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ORIGINAL RESEARCH

A 1,408 km bicycle tour with prostate cancer patients—results of a pilot study

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Abstract Negative psychological and physical effects of prostate cancer and its medical treatment may persist many years after diagnosis. The influence of a long cycling tour on rehabilitative or health-related effects with prostate cancer patients has not yet been studied. In practice, physicians and therapists rarely recommend cycling to prostate cancer. In May 2010, eight prostate cancer patients rode their bikes for over 1,408 km from Cologne to Marseille within 5 weeks. Endurance test, blood examinations (prostate-specific antigen (PSA), total testosterone, interleukin-6, oxidative stress, and antioxidant capacity) and quality of life questionnaires were completed before and after the tour. All eight subjects reached Marseille. Significant improvements could be observed in physical performance and certain quality of life scores (p=0.008), as well as a reduction of total testosterone (p=0.19). PSA levels did not change. This pilot study suggests that long bicycle tours with prostate cancer patients are feasible. Due to the missing control group and the small sample size, the results of this pilot study are limited.

Keywords Prostate cancer · Bicycle · PSA · Exercise · Physical activity · Testosterone

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Introduction

Every year, 60,120 men are diagnosed with prostate cancer, making it the most common malignant neoplasia in men in Germany [25]. Prostate cancer and its medical treatment cause a number of adverse effects on physical, psychological, and social level. Eighteen months after radical prostatectomy, 17–34 % of the men suffer from urinary incontinence and up to 60 % experience erectile dysfunction [33]. Hormone treatment can cause depressive moods, hot flushes, impotence, blood loss, diarrhea, and an increased body fat percentage [11, 13, 34, 36]. Additionally, muscular strength and bone density are reduced during and after androgen-deprivation therapy [32]. Investigations have shown that the risk of developing a metabolic syndrome, diabetes mellitus, or cardiovascular disease increases during a long-term hormone treatment [27, 34]. Also psychological impacts, anxiety, sadness, and depressive syndromes are often observed during medical treatment [8, 17]. Incontinence and impotence make patients feel uncomfortable and ashamed and their self-esteem may be weakened [8, 17]. Psychological stress frequently causes sleep disturbances, fatigue, nausea, and pain and negatively influences social skills [19] and quality of life [17, 19, 37]. The resulting risk is that patients underestimate their own performance due to insecurity and therefore become physically inactive. This may then lead to inactivity-induced health problems or even diseases (Fig. 1).

In the last few years, several studies have shown that physical activities are feasible and effective for prostate cancer patients; not only during rehabilitation and in the aftercare but also during the medical treatment [4]. Resistance and aerobic exercise reduce fatigue and improve quality of life, muscular strength, and cardiovascular fitness during irradiation [18, 31, 36, 39]. Positive influences on muscular fitness, physical performance, fatigue, and quality

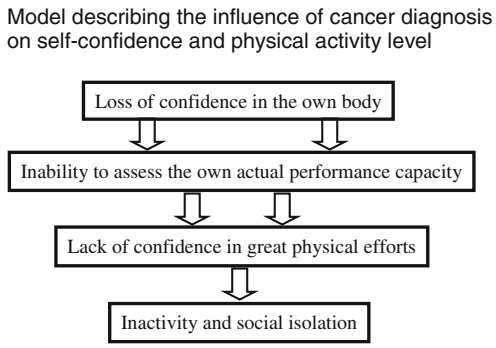

Fig. 1 Model describing the influence of cancer diagnosis on self-confidence and physical activity level

of life have also been observed in patients undergoing hormone treatment [5, 30]. Particularly, pelvic floor exercises improve incontinence in affected men [15, 20]. Finally, latest research suggests that the mortality risk is reduced in physically active prostate cancer survivors [9]. Even though the underlying effects are still unclear, an increased interleukin-6 (IL-6) release [21] as well as a decreased oxidative stress level is discussed [3]. The relevancy of the sexual hormone testosterone is mostly unknown [26]. However, there are references that physical activity may influence total testosterone [14] as well as oxidative stress levels [12] and interleukin-6 [21].

Even though cycling is a very popular sport in our society, no studies could be found that examine the feasibility of a bicycle tour which lasts for several weeks and involves prostate cancer patients. This may be the reason why cycling can hardly be found in physical exercise guidelines for prostate cancer patients [28]. In practice, physicians and therapists rarely recommend cycling to prostate cancer patients due to insecurity, fear, and/or ignorance. Within this pilot project, we evaluated the feasibility of a bicycle tour with prostate cancer patients which lasted several weeks and comprised 1,408 km.

Methods

Patient recruitment was conducted by a Federal Association for Prostate Cancer Support (Bundesverband Prostatakrebs Selbsthilfe). Inclusion criteria comprised diagnosed prostate cancer, good German language skills, and a written consent regarding participation in the study. Exclusion criteria were serious cardiac disease (New York Heart Association Class III–IV), severe orthopedic or internal disease that does not allow a bicycle tour, pronounced oncological progress within the last 12 months, brain and/or bone metastases, immunosuppression, and/or acute health, and somatic restrictions (e.g., infection, fever). A sports medical examination (e.g., anamnesis, electrocardiogram, etc.), which was conducted 3 months prior to the tour was meant to confirm safety. The protocol was approved by the ethics committee of the German Sport University Cologne and all procedures are in accordance with the Helsinki Declaration of 1975. All patients provided written informed consent prior to participation.

Subjects

A total of 10 subjects were recruited. Two subjects had to be excluded prior to the start of the tour due to orthopedic complaints and an acute sport injury. Therefore, eight prostate cancer patients participated in the bicycle tour. The mean age of the patients was 66.87 years, the mean body size was 180.37 cm, and the mean body weight was 88.0 kg (Table 1). One participant dropped out during the follow-up period (t4) without giving a reason.

Assessments

Assessments were conducted 3 months before (t1), 1 week before (t2), 1 week after (t3), and 6 months after (t4) the bicycle tour. In order to assess aerobic endurance, a spirometry on a cycle ergometer was conducted (VO2max, lactate, and respiratory quotient). The initial watt load of 60 W was increased every 5 min by 30 W with a 1-min break between each level. Spiroergometry is considered as the assessment method with the highest validity [7].

Patients completed two quality of life questionnaires (EORTC QLQ-C30 and PR25, version 3), which were developed by “the European Organization for Research and Treatment of Cancer ”(EORTC). The general questionnaire consists of 30 items, which result in five functional scales (physical, cognitive, role, social, and emotional functioning), three symptom scales (fatigue, nausea/vomiting, and pain), a global scale concerning health-related quality of life, and six single items (dyspnoe, insomnia, appetite loss, constipation, diarrhea, and financial difficulties). The prostate cancer-specific module EORTC QLQ-PR25 contains 25 items. Its subscales include three symptom scales (urinary, bowel, and treatment-related symptoms), as well as a sexual function scale [1]. Furthermore, the following blood parameters were analyzed in a central laboratory: prostate-specific antigen (PSA), total testosterone, and interleukin-6. For organizational reasons, blood samples were only taken at t2, t3, and t4. Oxidative stress levels and antioxidant capacities were examined by measuring the concentration of free oxygen radicals (reactive oxygen species) and the antioxidant capacity (antioxidants, antioxidant capacity) in patients’ capillary blood (Fort and Ford Test, Company Incomat, Glashütten, Germany) [12].

Table 1 Subjects and anthropometric data

Subject	Age	Weight (kg)	Height (cm)	BMI (kg/m^2)	Diagnosis
1	67	86	182	25.96	Prostate cancer; p T2c; G2; Gleasen score, 3+3=6
2	67	95	185	27.76	Adenocarcinoma of the prostate pT3b; pN0 (0/23); cM0; G3; Gleason score, 4+4=8
3	69	93	173	31.07	Prostate cancer pT2c; pN0; pR1; G2; Gleason score, 3+3=6
4	66	80	185	23.37	Prostate cancer T2c; pN0; Gleason score, 3+4=7
5	66	82	176	26.47	Prostate cancer pT3b; pN0 (0/6); R0; G2b; Gleason score, 4+3=7
6	66	87	182	26.26	Adenocarcinoma of the prostate pT2b; pN0 (0/3); pMX; pL0; pV0; pR0; Gleason score, 3+4=7
7	65	87	178	27.46	Prostate cancer T2c; N0; M0; G3; Gleason score, 5+5=10
8	69	94	182	28.38	Prostate cancer G2a; Gleason score, 3+3=6

The intervention

Eight prostate cancer patients took part in a 1,408 km bicycles tour from the west of Germany to the south of France. The tour started in May 2010 in Cologne and went through Germany, Luxembourg, and France, all the way to Marseille. The patients were accompanied by three students. Two joined the patients on their bicycles, while one drove the support car carrying luggage, food, and service materials. The distances covered within the 21 daily stages ranged between 34 and 120 km per day (Ø 67 km). On average, participants rode their bikes for 4.35 h per day. In order to assess energy expenditure and physical activity levels, four patients wore a Sense Wear armband (SMT medical GmbH&Co Würzburg, Germany) during the entire bicycle tour. Sense Wear is a metabolic activity and lifestyle monitor, which determines caloric expenditure [10]. The total time of travel added up to approximately 91.50 h and a mean total energy expenditure of 95,974 kcal per person was reached. The group took three rest days during their tour.

Statistics

Statistical analyses were performed using SPSS German version 20.0 (IBM). In order to analyze the study data, the median, standard deviation, and an analysis of variance was applied. A one-factorial analysis of variance for repeated measurements, including the Bonferroni post hoc test, was employed. For graphical processing and representation of the study data, the spreadsheet program Microsoft Office Excel 2007 was used.

Results

All eight subjects reached Marseille within 5 weeks. Patients were able to improve all aerobic endurance parameters throughout the tour. Lactate concentrations even showed a (highly) significant development in the preparation phase from t1 to t2 measurement (Fig. 2). There was no change from t2 to t3 but a slight decrease of lactate concentration to t4.

Overall, the subjective parameters of quality of life showed positive changes within this pilot study, even though these rarely reached statistical significance. More noticeable, changes were achieved in the prostate cancer-specific module PR25. Clear improvements could be observed, including a highly significant (p=0.008) effect on treatment-related quality of life (Table 2).

Regarding blood examinations, PSA concentrations did not change in any subject throughout the bicycle tour and therefore maintained stable. Interleukin-6 concentrations remained constant from the first to the second measurement; however, it increased 6 months after the intervention. Total testosterone concentrations decreased clearly yet not significantly (p=0.19). Values remained in the normal range (Table 3).

In terms of free radical determination, oxidative stress levels remained nearly constant throughout the intervention. Half a year after the bicycle tour, a nonsignificant decrease

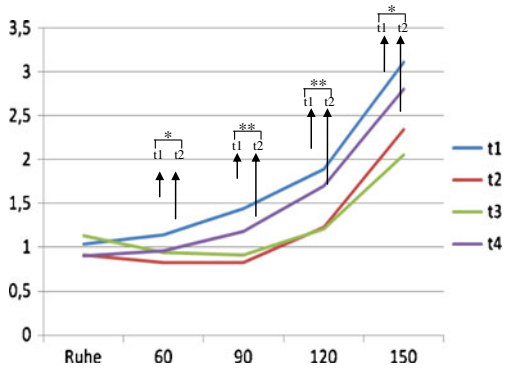

Fig. 2 Changes in lactate concentrations from t1 (n=8, SA±0.84), t2 (n=8, SA±0.64), t3 (n=8, SA±0.47) and t4 (n=7, SA±0.79), ANOVA, (standard deviation (SD), sample size (n), significance value (p), significant (*), highly significant (**), not significant (n.s.) for all p>0.05), t1, t2, t3, and t4

Table 2 Changes in quality of life from t1 (n=8) to t2 (n=8), t3 (n=8) and t4 (n=7), ANOVA (standard deviation (±SD), sample size (n), significance value (p), significant (*), highly significant (**), not significant (n.s.) for all p>0.05) t1, t2, t3, and t4

	T1	T2	T3	T4	p
EORTC QLQC-30					
Quality of life	73.81±8.91	73.81±10.12	82.14±19.50	73.81±13.11	0.447
Physical functioning	98.09±3.25	93.33±5.44	98.10±5.04	95.24±9.97	0.139
Role functioning	95.24±12.60	95.24±12.60	95.24±12.60	88.10±15.85	0.415
Cognitive functioning	80.95±24.40	76.19±28.64	80.95±17.82	90.48±18.90	0.98
Social functioning	85.71±17.82	88.10±15.85	92.86±13.11	83.33±16.67	0.321
Emotional functioning	84.52±18.28	75.00±25.00	90.48±13.11	79.76±24.93	0.097
Fatigue	15.87±24.73	17.46±23.00	9.52±13.50	9.52±13.50	0.246
Nausea/vomiting	0±0	0±0	0±0	0±0	k.A.
Pain	14.29±20.25	4.76±8.13	11.90±20.89	19.05±26.23	0.488
Dyspnea	9.52±25.20	14.29±37.80	0±0	9.52±25.20	0.721
Insomnia	23.81±31.71	33.33±27.22	23.81±25.20	23.81±31.71	0.825
Appetite loss	0±0	0±0	4.76±12.60	0±0	0.415
Constipation	4.76±12.60	4.76±12.60	4.76±12.60	0±0	0.415
Diarrhea	4.76±12.60	4.76±12.60	4.76±12.60	0±0	0.761
Financial difficulties	0±0	0±0	0±0	4.76±12.60	0.415
EORTC PR 25					
Sexual functioning	59.52±15.95	61.90±22.55	54.76±22.78	61.90±32.62	0.73
Urinary symptoms	22.88±25.32	25.33±25.95	22.29±23.29	27.38±25.06	0.07
Bowel symptoms	3.57±4.45	2.38±4.06	2.38±4.06	4.76±6.56	0.66
Treatment-related symptoms	19.84±13.90	11.91±16.17	8.41±12.03	13.33±14.55	0.008** (t1–t3: 0.006**)

could be observed (p=0.55). The antioxidant capacity increased nearly significantly from t2 to t3 and then remained stable in the follow-up period (p=0.063; Fig. 3).

Discussion

The results of this pilot study suggest that a long bicycle tour with prostate cancer patients is feasible. With an appropriate preparation and medical investigation, it was possible for each participant to accomplish the 1,408 km tour. Furthermore, no problems appeared when realizing the project. The findings show that above all, the aerobic endurance performance of the prostate cancer patients improved throughout and especially prior to the tour and in the follow up. Therefore, the greatest effects were already achieved in the preparation phase. Due to the fact that the patients began the project with a good status of quality of life (corresponds to mean value of the healthy population) [29, 36], significant changes could barely be seen. Aside from the positive psychosocial influence, PSA levels were not affected by the bicycle tour. In literature, an increased PSA level is described during or directly after a biking intervention. However, this observation is a short-term effect that is caused by the mechanical stimulus during cycling [22]. In our results,

Table 3 Changes in PSA, total testosterone, and interleukin-6 from t2 (n=8) to t3 (n=8) and t4 (n=7), ANOVA, (standard deviation (±SD), sample size (n), significance value (p), for all p>0.05), t2, t3, and t4

Parameter	t2	t3	t4	p value
Total testosterone	4.32±2.29	3.96±2.2	3.51±1.73	0.19
PSA	0.11±0.13	0.11±0.13	0.15±0.25	0.48
Interleukin-6	2.2±0.46	2.225±0.6	2.8±1.44	0.11
n		8	8	7

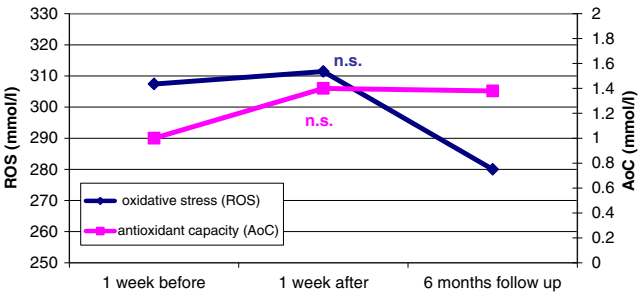

Fig. 3 Changes in oxidative stress and antioxidant capacity from 1 week before (n=8; reactive oxygen species (ROS), SD ±97.16; antioxidant capacity (AoC), SD ±0.64) to 1 week after (n=8; ROS, SD ±48.4; AoC, SD ±0.69) and 6 months after the bicycle tour (n=7; ROS, SD ±83.35; AoC, SD ±0.28), ANOVA (standard deviation (SD), sample size (n), significance value (p) for all p>0.05)

we observed a long-term effect. Total testosterone levels did not change throughout the 5-week tour but then decreased in the follow-up period. These findings correspond with recent data. However, since two patients received an androgen deprivation therapy, the interpretation of the results is limited. It is scientifically well proven that long-term physical exercise can decrease total testosterone levels in healthy athletes. Acute impacts on the other hand can increase total testosterone [6, 16, 24]. These issues are mostly unexplored in cancer patients [31]. Changes in IL-6 serum levels could not be detected. Physical activity has a strong immediate effect on the IL-6 concentration which is associated with a long-term change towards an anti-inflammatory environment in the organism. Yet the scientific data is inconsistent [35, 38]. In the future, studies with long follow-up periods should be considered. When regarding the oxidative parameters, it is remarkable that both oxidative stress and antioxidant capacity values improve. It is well proven that high physical impacts increase oxidative stress levels but long-term exercise interventions decrease them, as could be shown in this pilot study [2, 12, 23]. Antioxidant capacity levels meet the standard range at all assessment time points and even increased towards an upper standard range after the tour.

The limitations of this pilot study are the small, heterogenic sample size and the missing control group. In order to gain further information on the impact of such a physical exercise program on biological markers in prostate cancer patients, more detailed research is necessary. We involved subjects which already had a good quality of life and physical performance at baseline. Therefore, greater effects could hardly be expected. Yet, in summary, our results show that long cycling tours with prostate cancer patients are feasible and could bring about long-lasting positive effects. This most likely will increase physical activity levels in prostate cancer patients and may therefore counteract inactivity-induced health problems or diseases. Finally, this can also be of particular interest for the sport tourism sector. Based on these findings, further studies must follow in order to optimize therapeutic aspects of physical activities in the rehabilitation and aftercare of a prostate cancer disease.

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Conflict of interest The authors declare that they have no conflict of interests.

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