Contents lists available at ScienceDirect

Journal of Acute Disease

journal homepage: www.jadweb.org

Document heading doi: 10.1016/S2221-6189(13)60046-3

Two surgeons and the ECG-a double blind study

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ARTICLE INFO

Article history:
Received 29 November 2011
Received in revised form 23 December 2011
Accepted 9 January 2012
Available online 20 February 2012

Keywords:
ECG
Electrocardiography
Abdominal surgeon
Orthopaedic surgeon
Double blind

ABSTRACT

Objective: To assess the capability of operating abdominal and orthopaedic surgeons to analyze a set of standardized ECG. **Methods:** Twenty operating abdominal and orthopaedic surgeons at a university hospital were included. Each participant analyzed a set of five standardized ECG with an answering scheme for eight different items, giving a maximum score of 40. The answers were matched according to specialty and experience of the doctors of less than 5 years, between 5 and 10 years or more than 10 years. The reference standard was set by two independent consultants in cardiology. **Results:** The mean overall score was 25.25 (63.13%±4.78%) varying between 38 (95%) and 20(50%). Abdominal surgeons performed a mean score of 27.625 (69.06% ±9.53%), and orthopaedic surgeons 23.67 points (59.17%±3.69%). The difference between the performance of abdominal and orthopaedic surgeons was not significant (P=0.09). 20/20 surgeons identified ST-elevation and no surgeon accepted the ECG showing acute ST-elevation myocardial infarction as normal. **Conclusions:** Abdominal and orthopaedic surgeons provided an answering scheme are able to interprete the ECG and identify both the normal and the ECG showing life-threatening pathology. The hypothesis that surgeons were unable to interprete the ECG must be rejected.

1. Introduction

Among medical doctors, an old joke tells that two surgeons and an ECG are a double-blind-study[1-6]. To our knowledge, this prejudice was never controlled scientifically. To our surprise, reviewing the literature by search in Pubmed. Medline and GoogleScholar no article addressing this issue could be identified[7-16]. Thus, the real capacity of surgical colleagues regarding the interpretation of the ECG must be assumed to remain uncertain yet so far[17-20]. The aim of this study was to test the capability of operating surgeons to interprete the ECG to either reject or confirm the prejudice stated.

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2. Material and methods

Operating abdominal and orthopaedic surgeons at our university hospital were directly approached to volunteer for this study. Participating doctors received randomized envelopes containing five standardized ECG showing sinus tachycardia, atrial fibrillation with left bundle branch block, atrial flutter, pacemaker-ECG and ST-elevation myocardial infarction (Figure 1 a-e) and an answer scheme containing eight items for every ECG (Table 1). The pathologies shown by the ECG were chosen according to the estimated relevance for the clinical work in the surgical specialty and in respect to the limited time available for the participating physicians. A maximum score of 40 points could be achieved in 5 ECG.

As it was assumed that the capability of correct ECG-interpretation might be influenced by the experience of the physician and his specialty, the doctors were asked to give the information about their speciality (abdominal/

orthopaedic) and if they worked in the speciality for less than 5 years (junior grade level, JL), between 5 and 10 years (specialist grade level, SL) or more than 10 years (consultant level, CL). Two consultants in cardiology were asked to interprete the ECG's according to the scheme to set an independent reference standard.

No approval of the ethical committee was needed for this study.

The interpreted ECG's were recollected by the hospitals internal mail-system and evaluated three months after the initiation of the study. ECG's returning after this period (1 set) were excluded from the study.

The ECG recollected were evaluated regarding to the individual physician, the group as abdominal or orthopaedic surgeon, the subgroup and the total performance. Only correctly assessed items were accepted, unanswered items were regarded as incorrect. Heart frequencies were accepted with a margin of±10% of the actual frequency. Statistical analysis was performed by the Student's *T*-test and confidence intervals were calculated at 95%. Probability (*P*)

Table 1.
Answering scheme added to each ECG.

Normal		Pathologic			
Ischemic Rhythm	Yes/No Rhythmic/arrhytmic ···/min	Sinus	AV-block	Atrial flimmer/flutter else	Frequency
P-wave	Normal	Pathologic	–	–	–
QRS	Normal	Pathologic	Broadened	Bundle branch block	Else
ST	Normal	Pathologic ST-elevation	ST-depression	Else	–

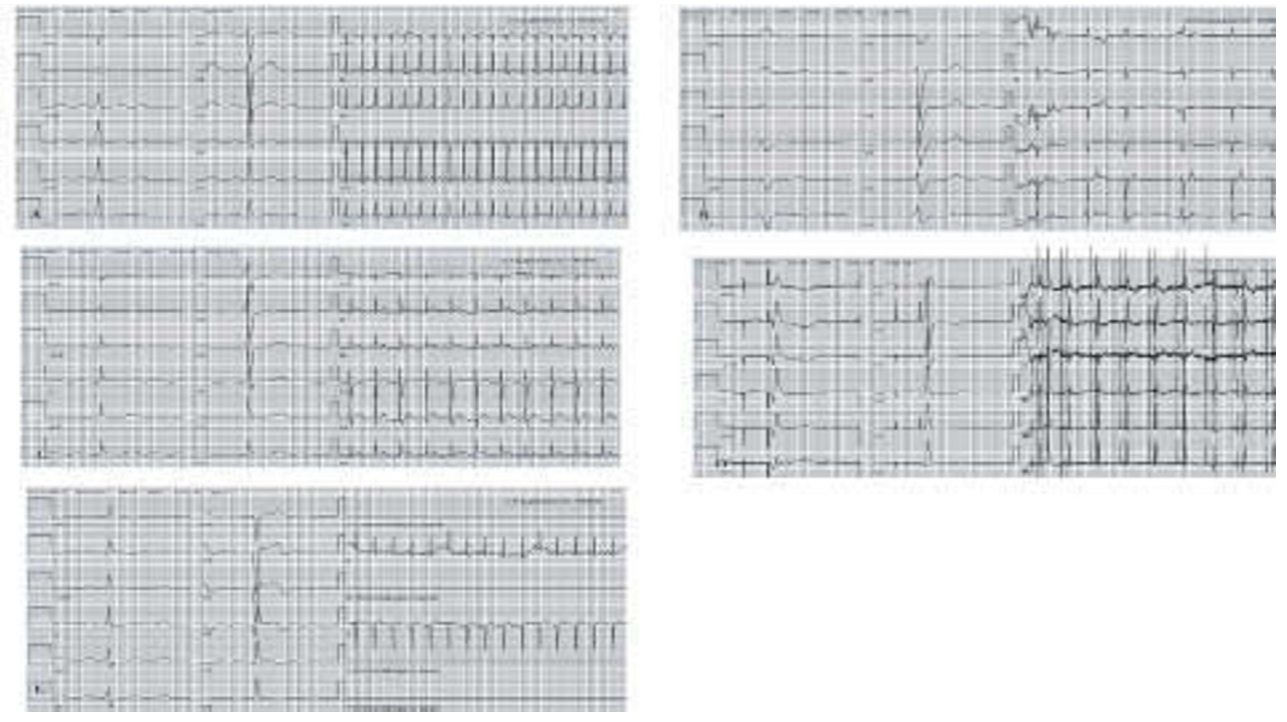

Figure 1. Set of ECG.
A) ECG 1 (12.5 mm/s). Normal ECG. No ischemia. Rhythmic, sinus rhythm. Frequency 140/min. P-wave normal, QRS normal, ST normal. Conclusion: Sinus tachycardia.
B) ECG 2 (12.5 mm/s). Pathologic ECG. Ischemia no. Arrhythmic, atrial flimmer. Frequency ca. 40/min. P-wave pathologic. QRS widened, incomplete left side bundle branch block. ST normal. Conclusion: Atrial flutter with incomplete LBBB.
C) ECG 3 (12.5 mm/s). Pathologic ECG. No ischemia. Rhythmic, atrial flutter 1:3 conduction. Frequency 66/min. P-wave pathologic (flutter). QRS pathologic (septal hinder). ST pathologic, ST-elevation. Conclusion: Atrial flutter, 1:3 conducted with impaired septal conduction.
D) ECG 4 (12.5 mm/s). Pathologic ECG. No ischemia. Rhythmic, else (pacemaker with atrial and ventricular stimulation). Frequency 60/min. P-wave pathologic (atrial flimmer, no p-wave detectable). QRS pathologic, widened, LBBB. ST pathologic. Conclusion: Pacemaker ECG.
E) ECG 5 (12.5 mm/s). Pathologic. Ischemic. Rhythmic. Sinus rhythm. Freqency 90/min. P-wave normal. QRS pathologic (anterior Q-wave, impaired R-progression in aVF and III). ST pathologic, ST-elevation. Conclusion: Ischemic ECG. Acute anterior myocardial infarction.

levels of <0.05 were accepted as significant.

3. Results

A total of 30 envelopes were distributed, of which 21 could be recollected. 20 envelopes (66.67%) could be included, 1 envelope did not return the full set of ECG's and could neither be identified as surgical or orthopaedic and had to be excluded from the study. 12 were received from orthopaedic colleagues (3 JL, 5 SL, 4 CL) and 8 from abdominal surgeons (3 SL, 5 CL). 100 ECG were included in total. 59 items of possible 320 (18.43%) were not answered by the surgical physicians and 120 of possible 480 (25%) were not answered by the orthopaedic colleagues and accepted as faulty answer.

The mean overall score was 25.25 of a maximum of 40 points (63.13%±4.78%). The best single score achieved was 38 (95%), and the worst was 20 (50%).

For the total of abdominal surgeons, a mean score of 27.625 (69.06%±9.53%) was achieved with a mean of 26 points (65%± 12.85%) for the SL and a 28.6 points (71.5%±15.75%) for the CL (P=0.56). The best score achieved by an abdominal surgeon was 38 and the worst 20. For the orthopaedic surgeons, the mean total score was 23.67 points (59.17%±3.69%), distributed into 24.33 points (60.83%±10.71%) for the JL, 22.4 points (56% ±4.8%) for the SL and 24.75 points (61.88%±5.05%) for the CL. No significant difference could be detected between these groups. The best score achieved by orthopaedic surgeons was 27 (67.5%), and the worst was 20 (50%). Among the results of abdominal surgeons a high variation (SD±9.57%) had to be noticed, whilst orthopaedic surgeons performed with a more balanced outcome (SD±6.51%).

The percentage of right answers for all physicians, abdominal and orthopaedic surgeons is shown in Figure 2-5.

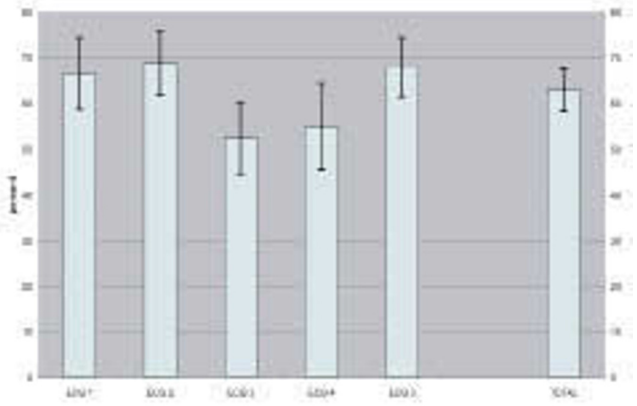

Figure 2. Percentage of items correctly analyzed by the total of physicians.

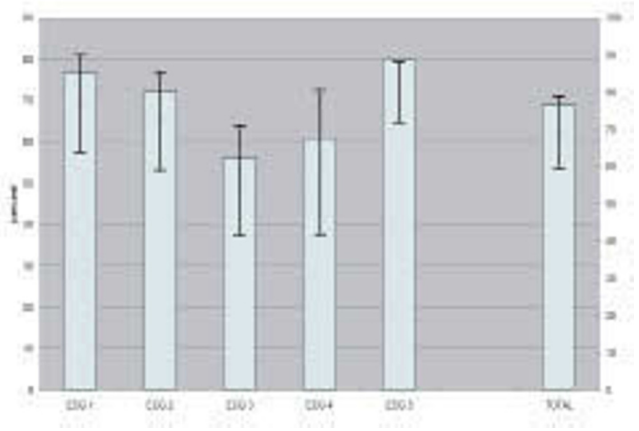

Figure 3. Percentage of items correctly analyzed by the abdominal surgeons.

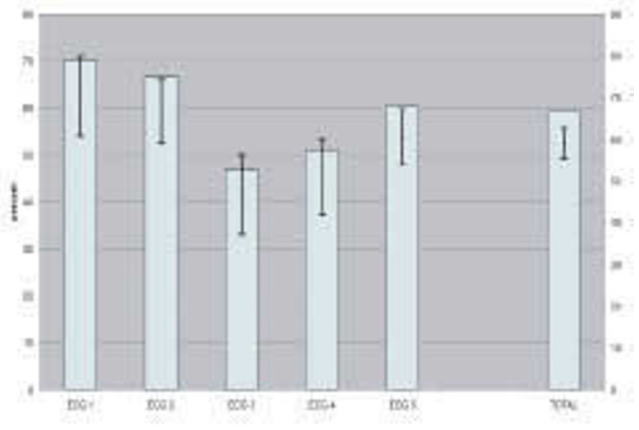

Figure 4. Percentage of items correctly analyzed by the orthopaedic surgeons.

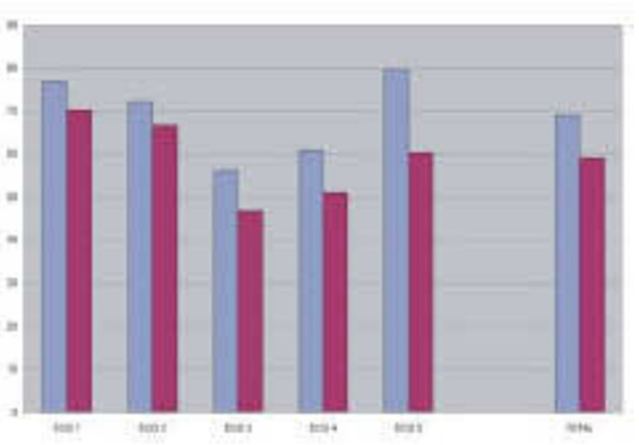

Figure 5. Comparision of the percentage of correctly analyzed items between abdominal (left column) and orthopaedic (right column) surgeons.

Comparing the total score of abdominal (27.625) and orthopaedic surgeons (23.67), no significant difference could be noted (3.955, P=0.09). However, no abdominal surgeons with less than 5 years experience participated in this study whilst 3/12 orthopaedic surgeons had this level of experience. Even if excluding the results of these junior doctors, no sinificatn difference between orthopaedic and abdominal surgeons could be detected.

When comparing between the matched subgroups, no significant difference could be detected between the respective SL and CL.

Overall, the ECG's A, B and E were interpreted best with the maximum performance at the ECG E (ST-elevation myocardial infarction, 79.68%) for the abdominal and at ECG A (sinus tachycardia, 70.31%) for the orthopaedic surgeons. 20/20 physicians positively recognized the item of ST-elevation at the ECG E, and no physician regarded ECG E as normal (with 6 missing answers at the item normal/pathologic).

4. Discussion

To our knowledge, this was the first study performed to reveal the capability of analyzing the ECG of operating abdominal and orthopaedic surgeons. Five different ECG showing sinus tachycardia, atrial fibrillation with left bundle branch block, atrial flutter, pacemaker-ECG and ST-elevation myocardial infarction were analyzed by the participating physicians. Eight items had to be assessed according to a scheme attached to each ECG.

The mean overall performance was 63.13%. The ECG showing the most immediate life threatening condition of acute ST-elevation myocardial infarction was recognized by all 20 participating colleagues and was correctly analyzed by 79.68% of the abdominal surgeons but only 60.42% of the orthopaedic surgeons.

Abdominal surgeons performed a mean 69.06% for all ECG whilst orthopaedic surgeons performed a mean 59.17%. The difference of 9.89% between these groups was not significant. Thus it might be concluded that abdominal surgeons do not interprete the ECG better than orthopaedic surgeons.

However, is a performance of 63% at the interpretation of the ECG acceptable in the clinical context? At medical school in Germany, a 60% performance is usually needed to pass an test. Unregarding personal opinions if just this limit is acceptable or not, it is standardized and widely spread. For this anonymized study no preparation was encouraged and no exam-situation was created. Thus, we chose to set a limit of 55% as acceptable. In the context of a 55% limit, 7/8 abdominal and 8/12 orthopaedic surgeons would have analyzed the ECG's satisfactorily. At a 60% limit test, 13/20 surgeons (65%) would have passed (6/8 abdominal, 5/12 orthopaedic). Thus, it must be concluded that at both limits the majority of the participating surgeons were able to interprete the ECG.

Interestingly, a tendency could be noticed for the overall performance of abdominal and orthopaedic surgeons suggesting a better accuracy of assessment of the abdominal surgeons (P=0.09). Comparing the matched groups at CL and SL, the difference was not statistical significant which could be attributed to the small number of participants.

It might be speculated that as upper abdominal and retrosternal pain can be related both to cardiac as surgical disease, abdominal surgeons would have to include cardiac disease, specially anterior and inferior myocardial infarction, in their routine differential diagnosis in the emergency patient. The orthopaedic patient would rarely present with atypical referred cardiac symptoms at the orthopaedic emergency department thus reducing the importance of the ECG for the diagnosis of the primary problem, whilst strengthening its importance in the objective assessment of pre- and postoperative pain, anemia, infection or the complication of pulmonary embolism as shown by e.g. tachycardia. These hypotheses could be strengthened by the peak performance of the abdominal surgeons in the interpretation of the ECG E (anterior myocardial infarction) versus the peak performance of the orthopaedic surgeons at ECG A (sinus tachycardia).

Physicians at consultant level performed slightly better than physicians at specialist or junior level. However, the difference in the accuracy of assessment between the levels of experience within the subgroups of abdominal resp. orthopaedic surgeons did not prove significant in this study. Even if it might be assumed that the level of experience in the surgical specialty is not related to the capability of assessing the ECG, the small number of participants in each subgroup does not allow a definitive conclusion.

As relatively few colleagues chose to participate, the data must be interpreted with caution. A high percentage of items was not analyzed by the performing colleagues (18.43% abdominal, 25% orthopaedic surgeons) and consecutively counted as false answers. The interpretation of the results is further complicated by this high rate of unanswered items which were assumed as faulty (worst case scenario). If answered correctly (best case scenario), these items could significantly change the findings for each group of doctors. Omitting the unanswered items in the analysis, abdominal surgeons would have analyzed correctly 87.4% and orthopaedic surgeons 83.7% of all items resulting in a hypothetical overall

performance of 85.8%. Furthermore, it has to be noticed that the two individues performing 50% (one abdominal, one orthopaedic surgeon) did not analyze 16 respective 18 items (40% resp. 45%), but recognized correctly 20/24 (83.33%) resp. 20/22 (90.90%) of the total items actually assessed.

Abdominal surgeons performed with a high variation (SD± 9.57%) whilst orthopaedic surgeons performed with a more balanced outcome (SD±6.51%). One single abdominal surgeon performed a 95%. Due to the size of the groups, this individual performance could interfere with the final results, however, even if omitting this single result no significant difference between the groups could be found.

Unregarding the influence of non-analyzed items and high performing individuals, the overall performance of 63.13% could be considered as relatively low. The answering scheme attached to the ECG did not allow any flexibility of interpretation and might have influenced the overall outcome negatively, as the items not analyzed automatically resulted in a worse performance. Under this aspect, a mean performance of 69.06% for the abdominal surgeons with a single performance of 95% must be regarded as a positive result, specially if regarding that the ECG showing the most immediate life threatening condition of acute ST-elevation myocardial infarction was recognized by all participating colleagues and correctly analyzed by 79.68% of the abdominal surgeons. The overall result thus must be interpreted that abdominal and orthopaedic surgeons are able to analyze the ECG and to recognize major electrocardiographic pathology.

Abdominal and orthopaedic surgeons are able to interprete the ECG provided with an answering scheme. They can identify both the normal ECG and the ECG showing life-threatening pathology[21-25]. The hypothesis that surgeons were unable to interprete the ECG must be rejected according to our data. Further studies might reveal how far the level of experience and the specialty do influence the capacity to interprete the ECG.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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