Laparoscopic vs. open Appendectomy
Systematic review of medical efficacy and health economic analysis
Gorenoi V, Dintsios CM, Schönermark MP, Hagen A

Scientific background

Appendicitis is an inflammation of the appendix of the blind intestine. Appendicitis in the developed countries is by far the most frequent cause for an acute abdomen. The risk to fall ill with appendicitis in the course of life lies in a range of approximately 7 to 9%. Appendicitis occurs in all age-groups, most frequently in children, adolescents and young adults between four and 25 years (age peak: ten to 19 years). Young boys and men fall ill more frequently than girls and young women.

If there is a suspicion of appendicitis, an operation, called appendectomy, is indicated. This procedure should be conducted as early as possible (within approximately 48 hours). Both, an open surgical intervention as well as a laparoscopic intervention are used for the excision of the inflamed appendix. The open appendectomy is considered to be the gold standard in the treatment of the appendicitis. The appendix is usually dissected and removed through opening of the abdominal cave by cut on the right side of the abdomen under the umbilical line. The junction to the blind intestine will be sutured, the epidermis will be either sewed or stapled.

The appendix can be alternatively removed by a laparoscopic approach. In this intervention, the abdominal cave is not opened. An optic system and instruments are introduced through three small incisions in the abdominal wall. The surgeon performs the excision of the inflamed appendix, watching the surgical site on a monitor. The excision of the appendix follows the same principle as the open abdominal operation but the inflamed tissue is removed from the abdominal cave through the trocar.

The laparoscopic operation avoids the long cut through the skin and the layers of the abdominal wall (cosmetic effect) and can therefore diminish the postoperative pain and wound complications. As an exploratory procedure, checking out unspecific lower abdominal pain, it allows both diagnostic and simultaneous surgical treatment. A shorter average length of hospital stay as well as an earlier return to normal everyday life activity are expected as sequelae of laparoscopic appendectomy.

On the other hand the risk of intraabdominal abscesses by the laparoscopic procedure is suspected to be increased. The experience of the operator is also important since the handling of the longer instruments and the two-dimensional vision of the operation field in the laparoscopic appendectomy are unusual for the surgeon. The laparoscopic appendectomy seems also to be more cost-intensive if one considers the costlier devices and probably slower procedure.
Research questions

Medical evaluation

The medical evaluation addresses the questions on the medical effectiveness of the use of laparoscopic appendectomy and its complications as compared to the classic open appendectomy.

Health economic evaluation

The health economic evaluation addresses the questions on the cost-effectiveness of the use of laparoscopic appendectomy as compared to the open approach based on the German health system.

Medical evaluation

Methods

A literature search was conducted in the most important medical electronic databases in October 2005. The medical analysis was performed on the basis of the most up to date systematic review (basic review) of the randomized controlled studies (RCT), newly published RCT and on own quantitative information synthesis of all studies as well as of selected methodically high-value RCT (subanalysis). By information synthesis of all studies, the results for dichotome endpoints were statistically summarized. The results of new studies for metric parameters were compared with the results of the basic review. Within the scope of the subanalysis on the basis of selected methodically high-value RCT only studies with details on randomisation procedure as well as studies which performed analyses without violation of the ITT-principle were included into the evaluation. For the combination of the dichotom variables, Peto-OR were used as well as relative risks in a random model. For the combination of the metric variables, weighted mean differences (WMD) were employed also in random model. For the meta-analyses 95%-confidence intervals (95 %-CI) were calculated.

Results

The literature search yielded 753 hits. 93 publications were selected for the examination in the full text. From 14 identified reviews only one was selected as the basic review. From a total of 79 identified publications of original studies, 65 publications were already considered in the basic review. From further 14 publications, only two new publications could be included into the analysis. Overall, one systematic review and 56 primary studies were included into the analysis, 24 of these studies with details on randomisation procedure and without violation of the ITT-principle could be selected into the subanalysis on the basis of methodically high-value studies. The Peto-OR for wound infections was 0.48 (95 %-CI: 0.36; 0.65), for intraabdominal abscesses 2.55 (95 %-CI: 1.47; 4.44). A total relation of three avoided wound infections per one additional intraabdominal abscess was found to be expected by the use of laparoscopic appendectomy in comparison with the open operation (43 additional wound infections and 14 avoided intraabdominal abscesses per 1000 patients). With regard to the diagnostic value of the laparoscopy, the presenting analysis was able to show that in the course of routinely leaving the macroscopically bland appendix in situ, the negative appendectomy rate would be reduced significantly and profoundly, RR = 0.05 (95 %-CI: 0.01; 0.15). Results of the basic review...
show that diagnostic laparoscopy within the scope of a planned appendectomy reduces the rate of not established diagnoses as well as the rate of the negative appendectomy in fertile women when leaving the macroscopically bland appendix in situ in the case of other visible pathology. The data for the postoperative clinical parameters was clearly worse and the interpretation of these results due to the heterogeneity of the studies complicated. Though the results speak for an advantage of laparoscopic appendectomy with respect to pain intensity at the first postoperative day (on the average 0.6 points on the ten points score) as well as for advantages in the time until reintroduction of liquid and solid diet and also in the time until first stool (on the average 0.13, 0.31 and 0.33 days, respectively), the relevance of these differences seems to be small. Overall, the presented results speak for a better cosmetic result and a better quality of life after laparoscopic appendectomy, which should be confirmed in further studies taking methodical aspects (missing patients blinding and incomplete follow-up) into account.

The operation time depends in general on the experience of the surgeon: according to the average duration of the operation (over and/or under 60 minutes) it requires approximately 15 to 21 and/or approximately one to eleven minutes longer, using the laparoscopic than the open appendectomy procedure. The length of hospital stay is influenced by the health system: the difference in the length of hospital stay between both interventions is reduced by shortening the length of hospital stay by open appendectomy: on the average 1.66 days in hospital stay over five days, 0.84 days in hospital stay between three and five days and 0.12 in hospital stay under three days. The time to return to work is also health system dependent: In case of time to return to work by open appendectomy over 15 days an advantage of the laparoscopic appendectomy was approximately four to seven days, in case of time to return to work after open appendectomy under 15 days, this parameter was similar by both technologies.

Discussion

A poor report quality of some primary studies makes the interpretation and the transferability of the results of these studies difficult. Only seven RCT used special procedures to blind the patients. The completeness of the follow-ups for the long-term endpoints (time to return to work) and for the endpoints with questionnaire use (pain intensity) was noticeably lower than for the other endpoints in many studies. It is to be noticed that many of the examined parameters are setting- and/or health system dependent.

In contrast to the basic review, which did not exclude studies from the analysis without details on the randomisation procedure as well as studies with violation of the ITT-principle by the estimations (exclusion of patients after conversion or without confirmed appendicitis), exclusively methodologically high-value RCT were considered in the present subanalysis.

Economical evaluation

Methods

In the presented analysis, relevant health economical publications on the comparison of the laparoscopic and open appendectomies were identified and evaluated as well as own calculations of the cost differences in the use of both interventions performed.

A literature search was conducted in the most important electronic databases in October 2005. To be included in the analysis, the assumptions for the medical effectiveness, applied in the identified health economical evaluations, should be directly derived from primary RCT or indirectly from the synopses of these RCT.
As no identified health economical analysis considered the aggregated medical assumptions from all current RCT (highest available evidence degree from the literature) as well as current treatment costs in Germany (relevance for the German context), an own calculation of the cost differences between laparoscopic and open appendectomies was undertaken.

Two approaches were used in the presenting analysis for the calculation of the operation costs: First, calculations from a foreign study which provided data on the difference of the device costs per patient were involved. Differences in operation personal costs were calculated through multiplication of the differences in operation times between both procedures, which were received from the results of conducted own medical evaluation, with the corresponding personal costs per minute of presence in the operating room. The data on personal costs per minute of presence in the operating room were supported by the controlling unit of Hannover Medical School. Second, an own calculation of the difference in the operation device costs as well as in the operation personal costs was conducted on the basis of the G-DRG-2006 for G23A and G23B, in which laparoscopic and open appendectomies are rated proportionally.

The differences in the non-operation costs of hospital stay was calculated from the difference in the length of hospital stay from the presented medical analysis and the average day costs of the hospital stay without operation. For the calculation of the average day costs of the hospital stay without operation, data for expense allocation from G-DRG-2006 were applied. Differences in indirect costs for Germany were calculated from the differences in time to return to work between both technologies from the presented medical analysis and the average costs of daily productivity loss. The average costs of daily productivity loss was estimated over the average labour costs per employee in Germany for the year 2004 based on the data of the Federal Statistical Office (first per employee and then per average patient of the total population, both by full employment and by taking in the unemployment rate for the year 2004).

Results

The literature search yielded 315 hits. Overall, 315 titles and 57 abstracts were looked through, 17 publications were selected for a full text screening and eight were included into the analysis. However, none health economic analysis considers to use aggregated medical results of all current RCT (highest evidence grade) as well as current treatment costs in Germany (relevance for the German context). Therefore, our own calculation of the cost differences between laparoscopic and open appendectomies was conducted. Both calculation approaches used in the health economical evaluation indicated similar results. The use of laparoscopic appendectomy in the current health care situation in Germany is associated with additional operation costs of approximately 150 to 200 Euro in comparison with the open appendectomy (both through additional operation device costs of 94 to 115 Euro and through additional operation personal costs of 52 to 76 Euro). As there are cost savings of approximately 200 Euro due to shortening the length of hospital stay the total in-patient costs of both procedures are approximately the same. Due to similar indirect costs (costs of the productivity loss), the total costs of both procedures lie in the same range and the incremental cost-effectiveness ratio of both technologies is driven to zero.

Discussion

The calculation approaches used in the presenting analysis have some methodical uncertainties: Transferability of the operation device costs derived from a foreign study on the current health care situation in Germany, assumptions over the person-
al costs per minute presence in the OP-room derived from a large university clinic with maximal medical care, deductions from the aggregated data for two DRG. The consistency of the results by different approaches supports the plausibility of the performed calculations. Unfortunately, no more precise data were available.

Due to failed differences in the total costs by the use of laparoscopic in comparison to the open appendectomy as well as small differences in the effectiveness, the incremental cost effectiveness ratio of both technologies has also no clinical relevance.

**Ethic / social aspects**

The data are insufficient.

**Juristic aspects**

The data are insufficient.

**Summary discussion of all results**

The use of the results of the performed own medical analysis in the cost calculations supports conclusions of the health economic evaluation on the same evidence level as in the medical analysis.

**Conclusions**

The laparoscopic appendectomy showed both advantages and disadvantages in comparison with open appendectomy in the performed medical evaluation.

Results of the basic review show that diagnostic laparoscopy within the scope of a planned appendectomy is reasonable in fertile women. By routinely leaving the macroscopically bland appendix in situ, the rate of the negative appendectomies will be reduced significantly and profoundly.

Laparoscopic appendectomy has only minor advantages with respect to the pain intensity as well as with regard to the time until reintroduction of liquid and solid diet as well as to the time until first stool. It showed also a slightly better cosmetic result and a better quality of life, what should be confirmed in further studies.

Which of the alternatives (three avoided wound infections per one additional intraabdominal abscess by laparoscopic appendectomy in comparison with open operation) is to be preferred from a clinical view should be appraised by professional expert groups.

In the contemporary practice in Germany, a longer operation time, a reduction in the length of hospital stay as well as a similar time until return to work by the use of laparoscopic appendectomy in comparison with the open appendix excision may be assumed.

From a health economic perspective, the costs of laparoscopic and open appendectomies are generally similar in respect to the direct in-patient and indirect costs. These costs should not play any role for the decision in favour of any of these intervention alternatives.

Therefore, the decision between the two alternatives should be met by the physicians individually (e. g. depending on the necessity of the differential diagnosis by laparoscopy) as well as in dependence of the availability of experienced staff to perform a laparoscopic appendectomy.