Working capacity and well-being after radical cystectomy with continent cutaneous diversion

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ABSTRACT

Objectives: The primary aim of the present study was to compare the working capacity in patients with continent urinary diversion with a control group. Secondary aims were to assess the changes in electrolyte and acid-base homeostasis and the functional status during strenuous physical activity, and finally, the well-being in the two groups. *Methods*: Eleven patients who had undergone radical cystectomy and continent cutaneous diversion using an ileocolonic segment participated. The control group consisted of 12 men, matched for age and activity level. Working capacity was assessed by ergospirometry on an exercise bicycle. Venous blood samples were taken before the test, when the expiratory exchange ratio (RER) was about 1.0 and immediately after completion of the test. SF-36 was used to evaluate the subject's functional status and well-being. *Results*: The median working capacity in the patient group was 155 (85-190) W and 155 (125-215) W in the control group (n.s.) corresponding to 72 (43-97) % and 80 (59-97) % respectively of predicted values. Peak oxygen uptake was somewhat low in both groups when compared to P-O Åstrands norms. The blood tests revealed that the patients developed a slight metabolic hyperchloremic acidosis, not seen in the control group. There were no differences between the groups as assessed with the SF-36. *Conclusion*: Patients with a continent urinary diversion have a working capacity equal to a control group despite a slight metabolic hyperchloremic acidosis. Quality of life was similar in the two groups and corresponded well with the norms for the general Swedish population aged 65 to 74.

Key Words: Urinary bladder cancer, urinary diversion, working capacity, acid-base homeostasis, ergospirometry, quality of life.

INTRODUCTION

The gold standard for treating muscle invasive bladder carcinoma is radical cystectomy and, in suitable patients, continent reconstruction of the lower urinary tract, i.e. orthotopic bladder substitution or continent cutaneous diversion. Techniques for these procedures are established and considerable clinical experience has been gained [1].

Much attention has been paid to the metabolic consequences of the incorporation of an intestinal segment in the urinary tract [2]. Long-term observation has not revealed any severe metabolic or nutritional effects providing renal function is normal. However, patients with large intestinal segments incorporated in the urinary tract show a respiratory compensation of a hyperchloremic metabolic acidosis [3,4].The pathophysiology behind the hyperchloremic acidosis is mostly reabsorption of ammonium from urine through the intestinal mucosa, while secretion of bicarbonate adds only minimally to the acid load [4].

All studies on metabolic aspects in patients with various types of lower urinary tract reconstructions have been carried out with the patients at rest and no studies have to our knowledge been performed in order to investigate if the metabolic situation changes when the patients is exposed to strenuous physical activity.

A number of studies have been performed on quality of life after radical cystectomy. These have, in general, failed to confirm superiority of one type of diversion over others [5]. Common for all findings are psychosocial and sexual problems [6].

It may be hypothesised that the patients with a mild hyperchloremic metabolic acidosis with a tendency to respiratory compensation have utilised parts of their buffering capacity to maintain a stable pH in blood and therefore may have a reduced working capacity due to decreased remaining buffer capacity.

The primary aim of the present study was to assess the working capacity in patients with reconstructed lower urinary tracts, and to compare these results with a control group. Secondary aims were to assess the changes in electrolyte and acid-base homeostasis and the functional status and well-being in the two groups.

PATIENTS AND METHODS

The study protocol was approved by the local ethics committee.

Subjects

Patients who had undergone radical cystectomy with continent cutaneous diversion at the Department of Urology were assessed for participation in the study. Patients eligible for inclusion were male residents below 80 years of age, living in the hospital's primary catchments area, with at last 12 months follow-up after radical cystectomy and continent cutaneous diversion a m Lundiana [7, 8]. They should have no signs of recurring malignancy, have no diabetes, and be able to perform the test for musculoskeletal, cardiac, and pulmonary reasons. With a statistical power at 80% and a difference in 50 W between patients and a control group, and a standard deviation of 40 W, 12 persons were needed in both groups. Fourteen male patients were invited and gave written consent to participate. A control group consisting of thirteen men, regarding themselves as healthy, was arbitrarily chosen and matched for age, and activity level. Eleven patients and 12 controls completed the tests. Two patients could not fulfil the test, one of them due to heart condition and one due to discomfort with the face mask. One of the subjects in the control group (CG) was excluded because of too high blood pressure and one patient was excluded since the blood analysis showed a pathologic value. The background characteristics of the participants in the study are presented in Table 1.

Ergospirometry

To assess working capacity the Oxycon Champion Ergospirometer™ (Jaeger, Breda, and The Netherlands) was used for the gas analysis by a dynamic breath-by-breath test in an open system. During the test, which was performed on an exercise bicycle (Ergomed 940™; Siemens AB, Upplands Väsby, Sweden), patients wore a tightly sealed breathing mask. Each subject started at a load of 50 W on the bicycle, and the load was increased by 5 W each 30 s. Patients were instructed to maintain the same speed (60 r.p.m.) throughout the test. The maximum working capacity was measured in watts. The flow of air during inspiration and expiration was continuously measured and the apparatus automatically calculated the rate of oxygen uptake (VO_2) and carbon dioxide elimination (VCO_2). Point of crossing (PX), which is the level of VO_2 at which the respiratory exchange ratio (RER) = 1.0, was taken as a measure of the anaerobic threshold [9]. The values were then expressed in VO_2 $ml \cdot kg^{-1} \cdot min^{-1}$ and in % of peak VO_2. Oxygen uptake was calculated at PX with blinded data.

The subjects were connected to a computerised 12-led electrocardiogram (ECG) (Siemens Elema ECG megachart™). The ECG signal was fed into a computer and the heart rate was calculated every 10 s. Blood pressure was measured manually. Rating of perceived exertion (RPE) using Borg scale (6-20 $Borg_{max}$), was performed every 2 min during the test [10].

Blood and urinary analysis

Venous blood sampling was performed through a Venflon® tube before the test, when RER was about 1.0 and at completion of the test. The plasma levels of sodium, potassium, chloride, lactate, calcium, and creatinine were measured as well as venous base excess and lactate.

Urine was collected just before the test on the bicycle and immediately after and was analysed for pH with indicator method.

Quality of life

The International Quality of Life (QoL) Assessment SF-36 Standard Swedish Version 1.0 was used to evaluate the patients' functional status and well-being [11]. The SF-36 is a widely used generic measure of health status and its item-internal consistency, reliability, and construct validity are satisfactory. Eight scales summarize the answers from 36 questions and are scored separately: physical function, physical role, bodily pain, general health, vitality, social functioning, emotional role, and mental health. The sums of final items were calculated according to SF-36 formulas for scoring and transforming scales.

Experimental procedure

All tests were conducted in the afternoon after the participants had undergone a medical workup. The subjects had fasted for 4 h before the tests and were instructed not to participate in any physically hard work, smoke or use other nicotine products during this period. Each patient's weight was determined on a standard physician's beam scale and height was measured on a standard wall-mounted height board. All tests were carried out by the same investigator and staff at the Department of Clinical Physiology. The ergospirometer was calibrated for prevailing temperature and barometric pressure. Gas mixture and volume calibration was also performed before each test. After the test, the subjects filled in the SF-36 form and a structured questionnaire concerning work and leisure activities.

Statistics

The Kruskal-Wallis test was used to determine differences within the groups for each subscale of the blood analyses. Mann-Whitney Rank Sum Test was used when comparing the two groups. $P < 0.05$ was considered significant. The results are presented as medians (range) and quartile one and three.

RESULTS

The subjects ranged in age from 55 to 78 years without difference between patients and controls (Table 1). Three patients were smokers and two used snuff daily. In the CG no one used nicotine in any form. Six patients were still working and so did three in the CG. Furthermore in CG six were active in some sports (Table 2). Three in each group had antihypertensive medication. All participants were asked to estimate how many hours per day they spent sitting in front of a computer, reading, or watching television. The medians were 5 (2-9) hours for the patients group (PG) and 5 (4-9) hours per day for CG.

Ergospirometry

The median working capacity in the PG was 155 (85-190) W and 155 (125-215) W for the CG (n.s.). A comparison was made with reference values previously collected at the same laboratory and based upon age, height, and gender [12]. A valid reference interval is 80-120 per cent of predicted value. The median values were 72 % (43-97) and 80 % (59-97) of predicted values for PG and CG respectively (Figure 1).

Just before the test, when the subjects were sitting on the bicycle, respiratory exchange ratio (RER) was 0.77 (0.71-0.80) in PG and 0.76 (0.71-0.94) in CG. At the end of the test, corresponding values were 1.2 (1.0-1.3) for PG and 1.2 (1.1-1.3) for CG, indicating that the exercise had been strenuous, since RER greater than 0.90 is indicative of anaerobic activity [13].

Peak oxygen uptake was 22 (16-31) ml $O_2 \cdot min^{-1} \cdot kg^{-1}$ in PG and 24 (16-34) ml $O_2 \cdot min^{-1} \cdot kg^{-1}$ in CG (n.s.). Compared to Åstrands norms [13] these figures are somewhat low. No differences were seen in CO_2 elimination at peak work between the groups (Table 3).

There was no statistical difference in PX between the groups. In % of VO2 max PX was 79% in PG and 75% in CG (Table 3).

The median peak heart rate in PG was 155 (109-184) beats per min (bpm), whereas in CG it was 158 (116-185) bpm corresponding to 93% (71-111) and 98% (78-119) respectively compared to the predicted values [12] (n.s.).

The median blood pressure in PG was 150/80 (100-185/70-95) mmHg during rest and 215 (165-255) mmHg at peak work. The corresponding values in CG were 145/83 (125-160/80-90) mmHg and 220 (145-255) mmHg. No differences were found between the groups during the test.

RPE at peak work was 17 (13-19) for PG and 16 (12-17) for CG (n.s.). The patient group worked on the bicycle for 11 (3-14) minutes and the control group 10 (7-16) minutes (n.s.).

Blood and urine analyses

Changes were seen in the blood analyses within both groups during the test. In PG significant changes were found in plasma levels of sodium (P= 0.024) and vB lactate (P=0.006) (Table 4 and Fig. 2). In CG changes were found in vB-lactate (P=0.001), plasma levels of potassium (P=0.002) and calcium (P=0.007) (Table 4 and Figure 2). The chloride values showed a significant difference between PG and CG both when RER was 1.0 (P= 0.018) and at peak work (P=0.007) (Figure 3). A difference between the groups was also found in base excess at peak work as the PG was more acidotic (P= 0.030) than CG (Figure 4). Plasma level of creatinine was higher in CG compared to PG at the end of the test (P=0.037) (Table 4).

The U-pH remained unchanged during the test in either group. There was however a difference between the groups both before and after the test. Urine-pH in the PG was 6.50 (6.00-7.00) and in CG 6.00 (5.00-6.00) (P= 0.001) before the test. After the test the U-pH was 6.50 (6.00-7.00) in PG and 6.00 (5.00-6.50) in CG (P= 0.002).

SF-36

No statistical significant difference between the PG and CG was found in any of the eight subscales of SF-36 (Fig. 5).

DISCUSSION

Our study was performed at least two year postoperatively in order to ensure that the patients were not affected by the operative trauma nor had a recurrence of their tumour. Patients with comorbidity were excluded. Therefore the study group did not reflect the entire postoperative cohort. The purpose was, however, to elucidate the consequences of a continent cutaneous diversion on working capacity in patients without other symptoms or diseases.

The patients in this study did not seem to have less active working conditions than had the controls. Thus, they were active in their private and professional life and consequently dependent on their working capacity. Only one patient reported a sedentary lifestyle. No difference was seen between the evaluated groups in working capacity measured in W but the % of expected values was somewhat low in both groups. Predicted maximum exercise loads were taken from Wohlfart and Farazdaghi [12], who found that the working capacity for both men as well as women were higher than expected from the reference values commonly used [14].The reference values were based on tests performed at the same laboratory, with the same routines and equipment as in the present study. However, when comparing our data with those of Nordenfelt et.al. [14] in % of expected value of maximum exercise loads, PG reached 101% (62-131) and CG 115% (88-144).

PX% and RER confirmed that all individuals passed the anaerobic threshold during the test. The RPE rating showed, however, that the tests were interrupted before the absolute maximum of effort was achieved since the maximum of effort should be rated as 19-20 which is to be compared to 17 in PG and 16 in CG. In spite of a mild hyperchloremic metabolic acidosis after the test in PG, no differences were seen in PX indicating that the patients have the ability to perform strenuous physical activity during a short period.

Maximal working capacity is usually measured in W, and incremental maximal ergometer exercise tests are routinely performed at departments of clinical physiology in Sweden, with diagnostics as main purpose [15]. Due to the on-line measurements of ventilation and gas exchange we could confirm that maximum capacities were not achieved in all subjects and therefore peak working capacity is a more relevant expression. This may be due to difficulties to stress a non trained person to the maximum of performance and thereby create an uncertainty whether the real maximal value is achieved or not during the test.

With the incorporation of intestinal segments in the urinary tract reabsorption of ions and urinary solutes occurs. Although clinical problems do not seem to arise when the renal function is normal, metabolic studies have shown changes in serum electrolytes and acid-base balance. Accordingly, in these patients a mild respiratory compensated hyperchloraemic metabolic acidosis have been noticed [2,3,4]. Many of these metabolic alterations are influenced by the degree to which solute absorption occurs across the intestinal segment. The factors that influence reabsorption include the mucosal area of the intestines used, length of time when urine is in contact with the intestinal mucosa, type of intestinal segment used and of most importance the renal function. [4]. Despite strenuous physical exercise during short time as in the present study urine pH remained unchanged both in PG and CG. It should, however, be realised that pH in urine from intestinal reservoirs remain stable over 24 h, probably because of buffering [16], and this is likely to be the case also after strenuous exercise.

The endogenous chronic acid load is mainly due to reabsorption of ammonium from urine [4]. In an acute metabolic acidosis the acidotic load is modified by breathing, serum and bone buffers and renal excretion of titrable acid. As patients with a urinary pouch already utilise these mechanisms to maintain a stable pH in blood their capacity to counteract the acidotic load is theoretically less. Thus, the findings in the PG may be due to a different handling of the lactic acid load during a strenuous work load. During work an increase in sodium, potassium and calcium levels were noticed in the patient group. This may at least partly be explained by the utilisation of bone buffers since the proton increase, due to lactate production, promotes exchange of bone surface ions, mainly sodium but also potassium, for protons, thereby directly buffering the acidity [17]. Another explanation might be dehydration occurring as a result of increased perspiration and redistribution of water to the skeletal muscles.

Many previous studies on function after continent urinary diversions have focused on psychosocial adjustments, general state of health and health-related quality of life [5,18,19]. We used SF-36, an established instrument to measure quality of life [11]. No differences were seen between PG and CG in any of the eight subgroups. Obviously most cystectomised patients do adjust well after the operation and our findings are in line with other reports showing similar quality of life in operated patients and in a control population [20]. It is possible that a combination of a generic and a disease-specific instruments or the use of a qualitative method could have provided further information.

To our knowledge, the present study is the first to focus on working capacity in patients who have undergone radical cystectomy with continent cutaneous diversion. Our conclusions are that patients who have a continent cutaneous diversion have a working capacity, when measured in watt, equal to a control group. However, working capacity includes more aspects than peak work, such as physical endurance and this remains to be evaluated in future studies. The findings also suggest that the patients' rating of their well-being and health do not differ from a control group.

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Legends to figures:

Figure 1 Peak workload in percent of expected values in patients (filled symbol) and controls (open symbols). Doted line at 80% represents lower normal value.

Figure 2. Boxplots showing the the median, 10th, 25th, 75th and 90th percentiles (dots represent outlayers) for vB-Lactate values in patients and controls before the test (A), when RER=1.0 (B) and at completion of the test (C). No difference was seen between CG and PG (n.s). Within the groups differences were found at A vs C and B vs C ($P<0.05$). n for CG 12 (A), 11 (B), and 11 (C); n for PG 10 (A), 9 (B), and 8 (C).

Figure 3. Boxplots showing the the median, 10th, 25th, 75th and 90th percentiles (dots represent outlayers) for the chloride values in patients and controls before the test (A), when RER=1.0 (B) and at completion of the test (C). Within groups no differences were found (n.s). Between CG and PG differences were found at B, ($P= 0.018$) and at C ($P= 0.007$). n for CG 11(A), 11 (B), and 11 (C); n for PG 10 (A), 10 (B), and 9 (C).

Figure 4. Boxplots showing the the median, 10th, 25th, 75th and 90th percentiles (dots represent outlayers) B-base excess values in patients and controls before the test (A), when RER=1.0 (B) and at completion of the test (C). No differences were found within the groups (n.s). When comparing CG and PG a difference was found at C ($P=0.03$). n for CG 12 (A), 11 (B), and 11 (C); n for PG 10 (A), 10 (B), and 9 (C).

Figure 5. SF-36 scores. A comparision between the patients, the controls, and norms for the general Swedish population aged 65-74 [11].

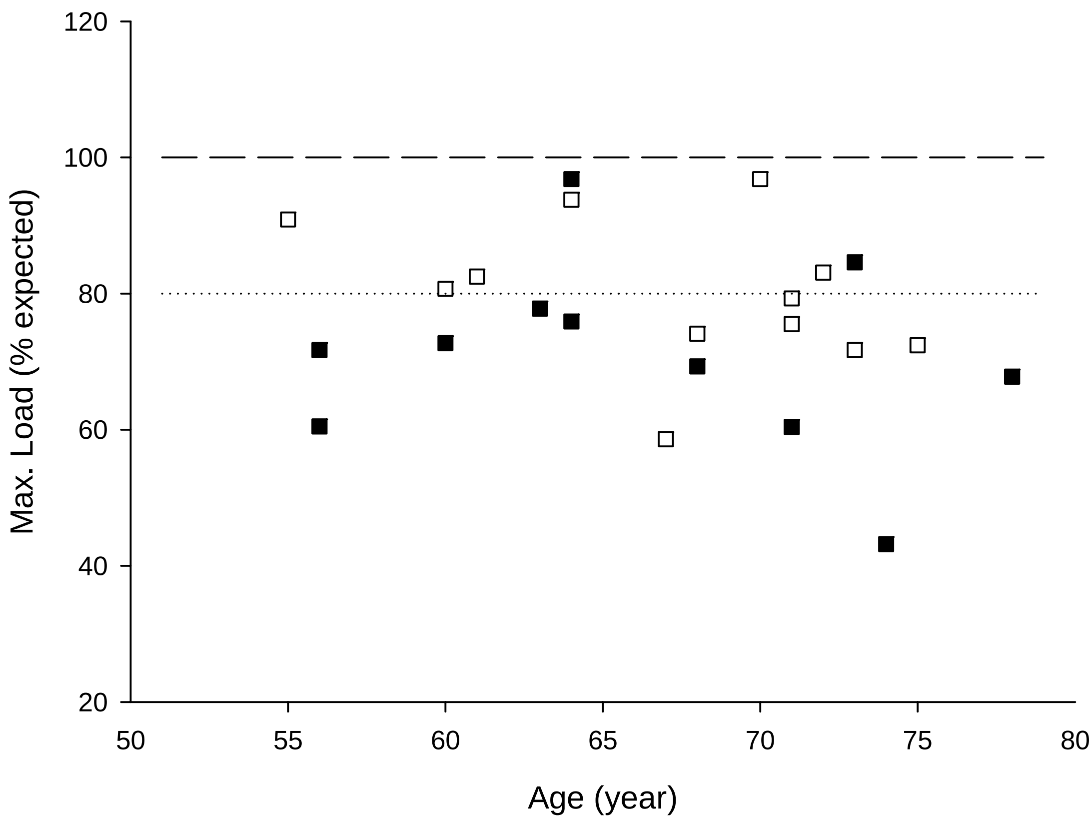

Table 1 Background characteristics of subjects who participated in the study.

	Patients (*n*=11)				Control group (*n*=12)				P value
	Median	Range	q1	q3	Median	Range	q1	q3	
Age (years)	64	(56—78)	61	73	69	(55—75)	63	72	ns
Height (cm)	174	(167—187)	172	182	179	(174—191)	177	184	ns
Weight (kg)	80	(69—120)	77	89	84	(69—110)	81	96	ns
Years postop	7	(2—11)	4	8	-	-	-	-	-

Table 2 Self-reported working and recreational activities.

	Patients **n=11**	Control **n=12**
Working conditions		
Heavy work (construction worker, bricklayer, carpenter etc.)	0	1
Moderate work (teacher,supervisors, locksmith, policeman etc.)	6	1
Light work (hairdresser, salesperson etc.)	0	1
Pension	5	9
Recreational activities		
Active in sport (boule, boccia, tennis, golf, callistenics etc)	2	6
Household work, (gardening, walking on level ground, taking out the dog on exercise etc.)	8	6
Sedentary lifestyle	1	0

Modified classification from Öhrström [21].

Table 3 Results from ergospirometry.

Variables	Patients (*n*=11)				Control group (*n*=12)				P value
	Median	Range	q1	q3	Median	Range	q1	q3	
Peak workload (watt)	155	(85—190)	135	180	155	(125—215)	143	190	n.s
% of predicted maximal workload	72	(43—97)	62	77	80	(59—97)	73	87	n.s
Peak VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	22.2	(16—31)	16.5	27.1	23.8	(16—34)	21.5	29.2	n.s
Peak VCO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	27.4	(14.3—29.7)	19.1	28.5	27.6	(17.9—39.4)	22.8	33.7	n.s
PX (VO_2 $ml \cdot min^{-1}$)	1590	(979—2040)	1272	1801	1634	(1212—1978)	1356	1760	n.s
PX % (%$VO_{2\ max}$)	79	(70—90)	75	87	75	(66—90)	71	83	n.s

Table 4 Results from blood analysis. The blood samples are taken [a]before the ergospirometry starts, [b] when RER is 1.0 and [c] at the completion of the test.

Variables	Normal values	Patients (*n*=11) Median	(*n*)	q1	q3	Control group (*n*=12) Median	(*n*)	q1	q3	P value
P-Sodium[a] (mmol/L)	134—151 mmol/L	143	(*11*)	142	144	143	(*11*)	142	145	n.s
P-Sodium[b] (mmol/L)		144	(*10*)	144	144	143	(*11*)	142	145	n.s
P-Sodium[c] (mmol/L)		146	(*10*)	144	147	145	(*11*)	142	146	n.s
P-Potassium[a] (mmol/L)	3.2—4.7 mmol/L	3.75	(*11*)	3.50	4.15	3.90	(*11*)	3.73	3.98	n.s
P-Potassium[b] (mmol/L)		4.10	(*10*)	3.80	4.20	4.40	(*11*)	4.30	4.40	n.s
P-Potassium[c] (mmol/L)		4.20	(*10*)	4.20	4.90	4.50	(*11*)	4.23	4.68	n.s
P-Calcium[a] (mmol/l)	2.15—2.50	2.43	(*10*)	2.34	2.47	2.40	(*11*)	2.30	2.43	n.s
P-Calcium[b] (mmol/l)		2.46	(*10*)	2.42	2.55	2.47	(*11*)	2.42	2.56	n.s
P-Calcium[c] (mmol/l)		2.51	(*8*)	2.26	2.61	2.54	(*11*)	2.45	2.60	n.s
P-Creatinine[a] (μmol/L)	55—116	78	(*10*)	66	97	86	(*11*)	79	101	n.s
P-Creatinine[b] (μmol/L)		74	(*10*)	66	97	88	(*11*)	80	96	n.s
P-Creatinine[c] (μmol/L)		75	(*8*)	64	82	87	(*11*)	82	96	0.037