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Ergometric performance and cardiovascular profile of obesity clinic patients

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Abstract

Background

Aerobic exercise capacity is considered as an independent prognostic factor for cardiovascular disease and mortality. It is usually expressed in maximal oxygen consumption (VO_2max) or metabolic equivalent (MET) and is measured by spirometry or calculated by a regression formula based on maximal performance achieved. Obesity is associated with reduced physical performance and increased cardiovascular mortality. The aim of our study was to describe the ergometric and cardiovascular profile of patients of an obesity clinic, and to compare a direct measure of VO_2max with an indirect by a regression formula and to.

Method

131 consecutive patients of an obesity clinic (95 females, 36 males) aged 16-75 years participated. The VO_2max was measured by spirometry on a treadmill and estimated by a regression formula on the basis of the speed and grade of the treadmill. We have determined the relationship between Body mass index (BMI), Waist Circumference (WC) and the parameters $\text{VO}_2\text{max/kg}$, MET, Performance Relative for Age, Heart Rate Recovery one minute after maximal effort (HRR), VO_2max relative to a theoretical normal body weight (corresponding to a BMI of 25 kg/m^2 ($\text{VO}_2\text{maxRel25}$)), blood pressure, at rest and 5 minutes after exercise, Framingham Score and C-reactive protein (CRP).

Results

For the different age groups the $\text{VO}_2\text{max/kg}$ was below normal values (mean -23.4 %). Measured VO_2max was 15.2 % lower than estimated by the regression formula. After adjusting to age and to a theoretical upper-limit normal body weight (corresponding to a BMI of 25 kg/m^2) $\text{VO}_2\text{max/kg}$ was 5-20 % (mean value 15 %) higher than the reference values. $\text{VO}_2\text{max/kg}$ and HRR were correlated with BMI, WC and Framingham Score. 40% of the patients were already treated for hypertension, 55% had elevated blood pressure measurements at rest and 52% after exercise.

Conclusions:

Ergometric stress testing in obese subjects delivers important information that helps to evaluate the cardiovascular risk in this population and to provide individual recommendations for training therapy (e.g. training intensity, heart rate etc). Obese patients show a marked diminution of aerobic exercise capacity. In this population, the use of a standard regression formula to calculate VO_2max leads to an overestimation of aerobic performance. The even higher than normal VO_2max related to upper-normal body weight indicates that the reduced physical performance in obese patients is rather due to the overweight than to a pathological loss of muscle mass.

Introduction

Since the 1980s obesity can be considered an epidemic. In 2008 half of all adults and one in five children in the WHO European Region were overweight. Based on the latest estimates in European Union countries overweight affects 30-70 % and obesity 10-30 % of adults (1).

Obesity is primarily related to an imbalance between food intake and energy expenditure. The health risks associated with obesity are numerous. Cardiovascular risks are multiplied by three, and it is a major risk for developing diabetes, several cancers as well as respiratory, musculoskeletal and rheumatologic problems. The increased cardiovascular risk relies on dyslipidemia, hyperglycemia, hypertension and sleep apnea (2). In total, obesity causes a significant co-morbidity (1). In Luxembourg, the cardiovascular mortality is responsible of about one third of all deaths in 2005 and this result establishes the cardiovascular health as a priority objective for the health authorities (3).

The cardio-respiratory fitness (expressed as maximal oxygen consumption ($\text{VO}_{2\text{max}}$), metabolic equivalent (MET) and the heart rate return after exercise (HRR) are predictive markers of cardiovascular risk factors and of cardiovascular morbidity and mortality (4, 5, 6, 7). The exercise stress test remains the only way to assess exercise capacity and hemodynamic adaptation to the effort. It provides both diagnostic and prognostic information.

Until now few studies have described the ergometric performance of overweight patients on a treadmill maximal test (8, 9, 10). It is difficult to compare results achieved by different methods of ergometry because in general the $\text{VO}_{2\text{max}}$ measured during exercise on the treadmill is about 10 % higher than that obtained by the cycloergometer (11). Furthermore, cycling represents an unusual exercise and causes discomfort with the sitting position in these patients.

The purpose of this study is to describe the ergometric and cardiovascular profile of patients of the Obesity clinic of the Centre Hospitalier de Luxembourg (CHL), and secondly to compare the $\text{VO}_{2\text{max}}$ measured by spiro-ergometry with the $\text{VO}_{2\text{max}}$ estimated by a regression formula according to the guidelines for exercise testing of the American College of Sports Medicine (ACSM) (12; 30) in order to study the possibility to derive the $\text{VO}_{2\text{max}}$ achieved on the treadmill without measuring it by spiro-ergometry in this of overweight and obese population.

Methods

Sampling

In the study we included 131 consecutive patients who were included in the pluridisciplinary program of the Obesity clinic of the CHL between 09/2009 and 01/2012. Ninety-five (72.5 %) females and 36 (27.5 %) males aged 16 to 75 years with a $\text{BMI} \geq 26.7 \text{ kg/m}^2$ attended the study.

Anthropometric measurements

The following data were collected: body weight, height, waist circumference, blood pressure, cardiovascular risk factors (including history of diabetes, cardiovascular disease or stroke), lifestyle (including alcohol consumption, physical activity, smoking) and current treatment.

Body weight was measured with electronic medical scales (Seca, Germany). The height with a portable wall stadiometer (Seca, Germany). WC was measured in a standing position, using a flexible non distensible tape, without pressure exertion on the tissues at the level midway between 12th rib and the uppermost lateral upper border of the iliac crest during mild expiration. The BMI was calculated using the formula weight divided by height squared (kg/m^2).

Biochemical parameters

Patients have realized the blood test in different Luxembourgish laboratories applying internal and external standard quality controls. [Ketterthill, Laboratories Reunis, Laboratory of Centre Hospitalier de Luxembourg, Laboratory of Centre Hospitalier Kirchberg, Laboratory of Hospital Emile Mayrisch, Laboratory Mondorf]. Laboratory tests performed include fasting blood glucose (Glu; mg/dl), glycosylated hemoglobin (HbA1c; mmol/mol), Triglycerides (TG; mg/dl), Total Cholesterol (TC; mg/dl), LDL-Cholesterol (LDL-C; mg/dl), HDL-Cholesterol (HDL-C; mg/dl) and C-reactive protein (CRP; mg/l).

Cardiovascular risk factors

Based on the International Obesity Task Force (13), convened by the World Health Organization, a subject with a BMI $\geq 30.0 \text{ kg/m}^2$ was defined as obese and with a BMI $\geq 25 \text{ kg/m}^2$ as overweight. Measures of WC were used to determine the extent of central adiposity (WC $\geq 102 \text{ cm}$ in men and $\geq 88 \text{ cm}$ in women) (14). Blood pressure was measured by the Riva Rocci method on both arms with a cuff adapted to the increased arm circumference of the obese patients in supine position before the exercise test (3 measurements in case of an elevated first value) and in standing position on the treadmill 5 minutes after maximum effort.

For the calculation of the absolute cardiovascular risk we have used the Framingham model which reflects 7 independent variables including diabetes and HDL-cholesterol which the SCORE model ignores (15). It is focused on the following seven cardiovascular risk factors: age, gender, hypertension, diabetes mellitus, lipid disorders (total cholesterol and HDL-cholesterol), and smoking.

In order to calculate the Framingham score the participants were classified as hypertensive if they reported taking antihypertensive medication and/or had a systolic blood pressure (SBP) $\geq 140 \text{ mmHg}$ and/or diastolic blood pressure (DBP) $\geq 90 \text{ mmHg}$ (16).

Diabetes type 2 was diagnosed according to American Diabetes Association Guidelines: Fasting plasma glucose ≥ 126 mg/dl (fasting for at least 8 hours), 2-hour plasma glucose ≥ 200 mg/dl in the glucose tolerance test and/or glycosylated hemoglobin $\geq 6.5\%$ or patients on antidiabetic medication (17).

The subjects were defined as having lipid disorders if they had at least one of the following abnormalities: TC ≥ 190 mg/dl, TG ≥ 50 mg/dl, LDL-C ≥ 115 mg/dl and HDL-C < 40 mg/dl for men or < 46 mg/dl for women (14), and/or were taking lipid-lowering drugs. Smoking was assessed by self-assessment questionnaire.

Aerobic capacity

Aerobic capacity (VO_{2max}) was determined by a walking test on a treadmill (Woodway, Lörrach) with an initial speed set at 2, 3 or 4 km/h and increasing 0.1 km/h every 10 seconds to a maximum speed of 3-6 km/h (depending on the individual walking capacity assessed during a test trial immediately before the test). After reaching the individual maximum speed, the slope is increased by 0.5 % every 20 seconds until exhaustion is reached.

Oxygen uptake (VO_2), carbon dioxide production (VCO_2) and ventilation were measured every 15 seconds using a direct gas analyzer (SCHILLER CS-200, Vista XT metabolic system). ECG was continuously monitored until five minutes of recovery. Heart rate was measured on the electrocardiographic recording and notified during the last 15 seconds of each test step and one minute after the test.

The following exercise test criteria were used for the achievement of VO_{2max} (18, 19,20):

- a) Leveling off (plateau) of oxygen uptake with an increase of work rate
- b) Respiratory exchange ratio (RER) = $VCO_2/VO_2 > 1.1$
- c) Achievement of 90 % of the age-adjusted estimate of maximal heart rate (220 minus age of the patient)

The mean RER was 1.14 ± 0.11 . Eighty-seven % ($n = 114$) of the patients had a maximal heart rate above 90% of the theoretical heart rate. Nine patients could not tolerate the oxygen mask and they performed the test without, one patient performed a cyclo-ergometry because of knee osteoarthritis and one patient has not tolerated the test at all and thus could not be included in the study.

The performance relative to age was calculated with the following formula:

$$\text{Performance relative to age} = \frac{VO_{2max} \text{ measured}}{VO_{2max} \text{ normal for age}} \times 100 \text{ (21)}$$

As a normal VO_{2max}/kg for the age we assumed for untrained men 42.5 ml/kg/min (the mean value of the range 40-45 ml/kg/min) and for women 37.5 ml/kg/min (the mean value of the range 35-40 ml/kg/min) at the age of 20-30 years and a decrease of 1 % per year above 30 years (21).

The formula according to the guidelines for exercise testing of the American college of sports medicine (12, 30) is integrated in the software of the treadmill and calculates the METs (1 MET = 3.5 ml VO₂/min/kg depending on the speed and the grade of the treadmill:

$$METs = \frac{V \times 1.675 + 0.3015 \times V \times G + 3.5}{3.5}$$

V=Treadmill speed (km/h), G = Grade of the treadmill (%), V < 8 km/h

For each subject a comparison was made between the VO₂max calculated by this formula with the VO₂max measured during the test.

For the purpose of the approximation of the physical performance corresponding to the theoretical (upper) normal body weight of each patient (VO₂maxRel25), the measured VO₂max was divided by the theoretical weight at a BMI of 25 kg/m² (Weight=25 x height²).

Heart rate recovery was analyzed at 60 seconds of recovery by the formula:

$$\text{Heart rate recovery (HRR)} = \text{Peak Heart rate (HRmax)} - \text{Heart rate at minute 1 (HR60)}$$

Statistical analysis

The results were expressed as mean ± 1 SD (standard deviation). A factorial ANOVA was used to determine the p statistics and the Pearson correlations (r). The statistical analysis was performed using SPSS Version 17.0 and the significance level was set at p <0.05.

Results

Anthropometry

The mean age and BMI were similar between sexes. The average height and average weight were different between sexes (p=0.0001). A positive correlation was found between BMI and waist circumference (p=0.0001) (table 1).

TABLE 1

Linear correlations between anthropometric data (BMI and waist circumference) and selected results.
For the abbreviations see legend table 1.

Characteristic	Overall (N)	BMI (kg/m ²)		WC (cm)	
		P Value	r	P Value	r
Age (years)	131	NS	NS	NS	NS
Waist circumference (cm)	131	0.0001	0.807	-	-
Body mass index (kg/m ²)	131	-	-	0.0001	0.807
VO ₂ max/Kg (ml/kg/min)	130	0.0001	-0.619	0.0001	-0.419
Calculated VO ₂ max/Kg (ml/kg/min)	120	0.0001	-0.451	0.002	-0.274
MET	130	0.0001	-0.623	0.0001	-0.423
Performance relative for age (%)	130	0.0001	-0.513	0.0001	-0.333
VO ₂ maxRel25 (ml/kg/min)	130	NS	NS	NS	NS
HRmax (/min)	130	NS	NS	NS	NS
HRR (/min)	130	0.0001	-0.313	0.001	-0.287
CRP (mg/l)	112	0.001	0.367	NS	NS
FR CVD R (%)	131	0.065(NS)	NS	0.006	0.253

Ergometry

VO₂max was higher among men (mean 26.1 ml/kg/min) than in women (22.3 ml/kg/min) (p=0.001) (table 2).

TABLE 2

Anthropometric characteristics, spiroergometric data and cardiovascular risk factors of the women, men and the overall group. Abbreviations: N=number of patients, X=mean value, SD=standard deviation, VO₂max/kg=maximal oxygen consumption per kilogram, MET=metabolic equivalent, VO₂maxRel25=VO₂max relative to a theoretical normal body weight corresponding to a BMI of 25 kg/m², HRmax=Peak Heart rate, HR60=Heart rate at minute 1, (HRR)=Heart rate recovery, B.P.=Blood pressure, B.P. 5min after ex.= Blood pressure 5 minutes after exercise, HbA1C= Glycated hemoglobin A1c, CRP=C-reactive protein, FR CVD R=Framingham Score

Characteristic	FEMALES			MALES			TOTAL		
	N	X	SD	N	X	SD	N	X	SD
Age (years)	95	42.2	13.1	36	43.8	12.5	131	42.6	12.9
Weight (kg)	95	106.8	20.1	36	131.6	24.1	131	113.6	23.9
Waist circumference (cm)	95	118.4	14.5	36	133.8	17.1	131	122.7	16.7
Height (cm)	95	163.4	6.7	36	179.7	7.4	131	167.9	10
Body mass index (kg/m ²)	95	39.9	6.8	36	40.7	6.8	131	40.1	6.8
VO ₂ max/kg (ml/kg/min)	94	22.3	5.3	36	26.1	6.1	130	23.3	5.8
Calculated VO ₂ max/kg (ml/kg/min)	85	26.7	5.3	35	30.4	6.8	120	27.8	6
MET	94	6.4	1.5	36	7.5	1.7	130	6.7	1.7
Performance relative for age (%)	94	74.8	15.1	36	81.2	19.2	130	76.6	16.5
VO ₂ maxRel25 (ml/kg/min)	94	35	6.1	36	41.4	6.6	130	36.8	6.9
HRmax (/min)	94	163	29	36	162	17	130	163	21
HR60 (/min)	94	134	23	36	135	20	130	134	22
HRR (/min)	94	29	11	36	27	9	130	28	10
Systolic B.P. (mmHg)	95	131	16	36	142	15	131	134	16
Diastolic B.P. (mmHg)	94	85	9	36	92	10	130	87	10
Systolic B.P. 5min after ex. (mmHg)	93	84	9	36	142	19	129	134	19
Diastolic B.P. 5min after ex. (mmHg)	93	84	9	36	88	10	129	85	9
Total cholesterol (mg/dl)	85	198	31.9	35	212	39.9	120	202	34.9
LDL cholesterol (mg/dl)	82	121	29.6	35	139	35.1	117	126.3	32.4
HDL cholesterol (mg/dl)	82	54	13.1	35	44	8.6	117	51.4	12.7
Triglycerides (mg/dl)	83	121	44.5	35	158	81.5	118	132.2	60
Fasting glucose (mg/dl)	86	97.1	13.6	35	116	47.2	121	102.7	29
HbA1C (%)	77	5.6	0.4	34	6.1	1.2	111	5.8	0.8
CRP(mg/l)	78	7.2	6.9	34	4.1	3.5	112	6.3	6.2
FR CVD R (%)	82	5.5	6.1	35	13.9	11.9	117	8	9.1

For the different ages the VO₂max/kg is on average 23.4 % below the normal values for the same age (figures 1, 2). Correlations were found between (BMI, WC) and the VO₂max/kg, the performance related to age, the MET (figure 3) and the HRR (table 1). A weak correlation was found between the VO₂max/kg and the HRR (p = 0.015, r = 0.212, table 3). 6.1 % of the patients (7 women and 1 man) had a HRR less than or equal to 12 /min (the “threshold” value indicating significant cardiovascular risk calculated by reference 5).

FIGURES AND TABLES

Figure 1: Comparison of the $\text{VO}_2\text{max/kg}$ measured in our male patients to normal values (40-45 ml/kg/min) by Kindermann W (21)

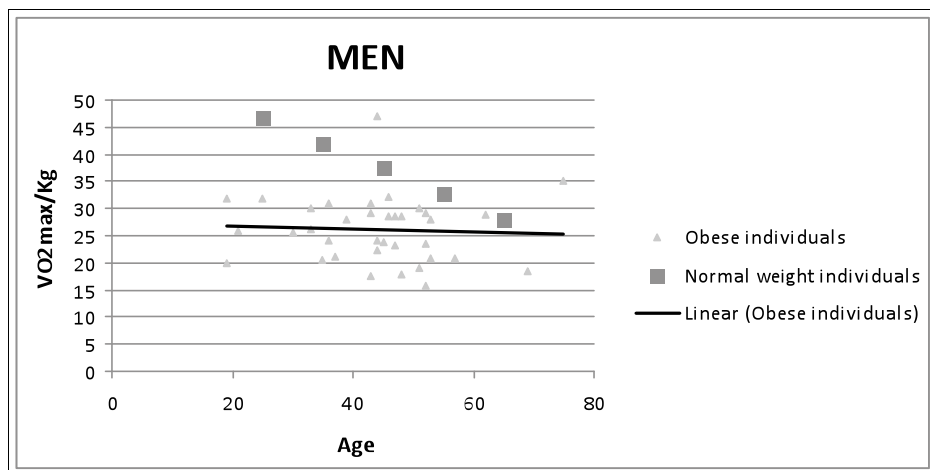
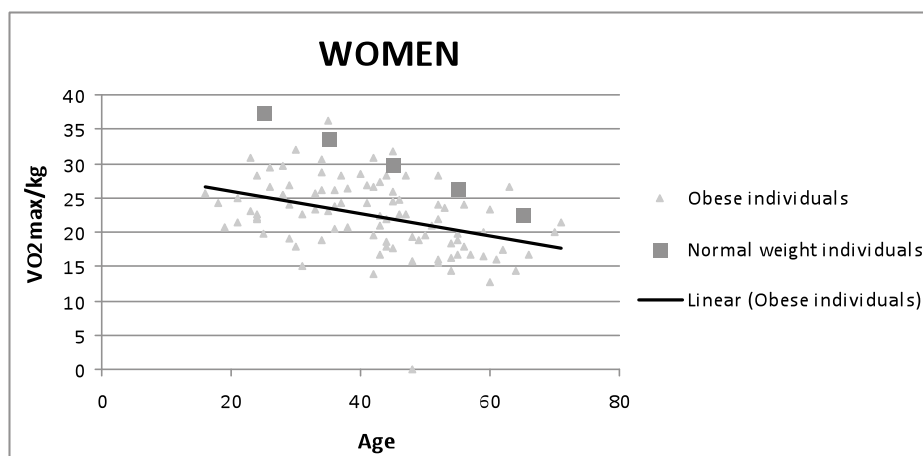


Figure 2: Comparison of the $\text{VO}_2\text{max/kg}$ measured in our female patients to normal values (35-40 ml/kg/min) by Kindermann W (21)



The difference between the $\text{VO}_2\text{max/kg}$ and the $\text{VO}_2\text{maxRel25}$ was found to be significant important for the group of men ($p = 0.0001$), for the group of women ($p = 0.0001$, figure 4) and for the total of patients ($p = 0.0001$, table 3).

TABLE 3

Linear correlations between selected results. For the abbreviations see legend table 2.

Characteristic	$\text{VO}_2\text{max/Kg}$ (ml/kg/min)			HRR (/min)		
	N	P Value	r	N	P Value	r
Calculated $\text{VO}_2\text{max/kg}$ (ml/kg/min)	120	0.0001	0.642	-	-	-
FR CVD R (%)	117	0.044	-0.186	117	0.02	-0.215
HRR (/min)	131	0.015	0.212	--	-	-
MET	-	-	-	131	0.014	0.214
CRP(mg/l)	112	0.001	-0.301	112	NS	NS

Figure 3: Negative correlation between waist circumference and MET

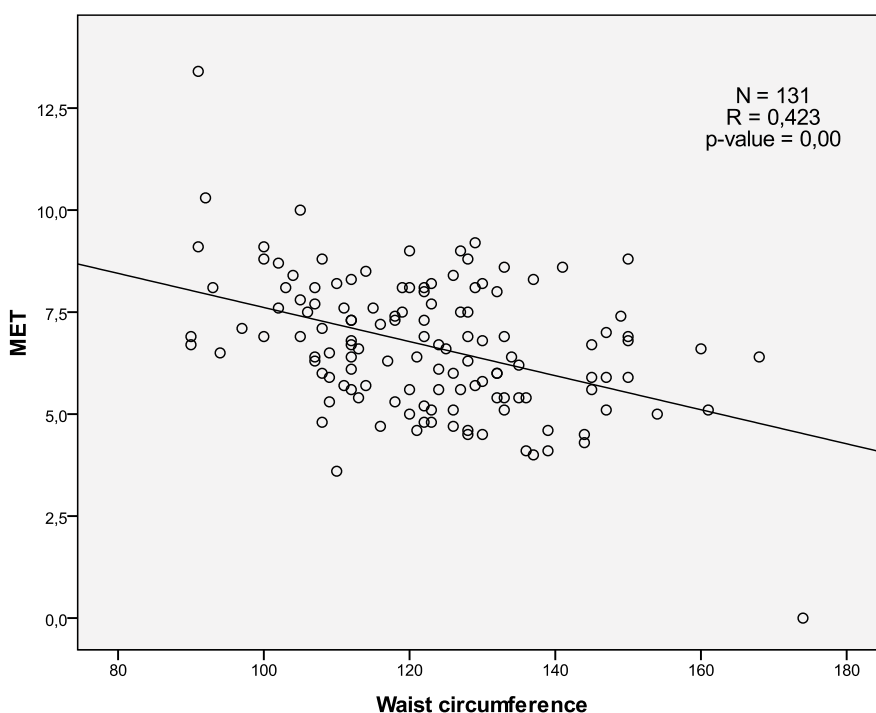
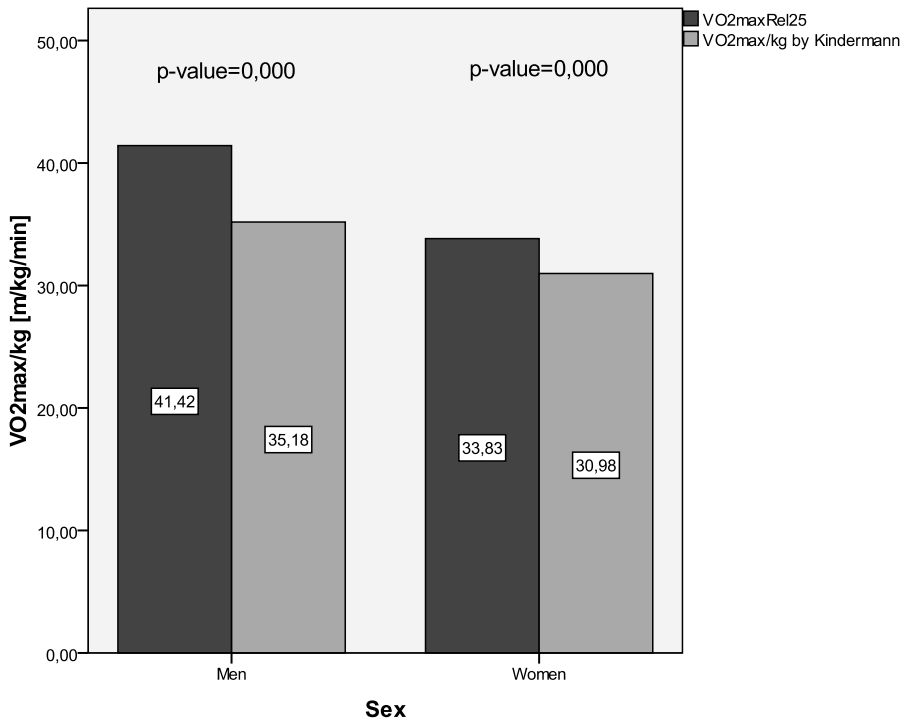


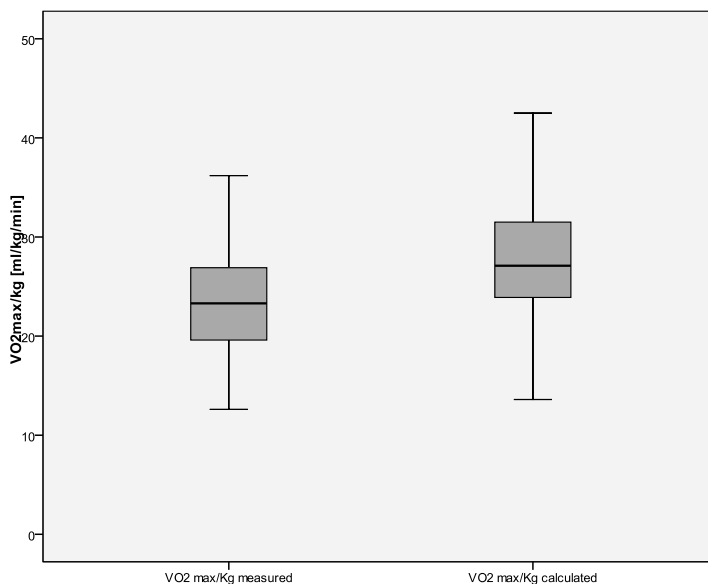
Figure 4: Comparison between VO₂maxRel25 (black) and normal ranges of VO₂max/kg (grey) by Kindermann (21) for men and women



Comparison between measured and calculated VO₂max

For the 120 patients who performed a spiro-ergometry and reached the spiroergometric exhaustion criteria, the measured VO₂max/kg (23.3 ± 5.8 ml/kg/min) was on average 15.2 % less than the calculated VO₂max/kg (27.8 ± 6 ml/kg/min) ($p = 0.0001$, figure 5). There was a significant correlation between the estimated and the measured VO₂max ($p = 0.0001$, $r = 0.642$).

Figure 5: Maximal oxygen uptake measured and calculated by the method of Lea & Febiger (12). The box diagrams show the median, interquartile differences and extreme values



Blood pressure

40 % of the patients were already known and treated as hypertensive. From these subjects 67 % had an elevated blood pressure at rest while this was the case in 47 % from the other subjects. Five minutes after exercise, 63 % from the already known hypertensive patients and 44 % from the other subjects had an increased blood pressure. In 10 % of the patients (6 % from the hypertensive group, 13 % from the others) with a normal blood pressure at rest before exercise showed an elevated blood pressure 5 minutes after exercise.

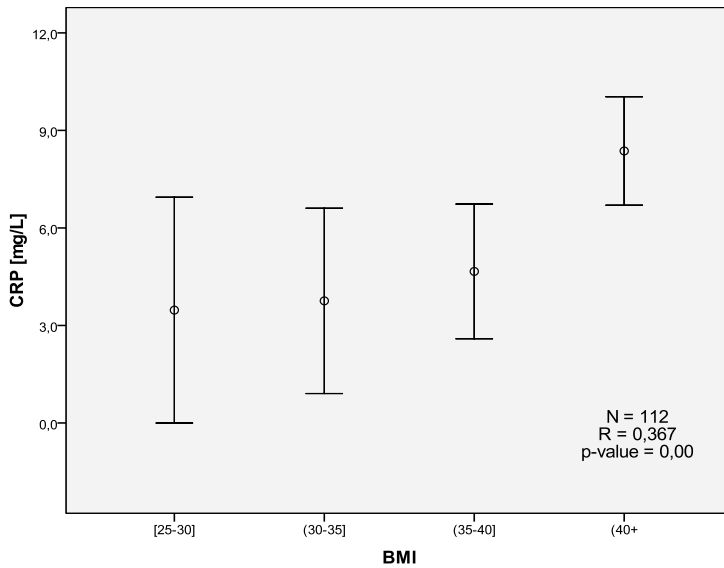
Framingham score

The Framingham score was negatively associated with VO2max/kg and HRR (table 3).

CRP

The CRP levels are elevated with a significant augmentation in all patients with BMI >40 kg/m². A weak positive correlation was found between BMI and CRP ($r=0.367$, $p=0.001$, figure 6). VO₂max/kg and CRP were found to have negative significant association ($p=0.001$, table 3).

Figure 6: Positive relationship between CRP and BMI



Discussion

Ergometric stress testing in obese patients delivers important information that helps to evaluate the cardiovascular risk in this population from an obesity clinic by analyzing performance, ECG and blood pressure response to exercise. In our population there were no pathological stress-ECG findings, but 10% of the subjects had an abnormal blood pressure response to exercise while the measurement at rest before the test had been within the normal limits. An elevated blood pressure after exercise has been described as a prognostic negative factor for the development of a hypertension (22).

VO₂max and MET as well as HRR are predictive markers of cardiovascular morbidity and mortality. Studies describe that an improvement in the physical performance of one MET causes a 12 % increase in survival and a decrease of 13 % of the mortality risk (4, 23). A physical performance of more than 10 METs predicts an excellent prognosis in the medium term (7). Cole et al (5) found that patients with a slower HRR, especially those with a HRR ≤12, within the first minute after an incremental exercise test exhibit a higher risk of cardiovascular mortality (relative risk 4.0, 95 % confidence interval 3.0 to 5.2). It is however unclear how far these relationships are valid in our population. In our sample of obese patients, those with a better physical performance (higher METs) had a faster HRR. There is also a marked reduction of VO₂max/kg (on average 23.4 % below the age-adjusted normal values) corresponding to a mean MET value of 6.7, that would indicate a 1.2 to 2 fold increase in relative risk of death (4).

The cardiovascular profile of our group is focused on the Framingham score, which estimates the overall cardiovascular risk and predicts the risk of a cardiovascular event in 10 years (24). 18.8 % of our patients had a moderate risk and 7.7 % had a high risk. The patients with a high score had a decreased physical performance and a slower HRR.

Increasing physical fitness reduces mortality, but decreasing body weight in obese patients also reduces the cardiovascular risk factors. Studies on patients undergoing a gastric bypass showed that a decrease in average of 45 kg went along with an increase of HRR by 13 beats/min (25). In our study, the patients with a lower visceral adiposity had a faster HRR.

Our results show that the calculation of VO₂max by using of a common regression formula (12,30), which is also incorporated in the software of the treadmill, leads to an overestimation of the aerobic capacity in these obese patients by a mean of 15 % compared with the actually measured VO₂max. This value is very similar to the overestimated VO₂max calculated by the ASCM running equation in a collective of athletes submitted to a running test on a treadmill (26). This has to be considered when the aerobic capacity is calculated and not measured by spiro-ergometry.

In our obese population we calculated for the first time the mean measured VO_2max adjusted to a theoretical upper-limit normal body weight (corresponding to a BMI of 25 kg/m^2). The patients showed a mean $\text{VO}_2\text{maxRel25}$ by 15 % above the age-related reference values subjects of same age. This indicates that the measured reduction in physical performance is predominantly due to overweight and not the consequence of a pathological loss of muscle mass for example induced by immobility. It may even represent the expression of a training adaptation due to the carrying of the additional body weight during daily activities.

The relationship between obesity and CRP is well-established (27). In our group, patients with morbid obesity ($\text{BMI} > 40 \text{ kg/m}^2$), had an increase of CRP by 44.3 % in comparison with the group of patients of a lower BMI level ($35\text{-}40 \text{ kg/m}^2$). Visceral obesity is correlated with high cardiovascular risk and CRP is the only marker of inflammation that independently predicts the risk of a cardiac event (28). Cardiorespiratory fitness is inversely associated with CRP, independent of BMI and emphasizes the importance of regular exercise, regardless of the level of adiposity (29).

Conclusions

Patients of the obesity clinic have a clearly impaired aerobic performance in the treadmill walking test by about one fourth compared to the normal population. In this specific population, the use of a standard regression formula derived from the anthropometric data, the speed and the grade of the treadmill to calculate VO_2max overestimates the aerobic performance. The correction of the measured VO_2max related to an upper-normal body weight leads to an even higher than normal performance which indicates that the reduced physical performance in obese patients is rather due to the overweight than to a pathological loss of muscle mass.

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Posterior fossa mass in immunosuppressed patient

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Abstract:

Background: Toxoplasmosis is the most frequent opportunistic infection of the central nervous system among individuals with the acquired immunodeficiency syndrome. Radiographic modalities include brain CT, MRI and PET scan. The differential diagnosis are usually: primary CNS lymphoma, cerebral metastasis, Progressive multifocal leukoencephalopathy, cytomegalovirus. It indicates severe immunodeficiency and, if it remains untreated, it may lead to death.

Case description: A 65 year old immunodeficiency woman with a Non Hodgkin Lymphoma treated with Chemotherapy. She had been suffering from vomiting, headache and vertigo. Treatment she received Dafalgan, Betaserc, neupogen and nexiam.

Conclusion: This case illustrates that a brain biopsy is compulsory before starting any treatment.

Keywords:

Toxoplasmosis, Non Hodgkin Lymphoma, immunosuppressed, brain biopsy.

Introduction :

Cerebral toxoplasmosis is one of the commonest presenting diagnoses in advanced HIV disease. Non Hodgkin lymphoma is common, about 30% of cases are associated with HIV infection.(7) Differentiation of the two pathologies is difficult owing to the similar clinical and radiological presentation. Imaging studies such as computed tomography (CT) or magnetic resonance imaging (MRI) are used to detect toxoplasmosis or lymphoma and may often reveal focal or multifocal ring enhancing lesions, but MRI and PET are the imaging modalities of choice, and tissue diagnosis is the gold standard.(3,8)

Hereby, we report of a female treated with chemotherapy for a Non Hodgkin Lymphoma with a posterior mass lesion.

Case report :

The case report regards a Female patient of 65 years old known with a Non Hodgkin Lymphoma. Before being referred to hospital, she initially was suffering from vomiting and then simultaneously complaining of headache and vertigo. As a result, she was admitted in an oncological department in another hospital where she was known for the Non Hodgkin Lymphoma. The neurological examination in our department showed no deficiency of the cranial nerves. The general status examination did not show any anomaly. The blood analysis showed: potassium 3.3, leukocytes 1.75G/L, haemoglobin 9.5 %, MCV 100 PG, MCH 34.8 g/dl, platelets 69 g/l, Neutrophils 0.94G/L. A biopsy of the bone was done which did not show any bony infiltration. Initially, she had a head scanner which showed a mass in the cerebellum and then a MRI was effected showing 4 intraaxial cerebral tumoral masses in the left cerebellum and in the right parietal area. They all had a necrotic center with contrast uptake. Thereafter, the patient was treated for her Non Hodgkin Lymphoma with R-Bendamustine which was replaced with R-FDR because of a splenomegaly and maintenance of Rituximab for (1 x 2 month). Our patient was then transferred to another hospital where she received bactrim and Ganciclovir. A ventriculocisternostomy was carried out on 5.11.2013 for her obstructive hydrocephalus and a biopsy for the intraaxial cerebral mass was effected after informed consent. The results of the histological exam through an extensive work out including immunohistological workout concluded that the most probable diagnosis is toxoplasmosis infection. An infection by CMV as a differential diagnosis appeared in the previous reports of histopathology not feasible. Aleucoencephalopathy due to rituximab would be very rare, histopathologically atypical but cannot be excluded. The tests were carried out at the Histopathology center Trier, Germany which was confirmed by the reference center for Neuropathology and prion research, university of Munich.

Discussion :

The present case with Toxoplasmosis involving the cerebellum and a good outcome is remarkable for several reasons.

Toxoplasmosis and Immunocompetence:

Toxoplasmosis is the most frequent opportunistic infection of the central nervous system. It indicates severe immunodeficiency and, if it remains untreated, it may lead to death (6). As such, referring to our case, the monoclonal antibodies (R-Bendamustine, R-FDR and Rituximab) she received for her treatment of non Hodgkin lymphoma were the cause of her immunosuppression.

Differential diagnosis:

At first our histopathologist suspected a CMV then it was Progressive multifocal leukoencephalopathy (PML). The final conclusion was Toxoplasmosis. Toxoplasmic encephalitis is the reactivation of disease from a prior parasitic infection. Patients normally suffer from symptoms with fevers, headaches, seizures, confusion, dementia, or focal neurologic deficits. Laboratory findings include polymerase chain reaction testing that is positive for Toxoplasma antigen in the cerebrospinal fluid, the presence of Toxoplasma antibodies indicative of past exposure, and a CD4 cell count less than 100 per mm³ (0.10×10^9 per L). With reference to our case, we did not do this test in our clinic as we thought that it was Non Hodgkin Lymphoma. The seroprevalence of *T. gondii* varies greatly among countries, ranging from 15% in the United States to 60% or more in countries with high endemicity such as France (2). Lesions are often multiple and localized to the parietal or frontal lobes, basal ganglia, or corticomedullary border (5). Our lesion was localised in the cerebellum which is another interesting point. Magnetic resonance imaging demonstrates that abscesses are generally isodense or hypodense lesions that are enhanced in a ring or nodular pattern with perifocal vasogenic edema and mass effect (9). Primary central nervous system lymphoma is an extranodal non-Hodgkin lymphoma that generally involves the brain, leptomeninges, eyes, or spinal cord without evidence of systemic disease, and patients suffering from confusion, memory loss, hemiparesis, aphasia, and seizures. Most patients have constitutional symptoms such as fever, night sweats, and weight loss, and there is also the probability of having Epstein-Barr virus DNA in the cerebrospinal fluid. The median CD4 cell count at the time of diagnosis is 50 per mm³ (0.50×10^9 per L). Lesions exhibit homogeneous contrast enhancement with edema and mass effect. Lesions that involve the corpus callosum, or the periventricular or periependymal area, and those larger than 3 cm are more likely to be caused by this condition (10,4). Brain biopsy is needed for definitive diagnosis.(1) In a nutshell, our case shows that a biopsy is compulsory to avoid irradiation, and this technique would have been recommended by other neurosurgeons. As it can be inferred that the patient had an obstructive

hydrocephalus because of the compression of the 4th ventricle and she had all the symptomatology for increased intracranial pressure.

Conclusion:

In immunodeficient patients its necessary to do a through work out. It's quite difficult to make such a diagnosis if you are not used to see such cases on a regular basis. The brain biopsy is the gold standard to confirm the diagnosis.

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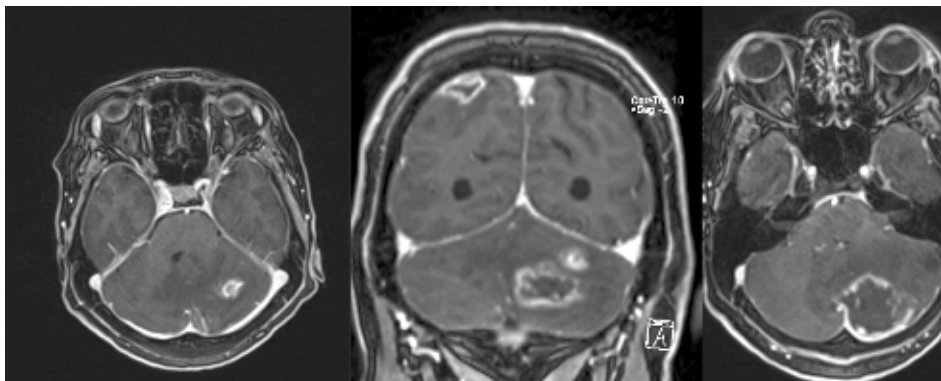


Figure 1. MRI on admission .

MRI images in axial and coronal planes showing a hypointense mass in the left cerebellum with an enhanced ring around it.

FÉLICIEN M. STEICHEN, M.D., F.A.C.S.

(1926 – 2011)

Portrait d'un chirurgien

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Abstract

The personality and the achievements of Professor Dr. Félicien M. Steichen, who was born in Luxembourg (10.13.1926) and died in Brignogan-Plages, France (6.27.2011) are brought into focus. His was a most distinguished career devoted to surgery, research, teaching and writing in Baltimore, Pittsburgh and New York. He will be remembered above all for his contributions to stapling in thoracic and abdominal surgery and to minimally invasive surgery.

Keywords: Steichen, stapling, minimally invasive surgery.

Il y a plusieurs années de cela, j'avais parcouru tous les numéros du « Bulletin de la Société de Sciences médicales du Grand-Duché de Luxembourg », des origines à nos jours. Force est de reconnaître que les articles à teneur scientifique vieillissent mal, à de rares exceptions près. Par contre, ceux qui contiennent des détails concernant la trajectoire de certains de nos prédécesseurs disparus conservent en général leur emprise sur notre curiosité ; pour une part, ce sont aussi autant de petites radiographies de leur époque. En voici un autre coulé dans un tel moule et consacré à un regretté confrère, le docteur Félicien M. Steichen. Il fit partie du conseil d'administration de la Société des Sciences médicales du Grand-Duché de Luxembourg, Section des Sciences médicales de l'Institut grand-ducal et contribua à la rédaction du Bulletin, mais ce n'était pas là son principal titre de gloire, comme on pourra le constater tout de suite.

Né à Luxembourg le 13 octobre 1926, il décéda à Brignogan-Plages (Finistère) le 27 juin 2011, inopinément, car il avait surmonté avec une bravoure peu commune les maladies graves qui l'avaient assailli.

Dès avant de devenir un chirurgien éminent, il était un ami très cher ; il allait toujours le rester alors que nos barques, ballottées par la houle de la vie, voguaient dans telle direction ou dans telle autre sous la poussée de vents tantôt favorables, tantôt contraires.

Comme tout portrait, celui-ci aussi porte l'empreinte subjective du portraitiste.

Le parcours

Au lendemain de la Seconde Guerre mondiale, après des études secondaires à l'Athénée de Luxembourg dans une classe qui engendre sept vocations médicales dont celle de l'auteur de ces pages, et une première année préparatoire aux Cours supérieurs luxembourgeois en sciences naturelles, il fait sa médecine à Lausanne. (L'Union européenne ne l'empêche pas encore, qui ne reconnaît plus les diplômes acquis hors de ses frontières et exclut donc désormais une alma mater helvétique, entre autres).

En 1953, il est interne au Lakewood Hospital à Lakewood, Ohio ; en 1954, il entre en chirurgie comme on entre en religion, et se spécialise jusqu'en 1961 au Johns Hopkins Hospital et aux Baltimore City Hospitals, Baltimore, Maryland. Il est certifié spécialiste en chirurgie générale, en chirurgie thoracique et en chirurgie pédiatrique.

En 1961, fin prêt à faire profiter ses compatriotes de ses connaissances, il rentre au Luxembourg toutes voiles déployées. Mais la chirurgie s'y exerce à l'époque sur des chasses jalousement gardées, et il s'entend surtout dire qu'on n'a pas besoin de ses services. Seule lui ouvre ses portes la clinique privée du Dr Émile Bohler, dont l'infrastructure reste malheureusement en deçà des ambitions du jeune chirurgien. Une de ses premières interventions consiste en une pneumonectomie chez le père d'un ami, pour tumeur des bronches. Le spécialiste déjà chevronné de chirurgie thoracique n'a d'autre choix que de passer plusieurs nuits à la clinique pour assumer lui-même la surveillance et les soins postopératoires alourdis par des complications. Scénario analogue après une colectomie totale pour colite ulcérohémorragique fulminante.

Il plie bagages en 1962. Après un intermède au U.S. Air Force Hospital de Wiesbaden, il se voit accueilli à bras ouverts par l'Amérique qui, elle, cultive la tradition de donner sa chance à la valeur. Il y entame une brillante carrière universitaire: Associate in Surgery, Assistant puis Associate Professor of Surgery, Albert Einstein College of Medicine, New York ; Associate Professor puis Professor of Surgery, University of Pittsburgh School of Medicine; Professor of Surgery, New York Medical College [= faculté de médecine] , Valhalla,



Le docteur Félicien M. Steichen dans Central Park à New York, en 1995. (Photo © Marianne Majerus)

New York. Cette trajectoire américaine est interrompue, de septembre 1969 à juillet 1970, par un séjour à Genève comme professeur invité dans le service universitaire de chirurgie cardiovasculaire de l'Hôpital cantonal.

Infatigable, il collectionne parallèlement les responsabilités hospitalières à partir de 1963, que voici dans l'ordre chronologique: Assistant Director of Surgery, Lincoln Hospital, New York ; Director of Professional Services,

Emergency Department, Lincoln Hospital ; Assistant Visiting Surgeon puis Associate Visiting Thoracic Surgeon puis Attending Thoracic Surgeon, Bronx Municipal Hospital Center, New York ; Associate Surgeon-in-Chief and Senior Attending, Montefiore Hospital, University Health Center, Pittsburgh; Physician-Consultant puis Chief, Surgical Services, Veterans' Administration Hospital, University Health Center, Pittsburgh; Associate Staff in Surgery, Children's Hospital, University Health Center, Pittsburgh; Active Staff Member, Presbyterian-University Hospital, University Health Center, Pittsburgh; Director of Surgery, Lenox Hill Hospital, New York; Attending Surgeon, Westchester County Medical Center, Valhalla, New York; Attending Surgeon, Doctors' Hospital, New York; Attending Surgeon, St. Agnes Hospital, White Plains, New York; Director, Institute for Minimally Invasive Surgery, St. Agnes Hospital, New York.

Au fil des années, il opère encore quelques-uns de ses amis intimes à Luxembourg dans la Zitha Klinik, alors chaque fois chaleureusement accueilli par tout le monde et très entouré...

L'oeuvre

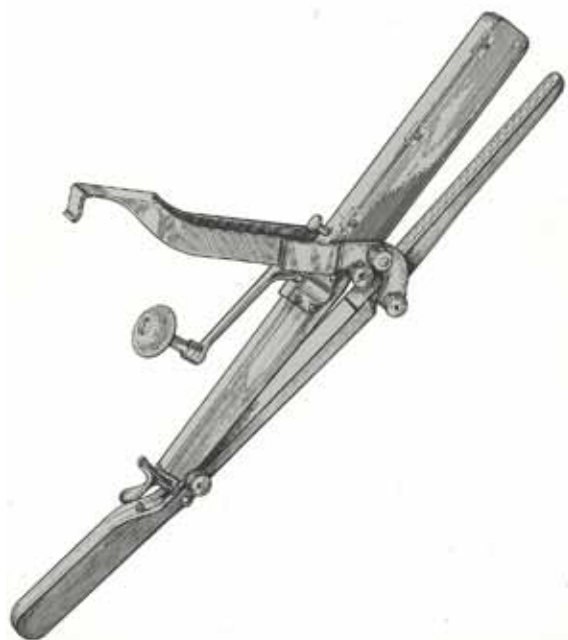
Le titre de professeur n'est pas une distinction que l'on recevrait comme une médaille, sans obligations futures ; il implique une incessante activité exemplairement productrice ; un professeur doit être inventif et créateur... Un événement précis, une occasion spéciale, une rencontre, peuvent devenir déterminants pour l'orientation d'un parcours professionnel. Exemple : la relation qui s'établit entre le docteur Mark M. Ravitch, professeur de chirurgie successivement à Baltimore, à Chicago et à Pittsburgh (« l'un des cinq ou dix meilleurs chirurgiens américains du XXe siècle » – Dr. Jere W. Lord, Jr) et

le docteur Félicien Steichen, c'est-à-dire entre un mentor à la fois sévère et affectueux, et son disciple préféré, doué, enthousiaste et travailleur. Celui-ci parle dans une lettre d'une « *relation de père à fils dans la formation chirurgicale et humaine, entre mon maître Ravitch et moi-même.* »

Né de parents russes immigrés, Mark M. Ravitch appartient à la lignée des grands chirurgiens américains au naturel ouvert, d'un abord facile et cordial, mais rigoureusement exigeants envers eux-mêmes et leurs collaborateurs.

STAPLING IN SURGERY

FELICIAN M. STEICHEN • MARK M. RAVITCH



« *Stapling in Surgery* », un ouvrage classique

sur Nevsky Prospect, la principale et mythique artère de Saint-Pétersbourg, l'Américain tombe en arrêt devant la vitrine d'un magasin d'appareils et d'instruments chirurgicaux, curieuse oasis inattendue en pleine économie marxiste-léniniste pure et dure. Il entre, demande à voir un instrument à sutures. On lui tend une élégante boîte en bois dans laquelle est enchâssé sur fond de velours noir un spécimen – le seul de la boutique – identique à celui qu'il a vu utiliser à Kiev. Il l'achète pour 440 roubles et retourne à l'hôtel délesté d'une somme d'argent importante, mais heureux.

Nous voici au cœur d'un sujet qui a nourri beaucoup de discussions et fait couler beaucoup d'encre surtout depuis le début du XIX^e siècle : celui du rétablissement

En 1958, il entreprend un voyage d'études en Union Soviétique en compagnie de trois collègues. A Kiev, il assiste à une démonstration du professeur N.M. Amosov qui se sert d'uneagrafeuse mécanique pour réaliser avec brio une pneumonectomie. Impressionné, Ravitch exprime le désir de s'en procurer un exemplaire. Sans succès, car le système soviétique rigide ne le met en contact qu'avec des fonctionnaires lymphatiques comme on en rencontre beaucoup dans la littérature slave, et ne prévoit pas que les échanges aillent jusqu'à de tels extrêmes. Quelques jours plus tard, flânant

de la continuité notamment entre deux parties séparées d'un organe creux, qui représente le temps technique le plus difficile, préparant la réparation tissulaire par néovascularisation et cicatrisation. À l'aiguille et au fil de provenance diverse (soie, catgut, fil synthétique ou métallique) se sont joints des procédés mécaniques les uns plus ingénieux que les autres. L'usage d'agrafes métalliques en acier inoxydable puis en titane moyennant des instruments à usage unique en est l'aboutissement. À la place des fils de suture, elles assurent une coaptation des tissus mieux ajustée, plus rapide et moins traumatisante. L'histoire des agrafeuses remonte à une présentation du chirurgien hongrois Humer Hüttl en 1908 à Budapest, au 2^e congrès de la Société hongroise de chirurgie. Il convient de citer aussi l'instrument amélioré d'Aladar von Petz (Budapest, 1921) modifié plus tard par des Japonais. En U.R.S.S., des chirurgiens innovateurs et aventureux se servent à partir de 1951 de modèles produits par l'Institut scientifique d'appareillage et d'instruments chirurgicaux expérimentaux de Moscou, d'abord pour des anastomoses vasculaires.

L'importation aux U.S.A. d'une agrafeuse mécanique par le professeur Ravitch aura des conséquences durables. L'industrie correspondante flaire à juste titre une affaire en or, qui bénéficiera de la puissance et du dynamisme inhérents à l'économie américaine, de toute évidence aussi dans l'intérêt des malades. Le Dr Steichen se trouve au centre d'une activité intense de recherche en laboratoire expérimental sur des chiens et en clinique humaine. Dans certains milieux on parle de l'« instrument de Steichen ». Des perfectionnements successifs, moyennant aussi des alliages de métaux appropriés, le rendent plus léger et plus maniable. Les interventions chirurgicales en sont écourtées, ce qui diminue le risque de complications infectieuses et de thromboses postopératoires. Des techniques et des tactiques opératoires nouvelles en découlent. Un exemple: l'excision de métastases pulmonaires multiples est devenue « faisable et raisonnable ». Mise en garde du chercheur pionnier: « *Particularly important is it, moreover, to understand that the instruments are no quick road to surgery for the untrained and will not turn a neophyte into a virtuoso* ».

Le succès n'empêche pas certaines déconvenues: « *In this instance, as in many others, procedures that we had devised, and were using, were first published by others, sometimes with attribution, as in this case, sometimes without* ». Les chirurgiens ne sont pas tous en tout différents du reste de l'humanité !

L'activité professionnelle du professeur Steichen bat son plein, quand la chirurgie vidéoendoscopique, laparoscopique et thoracoscopique, mini-invasive, prend son essor aux États-Unis en 1988, s'y développant à partir de la cholécystectomie d'abord mise à l'ordre du jour en France l'année d'auparavant par Philippe Mouret. Il s'y engage à fond, recherchant, comme toujours, l'excellence. La maîtrise talonne la démarche pionnière sur une courbe personnelle rapidement ascendante, au sommet de laquelle il devient en 1993 le fondateur et le premier

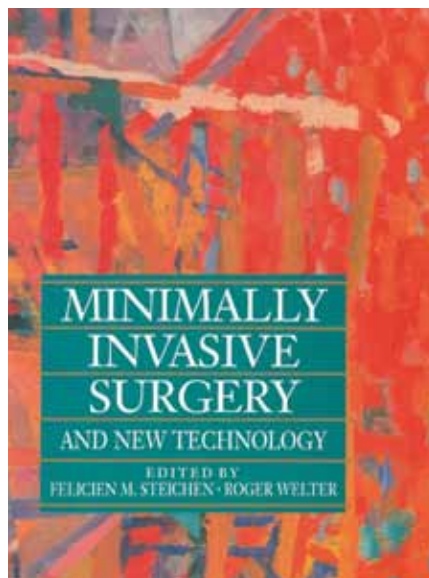
directeur de l' Institute for Minimally Invasive Surgery, à New York. Donc une autre méthode cruciale aujourd'hui incontournable avec une plus-value pour les patients – douleur postopératoire réduite, hospitalisation plus courte, convalescence plus rapide – , qu'il marque de son empreinte.

D'entrée en matière il souligne qu'il ne s'agit pas d'une révolution, mais d'une technique opératoire récente qui laisse intacte la philosophie générale de la discipline chirurgicale et n'en invalide pas les principes fondamentaux. Nouveauté utile, efficace et rentable, « *à condition que l'équipe chirurgicale dispose de compétences et des moyens nécessaires pour arriver à un résultat comparable ou supérieur à celui des opérations équivalentes traditionnelles, conférant ainsi à ces nouvelles techniques un haut niveau éthique...* » (1997).

«...Les opérations projetées et exécutées selon la manière traditionnelle ne doivent pas véhiculer l'impression d'être désespérément obsolètes... Si une approche laparoscopique d'emblée paraissait raisonnable et que des constatations en cours d'opération ont rendu nécessaire la conversion en une opération classique ouverte, ce changement de stratégie ne doit pas être jugé comme signifiant une complication ou une faute, mais simplement comme fournissant la preuve d'un jugement solide. A l'inverse, si une approche ouverte a été choisie et qu'au cours de l'exécution il s'est avéré qu'une laparoscopie aurait été tout aussi utile, efficace et économique, la conclusion en concordance avec l'éthique doit être qu'il s'agissait d'une précieuse leçon pour une future intervention comparable, et qu'il n'y a pas eu de mal, parce que la technique ouverte reste le paradigme auquel les autres approches doivent encore être comparées à l'heure actuelle » (2001).

Le « New England Journal of Medicine », sorte de « bible » périodique pour médecins, à propos du livre « Minimally Invasive Surgery and New Technology » orné aux couleurs de Maurice Estève (éditeurs responsables: Félicien M. Steichen et Roger Welter), s'extasie comme suit: « This book is a substantial foundation in the new surgical world, a thorough presentation of the state of the art, and a glimpse of what is to come » (13.4.1995).

Félicien Steichen a publié 125 articles dans des journaux de chirurgie. On est frappé par leur éclectisme, leur éventail s'étendant de la chirurgie cancérologique de la tête et du cou à la chirurgie cardiovasculaire, la chirurgie pulmonaire et la chirurgie



Une couverture réalisée avec la collaboration de Maurice Estève

digestive de pointe, oesophagienne, gastrique, intestinale, pancréatique et hépatobiliaire. Il est l'auteur ou le coauteur de 21 livres, de 50 chapitres dans des traités et des monographies, et le réalisateur de 17 films scientifiques dont 10 ont été intégrés dans la bibliothèque de l'American College of Surgeons. Au pays du « publish or perish » il n'y a donc jamais eu péril en la demeure.

Au fil du temps

Pendant notre séjour studieux aux États-Unis j'étais allé le voir à Baltimore, il m'avait rendu visite à St. Louis dans le Missouri. Le traumatisme de la guerre du Vietnam n'avait pas encore eu lieu, ce fer porté au rouge n'avait pas encore imprimé sa brûlure sur la face de l'histoire. L'Amérique était encore « God's own country », forte de convictions inébranlables et à juste titre unanimement fière d'elle-même. (« What we built and what we dreamt were, to many, the definition of the future » – Thomas L. Friedman, en 2013). Dans la fournaise des étés là-bas, nous avons échangé nos impressions d'expatriés que travaillait un peu le mal du pays, happés par l'activité frénétique et l'harassante mise à contribution qui rendent inoubliables les hôpitaux américains de nos jeunes années. L'Europe lointaine paraissait toute petite, comme vue par l'autre bout de la lorgnette, terre-mère ayant pris de l'âge et dont les signes de vie étaient quasi imperceptibles à cette distance.

L'éphémère insertion professionnelle de Félicien Steichen dans le microcosme grand-ducal, certes décevante, ne lui laissa pas d'amertume insurmontable. Tout compte fait, il avait gagné au change...Au hit-parade des chirurgiens d'origine luxembourgeoise, toutes générations confondues, personne ne lui disputait la première place.

Les traits de sa personnalité américaine avaient peu à peu pris forme, greffés sur les racines et les branches porteuses luxembourgeoises sans les affaiblir. Nonobstant son précieux passeport américain, source de fierté et de reconnaissance, il choyait les attaches avec son pays natal, qui ont résisté sans usure à l'écoulement des ans. Il ne tarissait pas sur les souvenirs précis et les anecdotes évoquant son enfance et son adolescence. Il demandait des nouvelles d'un tel et de tel autre, était au courant de petits et de grands faits, politiques ou non, savait et savourait les rumeurs, parfois même les potins. Il rejoignait les réunions annuelles des « anciens » de sa classe de l'Athénée quand il le pouvait (la dernière fois le 28 mai 2011) et ne dédaignait pas la gastronomie locale. Le Riesling de la Moselle, le jambon d'Ardenne, la cancoillote, les gâteaux et les chocolats d'un confiseur fameux embrasaient la satisfaction du savant new-yorkais – on ne lui connaissait guère d'autres « faiblesses ».

Il a évoqué dans une lettre « *l'esprit ouvert au monde que nous avons reçu dans notre pays – le Luxembourg – justement parce que le territoire est petit*

(l'esprit parfois aussi!) et que nous sommes donc forcés de nous évader vers d'autres horizons. Je fais cette remarque non pas pour dire du mal ou me sentant supérieur, mais bien au contraire pour affirmer ma conviction que nous a été donnée, malgré les limites qu'un milieu ramassé sur lui-même impose, une éducation multiculturelle».

Il aimait profondément la France et les Français – leur essence identitaire est partie intégrante de sa famille –, ne s'interdisant pas pour autant de leur décocher à l'occasion l'un ou l'autre trait gentiment ironique, avec le recul géographique qui met bien en évidence les menus travers nationaux. La Bretagne était devenue sa troisième patrie ; il repose en terre armoricaine.

Tout en ne faisant pas fi des traditions, ni dans la vie quotidienne, ni dans l'activité professionnelle, il était réceptif aux exigences de la modernité : « *Il faut vivre avec le progrès. J'en suis donc à mon deuxième ordinateur, le premier ayant rendu l'âme sans avertissement il y a un mois...Economie d'effort en fait, et aussi de papier. Il faut éviter le déboisement du monde occidental...* ». (A propos de l'informatisation, son entourage corrige légèrement : « Il se servait de l'ordinateur comme d'une machine à écrire...Google et e-mails étaient toujours un mystère pour lui ». Il n'obtempéra donc que dans une moindre mesure aux injonctions d'une technologie envahissante).

A l'occasion du cycle « Les chercheurs luxembourgeois à l'étranger », l'université du Luxembourg avait invité en 1995 à la conférence publique en langue française: « Professeur Dr Félicien Steichen , Petites ouvertures et haute couture en chirurgie », que le programme introduisait comme suit: « La chirurgie, comme toutes les branches de l'art et de la science de guérir, exige la dextérité manuelle et une bonne base scientifique. La dextérité est celle de l'artiste ou de l'artisan, qui dans le cas particulier a appris la façon de suturer et de panser les plaies pour rétablir la configuration anatomique. La base scientifique mène le chirurgien aux bons choix thérapeutiques pour rétablir les fonctions physiologiques tout en respectant l'intégrité du corps humain et en tenant compte de sa susceptibilité aux infections. Le Dr Steichen parlera de l'art de la suture et de la science de l'asepsie au cours de l'histoire de la chirurgie ». L'orateur fit salle comble.

L'histoire de la médecine avec la touche poétique qu'il y décelait, le fascinait. Pour lui, l'actualité était la continuation momentanée du passé en médecine comme ailleurs, et ne se gérait bien qu'avec la connaissance approfondie des antécédents. Il se plongeait volontiers dans la littérature chirurgicale d'antan qui, bien que dépassée, le faisait dialoguer avec les mânes de ses pairs dans le sentiment d'appartenir à une communauté transcendant les limites des âges. Il s'inspirait de l'exemple et de l'enseignement des géants, les Ambroise Paré (qu'il citait : « Je le pansay, et Dieu le guarit » et adaptait au présent: « Je l'ai pansé, je l'ai guéri, Dieu est-il toujours notre compagnon ? »), William Halsted (« cut well,

sew well, do well »), René Leriche et autres Alfred Blalock. Personne d'autre n'a jamais relaté avec autant de minutie l'histoire de la suture, une étape évidemment déterminante de l'acte chirurgical pour réparer les dégâts prémédités, et les autres aussi, bien entendu.

Il maniait la plume avec la même habileté que le bistouri. Auteur scientifique prolifique, il aimait choisir les mots, sculpter les phrases, dans un style châtié qui tranchait sur l'habituelle sécheresse des écrits scientifiques américains. Rarement, le lyrisme sourdait à la pointe de sa plume, notamment quand elle célébrait les retrouvailles avec les paysages de son pays d'origine: « *If "small is beautiful," Luxembourg possesses both attributes – a proud and peaceful claim that is in part the result of history but also a gift of nature... within its narrow borders, the countryside can vary from gentle fields to rolling hills, covered by forests with unforgettable effects of light and colors depending upon the season and the time of the day. Rivers meander through valleys...sleepy villages, their inhabitants gone to work in the fields at early dawn, and bustling towns and small cities, offer the visitor the beautiful panorama of tastefully decorated farmhouses and artfully preserved urban centers...The surroundings of villages and towns often are those of a public garden or park, where flowers alternate with green lawns and wooded areas, permeated by light and shadows that lead the mind to an enjoyable state between dream and reality... ».*

Souvent en collaboration étroite avec un illustrateur professionnel, il s'occupait méticuleusement de l'iconographie accompagnant ses textes, veillant à l'exactitude anatomique et à l'exécution. Le résultat : de très beaux livres parfois apparentés aux éditions d'art et qui, au-delà de leur destination utilitaire dans un domaine très spécialisé, procurent un réel plaisir esthétique. Ils réussissent le tour de force de nous convaincre de la beauté d'une vésicule biliaire ou d'un rectum, entre autres... En grande partie grâce à sa contribution qui comportait aussi une lourde tâche éditoriale, l'ouvrage « *Minimally Invasive Abdominal Surgery* », dont prit soin une prestigieuse maison d'édition allemande, fut déclaré « plus beau livre scientifique » lors de la foire aux livres de Francfort (Deutsche Buchmesse) en 2001.

Ne se contentant pas de pratiquer l'art et la science de la chirurgie, il la pensait, amalgamant dextérité et réflexion : « *The playing field between thinkers and doers has been leveled to the point where the diagnosis and procedure oriented cardiologist and member of the department of medicine has more in common with the cardiac surgeon similarly interested in operative and functional correction of a heart defect, than he or she has in common with the neurologist, also a member of the medical department. The neurologist in turn is closer to the neurosurgeon and shares with him or her common diagnostic and therapeutic skills* ».

Et encore: « *The purely clinical approach to surgery and medicine... has its limits, as all empiricisms have, unless it is enlarged by the input of basic*

biological sciences and experimental research...it is quite certain that many of the discoveries would not have been possible without the availability of the necessary materials, the required financial resources, and the fiscal discipline by the public and political leadership to accept the cost of research... ».

Il développait des idées personnelles très pertinentes sur l'enseignement et l'apprentissage de la médecine en général, sur la formation des chirurgiens en particulier. Pédagogue et guide, il a contribué à former de nombreux jeunes chirurgiens qui ont profité du perfectionnisme, de l'honnêteté intellectuelle, de l'intégrité professionnelle, de la sincérité et de l'humanisme empathique dont il donnait l'exemple. Il leur communiquait son inquiétude: « *Would he [Ambroise Paré] be concerned that mankind has lost its soul to technology, abandoned its mind to the computer, sacrificed compassion to efficiency, and surrendered originality and courage to conformity ?* ».

En vivant la réalisation de son « rêve américain », il ne s'est jamais départi de sa modestie, elle n'était pas incompatible avec l'ambition. Les honneurs ne lui furent pas mesurés, il les accueillait avec un plaisir qu'il ne cachait pas : une chaire de chirurgie au New York Medical College porte à tout jamais le nom de « Félicien M. Steichen Chair of Surgery » ; il fut consul honoraire du grand-duché de Luxembourg à Pittsburgh avec juridiction dans l'État de Pennsylvanie; le 1er juillet 1986, au cours d'une cérémonie dans Battery Park, il reçut du maire de New York Edward I. Koch la « Mayor's 1986 Liberty Medal » créée lors de la commémoration de l'indépendance pour distinguer 200 personnalités immigrées aux mérites exceptionnels (« New York Times »); ne s'enfermant pas dans une tour d'ivoire, il siégeait aux côtés d'hommes d'affaires dans le conseil d'administration de la Luxembourg-American Chamber of Commerce implantée à New York ; de ce côté-ci de l'Atlantique il faisait partie de l'Académie nationale de chirurgie française, et de plusieurs autres sociétés savantes.

Il se prêta de bonne grâce au jeu lorsque la télévision luxembourgeoise le filma en 1992 dans sa belle propriété de Larchmont au bord du Long Island Sound, pour une émission qui le montrait sciant avec un petit air espiègle un épais tronc d'arbre dans une des séquences, prouvant non sans un zeste de coquetterie qu'il se servait avec aisance des lames tranchantes les plus variées. Il savait rire aux éclats, son exubérance était contagieuse et mettait les rieurs de son côté ; seuls de gros problèmes de santé parvinrent à voiler temporairement ce trait de caractère.

Il cultivait ses jardins sur deux continents avec une passion tranquille, planter un arbre lui apportait du bonheur.

La dernière fois où je voulus le joindre au téléphone, ce fut en vain : la communication ne tarda pas à s'établir, la voix de son épouse, altérée par l'émotion, m'apprit qu'à l'instant même elle venait de le trouver sans vie au milieu des senteurs du jardin. Une pure coïncidence? Probablement.

Le docteur Félicien M. Steichen a sa place dans l'histoire de la médecine américaine. Il appartient aussi à l'histoire personnelle de ceux qui ont fait plus d'un bout de chemin avec lui, et qui ont eu le privilège de souvent l'approcher dans un partage d'aspirations, d'espoirs, de préoccupations, d'illusions, de souvenirs, de joies et d'heures lumineuses.

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Moderate to severe injuries in football: a one-year prospective study of twenty-four female and male amateur teams

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Résumé

Cette étude avait pour objectif de réaliser un suivi prospectif des blessures sportives parmi les footballeuses et footballeurs évoluant dans la plus haute division luxembourgeoise. Des données portant sur les caractéristiques anthropométriques et la pratique sportive ont été recueillies chez 125 joueuses et 243 joueurs de football à l'aide de questionnaires au début de l'étude. Ensuite, un suivi des blessures modérées et sévères (> 15 jours d'interruption de la pratique du football) a été organisé lors de la saison 2013-2014. Seize blessures (incidence = 0,7 blessures/1000 h d'exposition) ont été déclarées chez 13 joueuses (10,4 %). Ces blessures étaient principalement localisées au niveau des genoux (n = 7 ; 43,7 %) et les ligaments étaient les tissus les plus souvent concernés (n = 7 ; 43,7 %). Chez les joueurs, 41 blessures (incidence = 0,6 blessures/1000 h d'exposition) ont été déclarées chez 36 sportifs (14,8 %). Ces blessures étaient principalement localisées au niveau des cuisses (n = 12 ; 29,3 %) et les muscles et les tendons étaient les tissus les plus souvent concernés par les blessures (n = 18 ; 43,9 %). Les blessures en football concernent majoritairement les membres inférieurs, en particulier les genoux chez les femmes. Les lésions musculotendineuses des cuisses survenant chez les hommes pourraient témoigner d'une préparation

physique insuffisante ou inadaptée pour un bon nombre de joueurs. Au regard des résultats, il est nécessaire de mettre en place une stratégie de prévention des blessures. Le programme « FIFA 11+ » pourrait être utilisé comme méthodologie de base, mais celui-ci devrait être plus personnalisé en fonction du sexe. Le recueil des blessures pourrait être optimisé par l'utilisation de bases de données électroniques telles que le Training and Injury Prevention Platform for Sports (TIPPS). A travers l'enregistrement systématique des données liées aux blessures (et à la charge d'entraînement) par les joueurs eux-mêmes ou par un responsable médical, ce système permet de partager des informations importantes entre les acteurs concernés, de suivre des joueurs, de fournir de alertes concernant les facteurs de risque et d'augmenter la prise de conscience de la problématique.

Mots-clés : blessures, football, membres inférieurs, prévention.

Abstract

This study aimed to realize a prospective follow-up of the injuries occurring in female and male football players involved in the highest league in the Grand-Duchy of Luxembourg. Data concerning anthropometric characteristics and football activities were gathered in 125 female and 243 male football players via questionnaires at the beginning of the study. Then, a follow-up of moderate to severe injuries (> 15 days of interruption in football practice) was performed throughout the season 2013-2014. Sixteen injuries (injury incidence = 0.7 injuries/1000 h of exposure) were observed in 13 female football players (10.4 %). These injuries concerned mainly the knee (n = 7; 43.7 %), with capsules and ligaments being the most often concerned tissues (n = 7; 43.7 %). In male football players, 41 severe injuries (injury incidence = 0.6 injuries/1000 h of exposure) were observed in 36 players (14.8 %). These injuries concerned mainly the thighs (n = 12; 29.3 %) and the muscles and tendons were the most often concerned tissues (n = 18; 43.9 %). Injuries in football are predominantly located at the lower limbs, particularly the knees in female football players. The predominant muscle and tendon lesions of the thighs occurring in males could reveal that physical preparation is insufficient or inadequate for a number of players. Regarding these results, it is necessary to implement an injury prevention strategy. The “FIFA 11+” programme could be used as the basic method, but should be personalized according to sex. The injury collection methodology could be optimized with the use of an electronic database, such as the Training and Injury Prevention Platform for Sports (TIPPS). Beside the systematic recording of injury data (as well as the training load) by the players or the medical staff, this system allows to share of important information between stakeholders, follow-up the players, provide risk factor warnings and increase the awareness of the injury problem.

Keywords: injuries, football, lower limbs, prevention.

Introduction

The injury rate in football is relatively high compared to many other sports. A US study which compared 15 sports showed that football is a sport where injuries are most frequent, except for American football [1]. The injury incidence ranges from 0.7 to 25.6 injuries per 1000 hours and varies according to age, sex, football level, and injury severity [2-6]. This high injury rate has negative impacts on the performance of the teams [7]. This is particularly relevant in (national) teams of small states like the Grand-Duchy of Luxembourg. Indeed, small countries tend to have fewer high-level players who can substitute those who are injured. Moreover, health care costs which are directly related to the treatment of these injuries and those in relation with a prolonged absence from work are high [8]. It is also essential to take into account the costs related to the long term consequences of the injuries, like osteoarthritis of the major joints of the lower extremities (e.g. gonarthrosis and coxarthrosis possibly leading to knee and hip replacements, especially in former football players) [9, 10] and their consequences on health, quality of life and profession of the injured player and his/her family circle. With the aim to decrease the number of injuries and their sports-related and economic consequences, the Fédération Internationale de Football Association (FIFA) and the FIFA Medical and Research Centre (F-MARC) have developed the “FIFA 11+”, a basic injury prevention programme [11]. Before the implementation of any injury prevention programme, a preliminary evaluation is necessary to describe the injury problem both in female and male football players.

Therefore, this study aimed to realize a prospective follow-up of the moderate to severe injuries (> 15 days of absence from football practice) occurring in the female and male football players involved in the highest league of the Grand-Duchy of Luxembourg during the season 2013-2014.

Methods

Participants

During the season 2013-2014, 10 female teams (162 players) and 14 male teams (342 players) participated in the highest Luxemburgish football league. Among these 24 teams, 22 teams volunteered to participate in the study (9 female teams and 13 male teams). In each team, several players declined to participate in the study. Thus, the study population included 125 female football players (mean = 13.9 players per team), and 243 male football players (mean = 18.7 players per team). This represented respectively 77 % and 71 % of the players involved in the highest league in the Grand-Duchy of Luxembourg, which is a satisfying participation rate. The study protocol had previously been approved by the National Ethics Committee for Research. This research project was executed by the Sports Medicine Research Laboratory of CRP-Santé on behalf of the Ministry

of Sports. It was endorsed by the Fédération Luxembourgeoise de Football (FLF).

Questionnaires and data collection

All players were asked to fill in a questionnaire concerning their personal characteristics, as well as information regarding football activities such as position of play (goalkeeper, defender, mid-field, and attacker) and training volume. The body mass index (BMI) was calculated based on reported weight (kg) and height (m), according to $\text{weight}/\text{height}^2$. Previous injuries were recorded to identify if injuries during the follow-up were recurrent in nature or not. A weekly follow-up of severe football injuries was organized during the season 2013-2014 (from September 2013 to May 2014). Whenever possible, a health expert was designed in each football team to report all injuries. A moderate to severe injury was defined as a physical complaint or trauma which occurred during football practice or competition and led the player to stop football activities for at least 15 days [12]. For each new injury, the expert described the context (training or competition), the anatomical location, the type of injury (contact acute, non-contact acute, or progressive) and the severity (days lost). The total volume of exposure was estimated based on the information gathered at the beginning of the study via the questionnaire, and the injury incidence (number of injuries per 1000 hours of football practice) was calculated for the season 2013-2014.

Statistical analysis

Descriptive statistics are presented as percentage, frequency or median ($\pm$ interquartile range), depending on the variable. Comparisons between injured and uninjured football players were produced using a non-parametric Mann & Whitney test on account of the relatively small sample size of injured female players and the non-normal distributions of many data. To compare males and females injuries, χ^2 or Fisher's exact tests was performed according to test application condition. A probability level of $p < 0.05$ was used as an indicator of significance.

Results

Female football teams

Amongst the female football teams, the staff members designated as the health expert reporting the injuries were mostly team managers ($n = 8$; 88.9 %). No medical doctor was involved in the injury surveillance for any of these female teams. Only one physiotherapist participated as the designated health expert in a team. The cohort was composed by 6 % of goalkeepers, 33 % of defenders, 38 % of mid-fielders and 23 % of attackers. The median age was 24.4 (± 10.4) years. The characteristics of injured and uninjured female football players are presented in Table 1. During the season 2013-2014 (Table 2), 16 severe injuries were recorded in 13 players (10.4 %): 3 goalkeepers (23.1 %), 2 defenders

(15.4 %), 5 mid-fielders (38.5 %) and 3 attackers (23.1 %). The median age of injured players was 24.4 ($\pm$ 8.3) years and the median BMI was 23.0 ($\pm$ 4.0) kg/m². No statistical difference was observed between injured and uninjured female players concerning the anthropometric and the training characteristics ($p > 0.05$). The knee was the most concerned body part ($n = 7$; 43.7 %) Capsules and ligaments were the main injured structures ($n = 7$; 43.7 %). Most of the injuries were not recurrent ($n = 14$; 87.5 %). Most of the injuries necessitated an interruption of football practice for a period lasting more than 28 days ($n = 12$; 75.0 %). The injuries were principally acute with a non-contact origin ($n = 6$; 37.5 %) and occurred during competition ($n = 10$; 62.5 %). Surgery and hospitalization were required for 43.7 % of the injuries ($n = 7$). During the season 2013-2014, the injury incidence for female players was estimated at 0.7 injuries per 1000 hours of football.

Male football teams

Amongst the male football teams, the staff members designated as the health expert reporting the injuries were mostly physiotherapists ($n = 9$; 69.2 %). No medical doctor was involved in the injury surveillance for any of these male teams. The team manager was the health expert in 3 teams (23.1 %). In one team, the expert was either the team manager or the physiotherapist (8.3 %). The cohort was composed by 6 % of goalkeepers, 35 % of defenders, 35 % of mid-fielders and 22 % of attackers. The median age was 24.3 ($\pm$ 10.4) years. The characteristics of injured and uninjured male football players are presented in Table 1. During the season 2013-2014 (Table 2), 41 severe injuries were recorded in 36 players (14.8 %): 3 goalkeepers (8.3 %), 12 defenders (33.3 %), 13 mid-fielders (36.1 %) and 8 attackers (22.2 %). The median age of injured players was 25.7 ($\pm$ 8.2) years and the median BMI was 23.0 ($\pm$ 2.3) kg/m². Among the anthropometric and the training characteristics, only height was statistically different between injured and uninjured male players (injured players being taller than uninjured players, $p = 0.020$). The thigh was the most often concerned body part ($n = 12$; 29.3 %). Muscles or tendons were the main injured structure ($n = 18$; 43.9 %). Over a quarter of the injuries were recurrences ($n = 11$; 26.8 %). An interruption of football practice for a period lasting more than 28 days was observed for 53.6 % of the injuries ($n = 22$). The injuries were principally acute with a non-contact origin and occurred slightly more often during competition ($n = 22$; 53.6 %). Surgery and hospitalization were required for 24.4 % of the injuries ($n = 10$). During the season 2013-2014, the injury incidence for male players was estimated at 0.6 injuries per 1000 hours of football.

Comparisons of female and male football injuries

The knee was more often injured in females than in males football players ($p = 0.018$). In addition, female football players had fewer recurrent injuries than males ($p = 0.032$).

Table 1. Characteristics of the injured and uninjured female and male football players participating at the highest league of the Grand-Duchy of Luxembourg during the season 2013-2014.

	Injured football players		Uninjured football players	
<i>Female</i>	n = 13		n = 112	
	median	(interquartile range)	median	(interquartile range)
Age (years)	24.4	(8.3)	24.4	(10.4)
Height (m)	1.63	(0.09)	1.65	(0.09)
Weight (kg)	63.0	(9.7)	58.0	(10.0)
Body Mass Index (kg/m ²)	23.0	(4.0)	21.5	(3.3)
Football experience (years)	10.0	(8.5)	8.0	(9.0)
Football experience in the highest league (years)	1.5	(3.0)	1.0	(3.0)
Football training (hours per week)	4.5	(1.6)	4.0	(1.0)
Football competition (hours per week)	1.5	(0)	1.5	(0)
Other sport training (hours per week)	1.7	(1.0)	2.0	(1.0)
<i>Male</i>	n = 36		n = 207	
	median	(interquartile range)	median	(interquartile range)
Age (years)	25.7	(8.2)	25.2	(7.8)
Height (m)	1.83	(0.05)	1.80	(0.08)
Weight (kg)	77.0	(12.5)	75.0	(9.0)
Body Mass Index (kg/m ²)	23.0	(2.3)	23.5	(1.8)
Football experience (years)	16.7	(6.7)	16.5	(7.0)
Football experience in the highest league (years)	3.0	(3.1)	3.0	(5.0)
Football training (hours per week)	7.7	(2.0)	8.0	(3.0)
Football competition (hours per week)	1.5	(0)	1.5	(0)
Other sport training (hours per week)	0.5	(2.0)	1.0	(2.0)

Table 2. Characteristics of injuries in football players during the season 2013-2014.

	Injuries in female players n = 16 n (%)	Injuries in male players n = 41 n (%)
<i>Injury location</i>		
Head	0	1 (2.4)
Thorax	0	1 (2.4)
Back	1 (6.2)	2 (4.9)
Low back	0	0
Shoulder	0	1 (2.4)
Arm	0	1 (2.4)
Elbow	0	0
Forearm	0	0
Wrist	0	2 (4.9)
Hand	1 (6.2)	0
Finger	0	1 (2.4)
Hip/groin	0	3 (7.3)
Thigh	3 (18.7)	12 (29.3)
Knee	7 (43.7)	6 (14.6)
Lower leg	0	1 (2.4)
Ankle	3 (18.7)	4 (9.7)
Foot	1 (6.2)	3 (7.3)
Other location/unknown	0	3 (7.3)
<i>Injury type</i>		
Muscle/tendon	4 (25.0)	18 (43.9)
Capsules/ligaments	7 (43.7)	9 (21.9)
Contusion	1 (6.2)	2 (4.9)
Laceration	1 (6.2)	0
Bone	2 (12.5)	7 (17.1)
Dislocation	0	1 (2.4)
Concussion	0	0
Nerve	1 (6.2)	0
Other injury/unknown	0	4 (9.7)
<i>Injury severity</i>		
15 to 28 Days	4 (25.0)	13 (31.7)
> 28 Days	12 (75.0)	22 (53.6)
Unknown	0	6 (14.6)
<i>Recurrence</i>		
No	14 (87.5)	23 (56.1)
Yes	2 (12.5)	11 (26.8)
Unknown	0	7 (17.1)
<i>Injury category</i>		
Contact acute	5 (31.2)	15 (36.6)
Non-contact acute	6 (37.5)	17 (41.5)
Progressive	5 (31.2)	6 (14.6)
Unknown	0	3 (7.3)
<i>Injury context</i>		
Training	6 (37.5)	15 (36.6)
Competition	10 (62.5)	22 (53.6)
Unknown	0	4 (9.7)

Discussion

During the football season 2013-2014, 10.4 % of female players and 14.8 % of male players reported an injury preventing them from football practice for more than 15 days. Our definition is slightly different from the time-loss categories definition suggested by Fuller [13], but it is justified by the fact that it represents a clinical threshold for which diagnostic and therapeutic interventions are generally more invasive in a nonprofessional setting with little medical coverage. The observed injuries concerned mainly the knees and the thighs, respectively, with a clear difference related to the sex. In females the predominant injury types were capsuloligamentous lesions whereas in males the main recorded lesions were muscle injuries of the thigh.

These percentages are close to those observed in a large Spanish study on male amateur football players, showing that 11 % of athletes aged under 30 had a physical complaint resulting from a football match or training session during the season 2010-2011 [12]. Nevertheless, they recorded all injuries irrespective of the medical attention or time loss from football activities. It appears therefore that the percentage of overall injuries (i.e. including slight and mild injuries with time loss < 15 days) in Luxembourg is probably higher than the percentage observed in Spain. The injury incidence observed in our study is quite similar between females and males (0.7 and 0.6 injuries/1000 h, respectively). It is close to that observed in male and female elite football players (0.7 injuries/1000 h) in Sweden [6] and to the incidence of severe injuries (time loss > 28 days) observed in female teenager football players (1.1 injuries/1000 h) in Denmark [2]. More injuries have been observed in male than female players in Belgium, but the latter had a higher incidence of severe injuries [14].

Our study shows that moderate to severe injuries occur more often during competition compared to training (71 % for females, 59 % for males). Competition is therefore a more risky context regarding injuries, as suggested by numerous other studies [4, 5]. This illustrates the lower stakes related to the training context, but could also reflect the education of the coaches who try to avoid situations that put their players at risk. Furthermore, it has been shown that the incidence of moderate to severe injuries is higher for amateurs than professionals [14, 15]. A possible explanation may be that the teams are smaller in amateur football and lead to fewer options to substitute injured players or players who are more at risk to sustain an injury. On the other hand, players with low football participation (< 1 hour per week) have a higher injury risk compared with players participating more frequently [2]. The percentages of injury recurrence observed in our study during the season 2013-2014 (12 % in females and 27 % in males) are close to those observed in competition (maximum observed = 22 %) [16]. However, they are slightly lower than those observed overall in Denmark (30 %) and Sweden (24 %) [17]. The recurrence of the injuries may suggest a maladjusted management of the previous injury with a precipitated return to play.

The injuries concerned mainly the lower limb, both in female and male football players. In female football, it has been shown that lower extremity injuries are related to greater BMI [18]. In our study, we observed a tendency for greater BMI in injured female players. Nevertheless, the group of injured female players was quite small ($n = 13$) giving rise to a low statistical power. Capsuloligamentous knee injuries, including ACL tears, were the most frequently recorded injury type in female football players. It is well known that non-contact ACL injuries are a major concern in female football, the injury risk being 2-3 times higher as compared to male football [19]. This is mainly due to internal risk factors (anatomical and structural, genetic, hormonal, neuromuscular and biomechanical) [20]. It has been shown that up to 72 % of these non-contact ACL injuries are preventable [21]. Hence, reducing the number of non-contact ACL injuries by introducing prevention programmes should be a primary target in Luxembourgish female football. Conversely, musculotendinous injuries of the thigh were the main recorded type of lesion in male football players during the season 2013-2014. These observations are in accordance with the data of the literature [12, 17]. This type of lesion may explain the higher incidence of recurrences observed in male compared to female football players, especially if players and coaches do not respect the medical prescription and precipitate the return to play. Again, it has been shown that many of these lesions are preventable through easily implementable training programmes [22]. Indeed, several sports injury prevention programmes have been developed and implemented to reduce the occurrence and the severity of injuries in football (e.g. FIFA 11+ programme) [11, 23, 24]. These programmes include stretching, muscle strengthening, balance exercises, sports-specific agility drills and landing techniques. Despite an unsuccessful attempt by the FLF to implement the FIFA 11+ programme in 2009 (personal communication of R. Huberty and H. Mausen), it is critical to try again to generalise such a programme in Luxembourgish football teams. However, such an endeavour is challenging, due to the low medical and physiotherapeutic coverage in the Luxembourgish teams, particularly in the female football. This is in strong contrast with other top-level leagues, in which generally more than 5 local stakeholders (mainly physiotherapists) are involved in the design and implementation of injury prevention programmes [25].

The number of recorded injuries is probably underestimated in our study due to a possible lack of compliance of the designated health expert, players' involvement and the above-mentioned injury definition. This first issue could be addressed in the future with the use of the Training and Injury Prevention Platform for Sports (TIPPS) for data collection [26]. The TIPPS is an internet-based electronic surveillance system allowing for easy recording of daily information by the athletes via personal access codes. The athletes upload volume and intensity of each sport session and the sports injuries on their TIPPS account. All football players should be sensitized for TIPPS. Further studies using the TIPPS are

needed to evaluate the effect of a preventive programme in the Luxembourgish football teams.

In conclusion, this study showed that injuries in top-level Luxembourgish football players were mainly located in the lower limbs. Knees and thighs were the predominantly concerned anatomic areas in female and male players, respectively. The injuries encountered in the Grand-Duchy of Luxembourg are similar to those observed in other countries. Many of them are preventable through the implementation of specific injury prevention programmes. Introducing a systematic medical coverage and developing an injury prevention strategy like the “FIFA 11+” may rapidly lead to a significant reduction of injuries in Luxembourg’s highest football leagues.

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