suggestions to the patient while under general anesthesia. Several studies of this subject concluded that hypnotic suggestions to patients while under general anesthesia resulted in decreased use of analgesic, decreased incidence of nausea and vomiting, decrease need for bladder catheterization and decreased length of stay in the hospital.<sup>48,49,50</sup> The potential effect of statements about the patient's condition and prognosis made while the patient is unconscious is significant.<sup>51</sup>

## METHODS

Twenty-six patients scheduled for BSSO and twelve patients scheduled for LFI osteotomies without any other adjunctive procedures between March 1989 and February 1993 volunteered to participate in this study. Four surgeons with resident assistants performed the procedures. The members of the LFI group each donated one unit of autologous blood 1 to 2 weeks prior to surgery and were prescribed 300 mg of ferrous sulfate three times daily. The members of the BSSO group did not predeposit blood and did not take iron supplements. None of the patients involved in this study received blood transfusions. All osteotomies were rigidly fixated with titanium bone plates, position screws or lag screws. None of the patients were placed in maxillomandibular wire fixation during the postoperative period. All patients received the same dietary counseling.

All patients judged ASA I or II were admitted to the hospital on the day of surgery. Inhalation/opioid general anesthesia was administered to each patient via nasal endotracheal intubation. The LFI group's anesthetic was modified by induced hypotension to reduce intraoperative blood loss. Operative blood losses were estimated by carefully measuring irrigation and suction cannister volumes.

Data collection began on the day before surgery (PSD) and consisted of answers from each patient obtained by questionnaire, weight, vital signs and levels of hemoglobin and hematocrit. Data collection con-

tinued on the first postoperative day (POD), at one week (POV1), three weeks (POV2) and six weeks (POV3) postoperation. Subjective answers, body weight and vital signs were collected at each postoperative visit. Hemoglobin and hematocrit samples were repeated at POD and POV2. If necessary to document return to normal hemoglobin and hematocrit, additional blood was sampled at POV3. Hemoglobin and hematocrit were considered to have returned to preoperative levels when they reached at least 95% of the recorded preoperative value. Telephone interviews were conducted if answers from the patients were needed after six weeks.

The subjects were asked to respond to questions about recent illnesses and the exact dates they returned to normal activity and to school or work (Figures 1,2,3). A subgroup of twenty BSSO patients was also studied using visual analog scales for rating various daily living activities to assess return of normal activity (Figure 4). These patients were asked to rate their ability to perform routine household, mobility and recreational activities at PSD, POV1, POV2, and POV3. A score of 100% for a category of activity indicated full ability in that category. A score of 0% indicated complete dependency on others.

Statistical methods included Wilcoxon 2-Sample Test for differences between the two groups with respect to return to full activity, return to work or school, weight loss, length of operation, hemoglobin change and operative blood loss. Cochran-Mantel-Haenszel Row Mean Score was used to analyze return to preoperative hemoglobin levels. Repeated Measures Analysis of Variance was used to analyze visual analog scales of the BSSO group.



## RESULTS

Two subjects in the BSSO group were excluded because of postoperative complications requiring additional surgical procedures. The mean age, length of operation, estimated blood loss and postoperative changes in hemoglobin and body weight are listed in Table 1. The LFI group endured longer operations with larger mean estimated blood loss and greater mean postoperative decrease in hemoglobin. The LFI group also sustained a larger postoperative weight loss.

The BSSO group returned to work or school before the LFI group (Graph 1). At 1 to 2 weeks postoperation, 50% of the BSSO patients had returned to work or school while none of the LFI patients had returned. By 3 to 4 weeks, 81% of the BSSO patients were back at work or school compared to 57% of the LFI patients. By 5 to 6 weeks, differences between the two groups had virtually disappeared.

The BSSO group also returned to full activity sooner than the LFI group in a pattern similar to return to work or school, but the differences were not statistically significant (Graph 2).

The LFI group returned to preoperative hemoglobin and hematocrit levels before the BSSO group, but the differences were not statistically significant (Graph 3). By POV3 75% of the LFI patients had recovered to within 95% of preoperative hemoglobin levels compared to only 40% of the BSSO patients (Graph 3).

The subgroup of BSSO patients who completed visual analog scales

for routine, mobility, and recreational activities revealed statistically significant decreases in all three categories of activity at POV1 (Graph 4). Preoperatively, mean visual analog scale scores were near 100% in all three categories. At POV1 mean scores had dropped to as low as 41% for recreational activities. Routine activities and mobility activities decreased to 72% and 81% respectively at POV1. Significant decreases persisted to POV2 for only recreational activity which had nevertheless improved to 80%. By POV3 all forms of activity had returned to preoperative levels.

## DISCUSSION

Fatigue after surgery is common. Previous studies have described a syndrome of postoperative fatigue and have associated it with several intraoperative and postoperative factors such as the magnitude of surgical trauma, postoperative weight loss and deterioration of nutritional status.<sup>13,20,22,24</sup> Age, gender, preoperative nutritional status, duration of surgery, or change in hematocrit are not factors associated with this condition.<sup>13,21,22,23</sup> Patients with postoperative fatigue lack stamina when doing light exercise such housework or climbing stairs.<sup>24</sup>

Patients in this study demonstrated some of the characteristics attributed to postoperative fatigue syndrome. For example, all patients reported some degree of fatigue after surgery with the LFI group of patients taking longer to return to work or school than the BSSO group. The LFI group also took longer to return to full activity than the BSSO group, but these results were not statistically significant possibly because of the small number of patients studied. The subgroup of BSSO patients studied with visual analog scales revealed significant mean decreases in all activity levels at one week postoperation. Stamina steadily improved until normal levels had returned by 3 weeks for routine and mobility activities and by 6 weeks for all activity.

Also, postoperative weights decreased for most of the BSSO patients and all of the LFI patients. The mean weight loss of the LFI group was significantly more than for the BSSO group. Liquid nutri-

tional supplements have been shown to reduce postoperative weight loss and deterioration of nutritional status<sup>35</sup> and were prescribed to all study patients.

The magnitude of surgery in the LFI group was greater than that of the BSSO patients. Although development of postoperative fatigue has not been related to length of surgery,<sup>23</sup> the LFI patients in the present study had longer operations usually due to increased technical complexity such as multiple segments, harvesting of bone for grafting and tooth extractions. The BSSO group had no adjunctive procedures.

Christensen and his coworkers demonstrated that the loss of 1 liter of blood by phlebotomy over 2 days produced a marked decrease in maximal oxygen uptake and maximal work capacity.<sup>36</sup> However, in another study of surgical patients they were not able to correlate the development of fatigue with changes in hematocrit.<sup>21</sup> Neuwirth *et al* studied autologous transfusions in orthognathic surgery patients and found that asymptomatic patients who were postoperatively transfused with predeposited autologous blood subjectively recovered from surgery sooner than their non-transfused counterparts.<sup>7</sup> In the present study, no patients were transfused. The LFI group had a larger mean estimated blood loss and larger postoperative decrease in hemoglobin. However, the LFI group returned to preoperative hemoglobin levels sooner than the BSSO patients although this observation was not statistically significant. This interesting effect is possibly due to erythropoietic stimulation resulting from blood predonation followed by surgical bleeding or nutritional differences. In subjects making serial blood donations, Lorentz *et al* demonstrated transient peaks in serum erythropoietin after blood loss with sustained elevations after each peak.<sup>52</sup> Iron supple-

ments were taken by the LFI patients and may be a factor influencing iron stores and earlier return to preoperative hemoglobin.

Stewart *et al* demonstrated relationships between postoperative loss of energy, maxillomandibular fixation and depression.<sup>8</sup> Maxillomandibular fixation was not used in the present study.

Fatigue and absenteeism from work or school are negative side effects of surgery and are important issues to patients. Rittersma *et al* showed that many patients undergoing orthognathic surgery feel unprepared for various side effects of surgery and would have preferred better preparation regarding such issues and general anesthesia, postoperative diet, weight loss, absenteeism from work, loss of sensibility and possible damage to the dentition.<sup>53</sup> Incorporation of realistic information regarding these issues into preoperative preparation of the patient would therefore seem beneficial. Patients undergoing orthognathic surgery may expect to be unable to return to work or school for 2-3 weeks and perhaps longer after LFI procedures. They may also expect to lose weight related to catabolism and nutritional decline, and nutritional support may need more emphasis.

The small number of subjects in this study made conclusions on the basis of statistics difficult for some of these observations. Studying a larger series of orthognathic patients regarding the interconnecting issues of fatigue, magnitude of surgery, catabolism, weight loss, nutrition, and depression seems appropriate. In this study, hemoglobin was the only blood component that was measured and compared. Because of the myriad of other circulating factors involved in the endocrine metabolic response, future research of recovery from orthognathic surgery should examine the role of some of these factors. Comparing

patients of different levels of preoperative aerobic fitness and measuring changes in oxidative enzymes and how this relates to decreased hemoglobin after surgery could also be beneficial.

## SUMMARY AND CONCLUSIONS

Patients undergoing orthognathic surgery seem to suffer postoperative fatigue just as do patients undergoing other types of surgery. The LFI patients took longer to return to work or school than their BSSO counterparts. They also took longer to return to full activity although this finding was not statistically significant. By six weeks postoperation, there was no difference between the groups. Both groups had a mean decrease in body weight which has been shown by others to be related to the development of postoperative fatigue. The LFI group had longer mean length of operation usually due to increased complexity and adjunctive procedures. Magnitude of surgery has also been shown by others to be related to fatigue after surgery. Other studies have shown that patients benefit from realistic preparation regarding these and other issues affecting healing and recovery.

Table 1  
Patient and Surgery Characteristics

	BSSO (N=26)		LFI (N=12)	
	Mean( $\pm$ SD)	Range	Mean( $\pm$ SD)	Range
Age (yrs)	26.5 (11.5)	15-59	20.4 (6.5)	15-34
Length of Surgery (hrs) &	1.68 (0.54)	1-3.5	3.44 (0.75)	2-4
Preop Hemoglobin (gm/dl)	13.95 (1.19)	12.3-16.5	13.43 (1.96)	11.7-17.7
Estimated Blood Loss (cc) #	191 (80)	50-400	421 (206)	100-950
Hemoglobin Change (gm/dl) +	-1.59 (0.88)	-3.7 - +0.2	-2.4 (1.2)	-5.2 - +0.4
Percent Weight Loss \$	-3.9 (2.3)	-7.0 - 0.0	-5.8 (2.6)	-8.9 - -2.7

Wilcoxon 2-Sample Test:

& p=0.0001

# p=0.0001

+ p=0.021

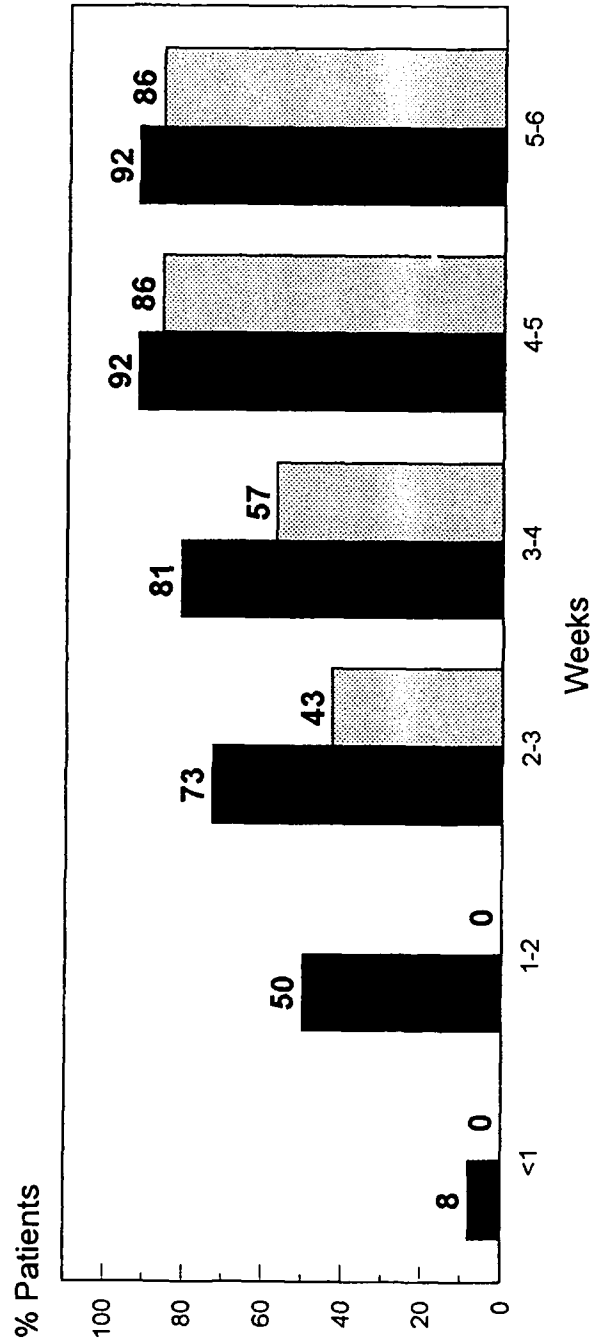
\$ p=0.014



Graph 1

### Return to Work or School

■ BSSO □ LFI



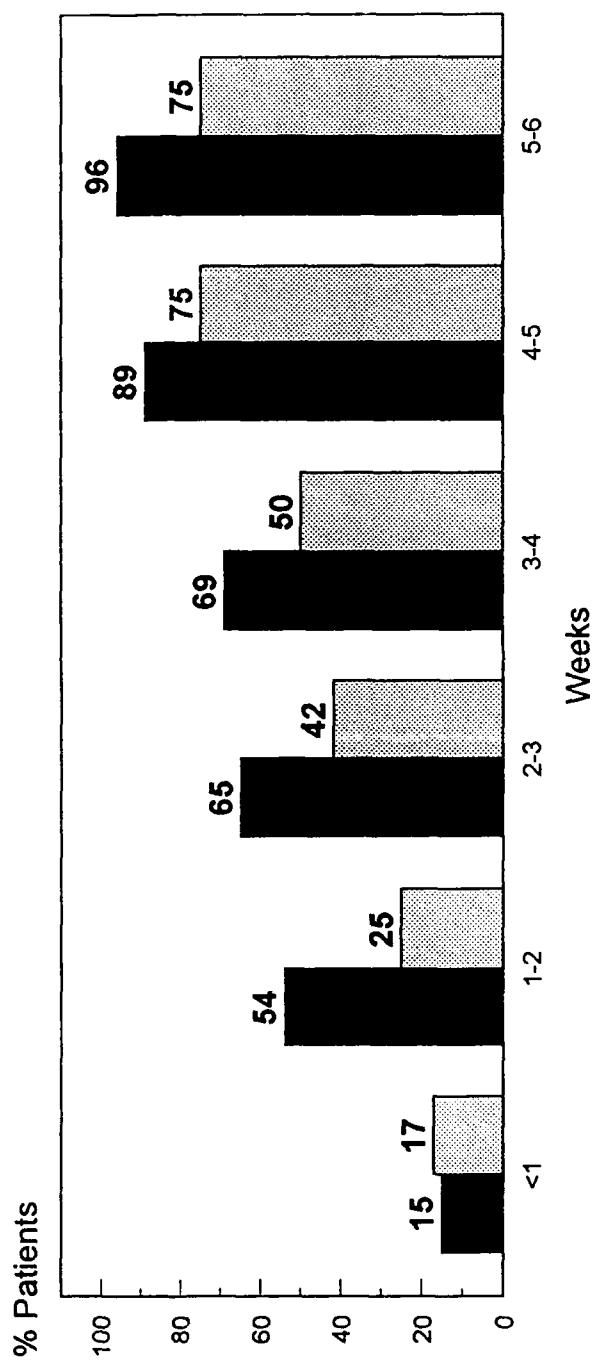
Wilcoxon 2-Sample Test

p=0.026

Graph 2

### Return to Full Activity

■ BSSO □ LFI



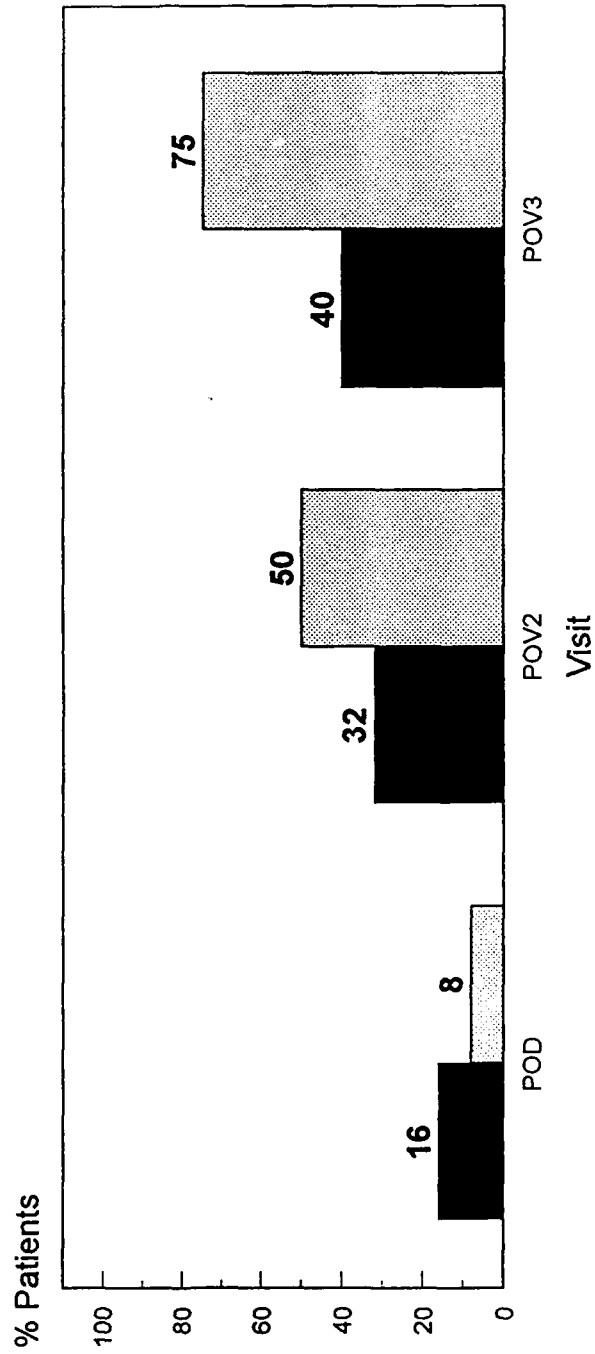
Wilcoxon 2-Sample Test

p=0.11

Graph 3

### Return to Preop Hemoglobin

■ BSSO □ LFI



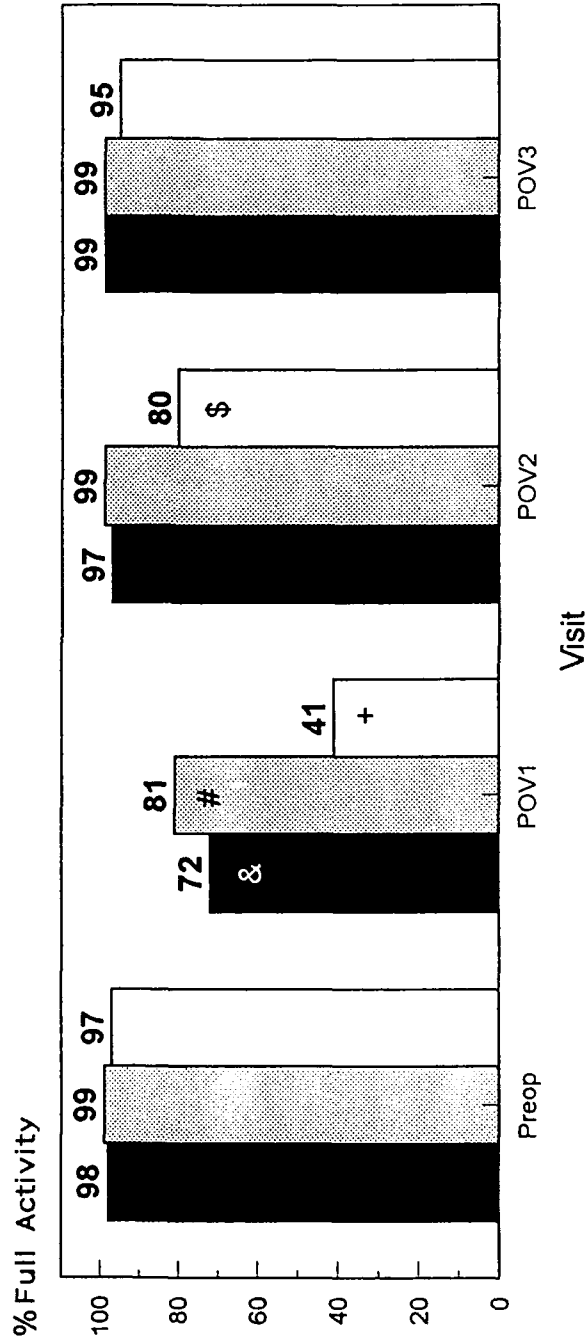
Cochran-Mantel-Haenszel Row Mean Score

p=0.26

Graph 4

# Return of Activity of BSSO Patients

■ Routine ■ Mobility □ Recreation



Repeated Measures Analysis of Variance

& p=0.0001 # p=0.0048

+ p=0.0001 \$ p=0.021

Figure 1

QUESTIONNAIRE #1

1. Have you experienced a recent illness? YES NO  
If yes, please explain: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

2. Have you had prior surgery of any kind? YES NO  
If yes, did you recover as expected? YES NO  
If did not recover as expected, please explain: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. Please rate on the scale below how well you feel:  
(Circle one number)

	Well			Not Well	
	1	2	3	4	5

4. Please rate the degree to which you have experienced any  
of the following recently: (Circle one number for each  
symptom)

	None			Often	
	1	2	3	4	5
Dizziness	1	2	3	4	5
Shortness of breath	1	2	3	4	5
Decreased stamina	1	2	3	4	5
Decreased activity	1	2	3	4	5

5. How many hours do you sleep each day? (Circle one  
letter)

- a. Less than 5 hours
- b. 5 to 7 hours
- c. 7 to 9 hours
- d. 9 to 11 hours
- e. More than 11 hours

6. Please use this space for any additional comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Figure 2  
QUESTIONNAIRE #2

1. Please rate on the scale below the degree to which you are satisfied with your surgery: (Circle one number)

Very Much					Unhappy
1	2	3	4	5	

2. Please rate on the scale below how well you feel:  
(Circle one number)

Well					Not Well
1	2	3	4	5	

3. Please rate the degree to which you have experienced any of the following: (Circle one number for each symptom)

	None				Often
Dizziness	1	2	3	4	5
Shortness of breath	1	2	3	4	5
Decreased stamina	1	2	3	4	5
Decreased activity	1	2	3	4	5

Figure 3

QUESTIONNAIRE #3,4,5

1. Please rate on the scale below the degree to which you are satisfied with your surgery: (Circle one number)

Very Much			Unhappy		
1	2	3	4	5	

2. Please rate on the scale below how well you feel: (Circle one number)

Well				Not Well	
1	2	3	4	5	

3. Please rate the degree to which you have experienced any of the following: (Circle one number for each symptom)

	None			Often	
Dizziness	1	2	3	4	5
Shortness of breath	1	2	3	4	5
Decreased stamina	1	2	3	4	5
Decreased activity	1	2	3	4	5

4. How many hours do you sleep each day? (Circle one letter)

- a. Less than 5 hours
- b. 5 to 7 hours
- c. 7 to 9 hours
- d. 9 to 11 hours
- e. More than 11 hours

5. Have you returned to work or school?

YES NO

If yes, when? \_\_\_\_\_

6. Have you returned to your normal level of activity?

YES NO

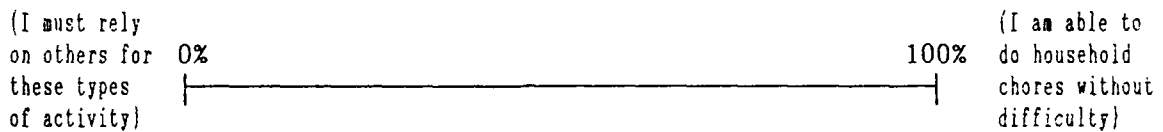
If yes, when? \_\_\_\_\_

Figure 4

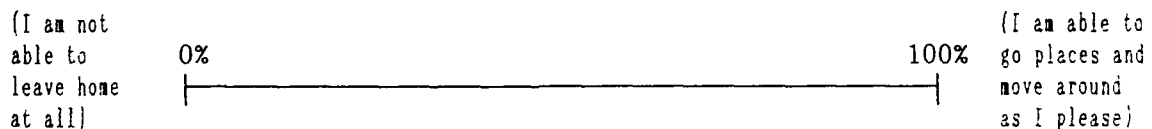
VISUAL ANALOG SCALE QUESTIONNAIRE

Please read each question below and notice the line below each question. Place a mark on each line at any place between 0% and 100% that best approximates your opinion of your ability to do the activity in each question. Read the statements at each end of each line to help you judge where to mark the lines.

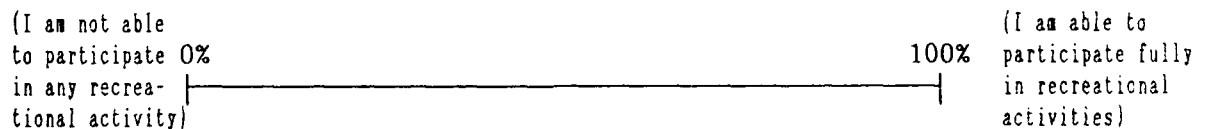
1. To what degree are you able to do routine activities around the house (cleaning, cooking, etc.)?



2. To what degree are you able to "get around" when you leave the house (walking, climbing stairs, etc.)?



3. To what degree are you able to participate in your favorite recreational activity (bicycling, jogging, tennis, etc.)?





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