

Research Article

Smartphone as a tool for the heart rate measurement

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Abstract

Background: Screening of heart rate (HR) can help in prevention of cardiovascular disease. One of the innovative, unverified method of HR testing is use of a smartphone, and applications specially design for this purpose. Health related applications (like HR testing) should be validated and check for feasibility before they will be approved for the use of society, because of possible inaccurate results, and misdiagnosis of heart related problems. That is why aim of this study was to check the usefulness of such application.

Material and method: Study included 30 subjects (15 males). During finger pulse oximetry, HR was measured using smartphone application (Instant Heart Rate[®] by Azumio Incorporation) simultaneously.

Results: The average values of HR did not differ significantly between finger pulse oximetry and smartphone application ($p=0.22$).

Conclusion: There were no differences between HR results obtained from smartphone application and finger pulse oximetry. Future research has to be done in the field of testing HR app in different condition of measurement.

Introduction

Heart rate (HR) refers to the number of times that heart beats per minute. There are many factors that may vary heart beat according to the body actual needs [1,2]. Knowledge about unusual HR and connected with this condition symptoms, can help in detection of developing cardiac events, which are one of the major issue facing medicine nowadays [3,4].

Cardiovascular disturbances usually develop slowly and get worse over time, becoming severe, but they may also come on suddenly. That is why screening of e.g. HR can potentially help in prevention of cardiovascular diseases [3]. Importance of heart rate control has been proven by epidemiological, pathophysiological, and clinical trials [5].

Despite its significance, the HR is one of the easiest component of the cardiovascular system to examine in many conditions [6]. The most popular method of HR measurement is feeling the compressed artery pulsation with the index and middle fingers on the body surface [1]. This method, developed by ancient Greeks centuries ago [7], is now, in clinical practice assisted by more sophisticated methods like the use of electrocardiography, photo plethysmography (PPG) and others [8,9]. However, it turns out that instruments, potentially not related with medical industry may also be used for medical purposes [10-14]. Authors of this report come across smartphone application (app) specially designed for HR testing.

Up to date, there are no research referring to this topic. Smartphones are now proving their huge impact on diverse aspects of modern society [10-14]. More and more people around the world are having access to mobile phone technology, so that authors of this report think, that applications designed for medical purposes (like HR testing) should be validated and check for feasibility before they will be commonly approved for the use of the society. That is why the aim of this study was to check the usefulness of such application.

Material and method

Study included 30 subjects (15 males). All participants were patients staying on cardiology ward. Baseline heart rate was read during finger pulse oximetry examination done by trained health care provider as a standard clinic procedure. We used 'AEROcheck[®] PO 11' finger pulse oximeter manufactured by HUM Corporation. Simultaneously, during classic finger pulse oximeter recordings, HR was measured using smartphone app - 'Instant Heart Rate[®] by Azumio Inc.' Application was used on Samsung Galaxy Mega[®] smartphone. Both measurements were taken from the same hand. Before procedure, patients rested for 10 minutes while the protocol of HR testing was explained to them. The procedure of smartphone HR testing was based on inventor of application guidelines, and included following instruction:

"Place the tip of your index finger of the phone's camera, and in couple of seconds your pulse will be shown. Make sure that your fingertip completely covers the camera lens."

Additional comments were made according to manufacturer instructions, and included:

- Hold very still
- Cover the entire camera lens with the soft part of your fingertip
- Press very, very gently on the lens

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After 10 seconds of measurement results were read, noted down and prepared for statistical analysis. After HR examination, we asked study participants, if they had problem with smartphone HR testing software, or if procedure was easy and user friendly for them. The study protocol was approved by the local ethical committee.

Statistical analysis

Data are presented as mean and standard deviation (SD). Student's t test was used. The threshold probability of $p < 0.05$ was taken as the level of significance for all statistical analyses. Statistical calculations were performed using the software STATISTICA 10-StatSoft. Inc software (Tulsa, USA).

Results

The HR did not differ significantly between classic finger pulse oximetry and smartphone app ($p = 0.22$). Mean values of HR obtained from finger pulse oximetry and smartphone application were 69,23 (SD 9,7) and 68,66 (SD 10,58) respectively. There were no significant differences in HR testing conditions (pulsioximeter vs smartphone) in both male ($p = 0.92$) and female ($p = 0.11$) groups. All study participants stated that application was easy to use and none of them had problem to follow given verbal instructions. All participants also agreed that app was intuitive to use for them.

Discussion

Monitoring of health condition done by smartphone can improve diagnostic and predictive accuracy in various field of medicine [10-13]. In this study the mean values of HR did not differ significantly between finger pulse oximetry recordings and smartphone application. A photo plethysmography (PPG) is often obtained by using a pulse oximeter which illuminates the skin and measures changes in light absorption [15]. The tested application is based on similar idea, measuring reflectance, as the light is adjacent to the camera. Probably, in authors opinion, that is why no differences in HR methods of measurement were observed.

Self-testing of HR using smartphone can be helpful for patients in many circumstances. Starting from fitness level monitoring and ending at detection of developing heart problems. From number app available, authors chose the most popular HR testing application (Instant Heart Rate® by Azumio Inc.) for android operation system, available free of charge on play.google.com. Instant Heart Rate® was downloaded more than 10 million times from play.google.com and according to app inventor there are more than 25 million users worldwide. Such a large number of users could be potentially used by clinicians for screening of heart rate in the general population. However, among many advantages, there are also some limitations of this method of HR measurement. First of all, testing of patients pulse in traditional palpation way gives physicians much more information about state of patient's cardiovascular system than just the heart rate. Only traditional pulse testing can provide information like rhythm, volume, force, tension, form or equality of pulse. Moreover, measurement conditions established by app manufacturer could be difficult or even impossible to follow during testing procedure for some users. For example, fulfillment of warm hand condition can be challenging in many circumstances like winter outdoor testing, measurement in the group of individuals suffering from some diseases (e.g. Raynaud's phenomenon) and others. On the other hand, traditional testing may also be a problem for some individuals, who have decreased sensation in fingers or are trying to measure pulse in an area covered by too many soft tissues. Tested application is designed to read HR only from

one point-index fingertip. Traditional method of pulse testing has the advantage of possibility to be taken from several points of the body, making possible to measure HR in condition, which smartphone could not handle.

Despite some limitations, testing of HR using smartphone was useful and accurate. Authors of this report think that smartphone application could be useful tool for heart condition monitoring in population, if we are interested in only heart rate, and if measurement conditions established by app manufacturer are fulfilled. We believe, that future research has to be done in the field of testing HR app in different condition of measurement.

Conclusion

There were no differences between HR results obtained from smartphone application and finger pulse oximetry. Results of this study showed, that tested application was easy to use and may be used interchangeably to pulse oximeter in cardiac patients.

Competing interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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