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Is reduction of routine radiograph use in patients with distal radius fractures cost effective? Analysis of data from the multicentre, randomised controlled WARRIOR trial

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ABSTRACT

Objective To assess the cost effectiveness of a reduced imaging follow-up protocol of distal radius fractures compared with usual care.

Design An economical evaluation conducted alongside a multicentre randomised controlled trial (RCT).

Setting Four level-one trauma centres in the Netherlands.

Participants 341 patients participated (usual care (n=172), reduced imaging (n=169)).

Interventions Patients were randomised to usual care (routine radiography at 1, 2, 6 and 12 weeks) or a reduced imaging strategy (radiographs at 6 and 12 weeks only for a clinical indication).

Outcome measures Functional outcome was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire and quality-adjusted life years (QALYs) using the EuroQol-5Dimensions-3 Levels (EQ-5D-3L). Costs were measured using self-reported questionnaires and medical records, and analysed from a societal perspective. Multiple imputation, seemingly unrelated regression analysis and bootstrapping were used to analyse the data.

Results Clinical overall outcomes of both groups were comparable. The difference in DASH was −2.03 (95% CI −4.83 to 0.77) and the difference in QALYs was 0.025 (95% CI −0.01 to 0.06). Patients in the reduced imaging group received on average 3.3 radiographs (SD: 1.9) compared with 4.2 (SD: 1.9) in the usual care group. Costs for radiographic imaging were significantly lower in the reduced imaging group than in the usual care group (€−48 per patient, 95% CI −68 to −27). There was no difference in total costs between groups (€−401 per patient, 95% CI −2453 to 1251). The incremental cost-effectiveness ratio (ICER) for QALYs was −15 872; the ICER for the DASH was 198. The probability of reduced imaging being cost effective compared with usual care ranged from 0.8 to 0.9 at a willingness to pay of €20 000/QALY to €80 000/QALY.

Conclusions Implementing a reduced imaging strategy in the follow-up of distal radius fractures has a high probability of being cost effective for QALYs, without decreasing functional outcome. We, therefore, recommend imaging only when clinically indicated.

Trial registration number The Netherlands trial register (NL4477).

Strengths and limitations of this study

- We used multiple imputations to deal with missing data.
- Multiple sensitivity analyses were performed to assess possible forms of bias.
- Results are based on a large and prospective trial with a randomised design.
- The use of questionnaires might have introduced recall bias.
- The amount of participants with missing data was relatively high.

INTRODUCTION

Fractures of the distal radius are common. The reported incidence of a distal radius fracture varies between 160 and 320 per 100 000 patients per year, accounting for 18% of all fractures.[1–3] This incidence is expected to increase as a result of an ageing population.[4] Both non-operative and operative treatment aim at restoring joint congruity, radial height, radial inclination and volar tilt.[5] Approximately, 23% of all distal radius fractures require operative treatment.[6] Reasons for surgery include primary instability, failed closed reduction and secondary loss of reduction during non-operative treatment. Trauma protocols recommend that radiographs be performed as a part of routine follow-up in all patients with a fracture of the distal radius.[7] For non-operatively treated patients, obtaining radiographs is recommended after

1, 2 and 6 weeks. For operatively treated patients, the same radiographic follow-up regimen is recommended, including an additional radiograph at 12 weeks.[7] In the Dutch population representing approximately 17 million people, €8 million is spent annually on radiography for patients with a distal radius fracture, based on an incidence of 55 000 per annum,[1] with three follow-up radiographs,[6] at a cost of €50 per radiograph.[8]

Studies have evaluated the clinical value of routine radiographs obtained immediately following surgery, and after the initial 3 weeks of operatively and non-operatively treated distal radius fractures.[6 9–11] These findings suggest that the health benefits of the current imaging protocols might not be worth their associated costs. In other words, current imaging protocols do not seem to be cost effective. The objective of this economic evaluation was to evaluate the cost effectiveness (CE) of a follow-up strategy for patients with distal radius fractures with a reduced number of routine radiographs, compared with usual care.

MATERIALS AND METHODS

Design

This economic evaluation was conducted alongside a multicentre, randomised controlled trial, which is described in detail elsewhere.[12] The protocol was published before the onset of patient enrolment.[12] International guidelines were followed in drafting this manuscript.[13 14] Four level-one trauma centres in the Netherlands participated in the study. Patients were enrolled between July 2014 and August 2016. The primary clinical outcomes of the trial have been published in 2019.[15]

Participants

Inclusion/exclusion criteria

Patients were included if: (1) they provided written informed consent, (2) were >18 years, (3) had a fracture of the distal part of the radius (Arbeitsgemeinschaft für Osteosynthesefragen[29] /Orthopaedic Trauma Association classification[16] type 23 A-C) and (4) were able to independently complete Dutch questionnaires. Exclusion criteria were the presence of fractures to multiple extremities, a pathological fracture or an open fracture (Gustilo-Anderson grades 2–3). Patients were also excluded if they were deemed unable to comply with follow-up.

Randomisation

Patients were informed about the study both verbally and in writing during their first visit to the emergency department or outpatient clinic. After obtaining written informed consent, patients were randomised using the online randomisation and registration programme Project Manager Internet Server (ProMISe; https://www.msbi.nl/promise/ProMISe.aspx). Patients were assigned in a 1:1 ratio stratified by centre and treatment (non-operative or operative), using randomly varying blocks (2–6). Randomisation tables were pregenerated within ProMISe.

Control group: usual care

In accordance with current protocols,[7] patients allocated to usual care were monitored in the outpatient clinic with the use of routine follow-up radiographs. Radiographs were taken at 1, 2, 6 and 12 weeks following trauma for non-operatively treated patients or following surgery. Additional follow-up moments and radiographs could be ordered by the treating physician if deemed necessary.

Intervention group: reduced imaging

In the reduced imaging group, radiographs were obtained after 1 and 2 weeks. Additional radiographs were only obtained if a clinical indication was present or at the discretion of the treating physician. Reasons for a protocol deviation were noted in the medical files. Additional clinical follow-up moments, with or without radiographs, could be scheduled at any time if deemed necessary.

Outcome measures

At baseline, participants reported functional status and quality of life just prior to when the fracture occurred. Patient demographics such as age, sex, dominant wrist, smoking habits, alcohol intake, socioeconomic status and previous medical history were queried. Follow-up was conducted at 6, 12, 26 and 52 weeks following trauma.

Clinical measures

Functional outcome was measured using the 30-item validated Dutch version of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.[17 18] DASH scores range from 0 to 100, with lower scores representing a better functional status. Health-related quality of life (HRQoL) was measured using the EQ-5D-3L. Utility scores were calculated using the Dutch tariff.[19 20] Quality-adjusted Life Years (QALYs) were calculated using the area under the curve approach.[21] The baseline score we assessed was the utility score prior to the occurrence of the fracture, instead of the utility score immediately following the fracture, which would have resulted in an overestimation of the average utility during the first 6 weeks of follow-up. The average utility score for the first six weeks of follow-up, therefore, was assumed to equal the utility score measured at 6 weeks of follow-up.

Cost measures

The number of radiographs was collected from the medical records, after which intervention costs were calculated using Dutch standard costs.[22] All other costs were measured using self-reported questionnaires. Primary healthcare costs included costs for general practitioner visits, visits to an occupational physician, physiotherapy sessions and visits to other specialised therapists. Secondary healthcare costs included hospital admissions, outpatient clinic visits, radiographic imaging other than plain radiographs, costs of a possible reoperation and

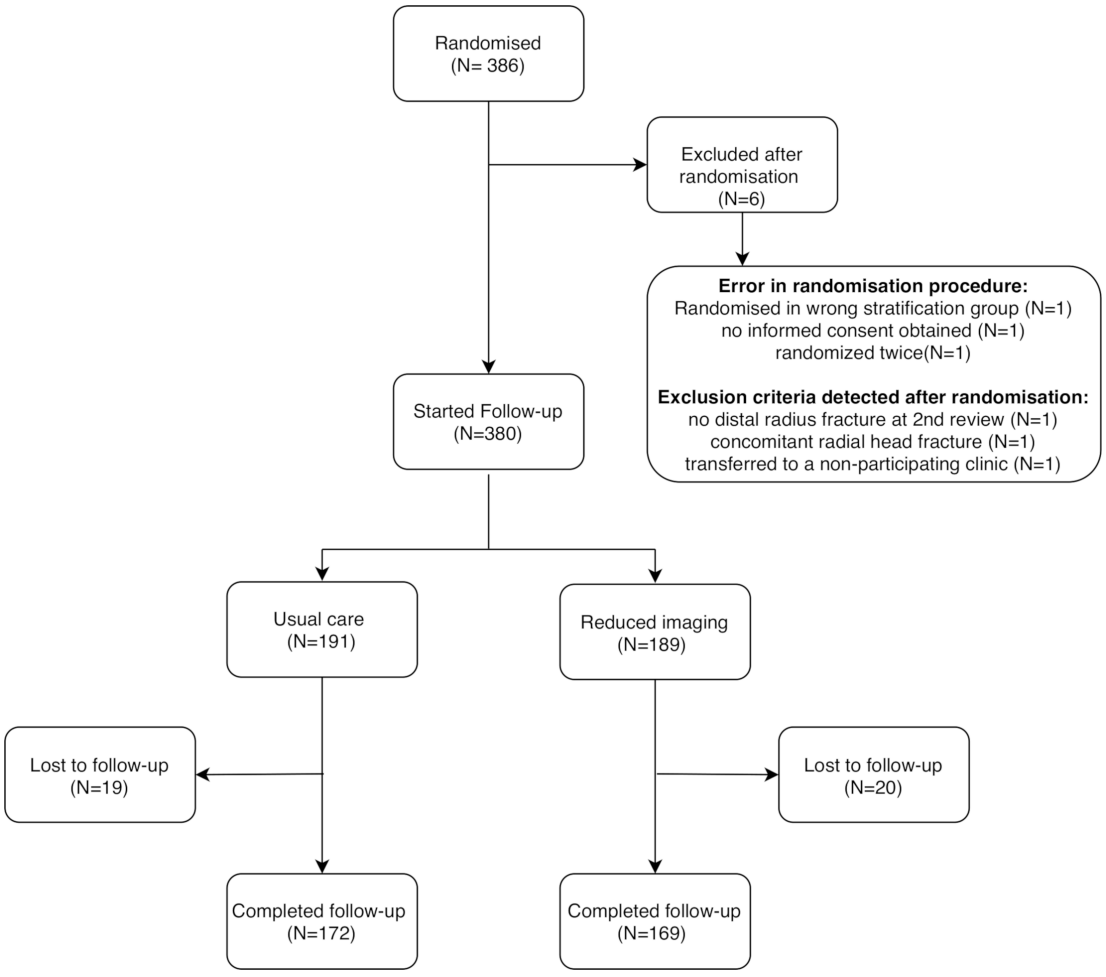

Figure 1 Flow chart of participants.

admissions to a nursing home or rehabilitation centre. Primary and secondary healthcare costs were valued using Dutch standard costs,[22] or tariffs if unavailable. Medication costs were valued using unit prices of the Royal Dutch Society of Pharmacy.[23] Informal care (i.e. care provided by relatives, friends or volunteers) and unpaid productivity losses (i.e. volunteer work, caregiving or domestic activities) were valued at €14.13 per hour.[22] Absenteeism was defined as the number of days of work absence due to the distal radius fracture. The Friction Cost Approach was used to value absenteeism (friction period: 12 weeks).[22] Presenteeism (i.e. reduced productivity while at work) was measured using the WHO Health and Work Performance Questionnaire.[24] Absenteeism and presenteeism were valued using gender-specific price weights.[22] All costs were converted to Euros 2016.[25] Follow-up was 12 months and therefore we did not discount costs and effects.

Statistical analysis

Missing data were imputed using the MICE algorithm in STATA (V.12). The imputation model included all available cost and effect measure values, variables differing between groups at baseline as well as variables predicting the 'missingness' of data. Five datasets were constructed to ensure a loss of efficiency of <5%.[26] We analysed each dataset separately, after which estimates were pooled using Rubin's rules.[26] Costs and effects were estimated using linear regression analysis, adjusted for baseline values and possible confounders. Seemingly unrelated regression analysis was performed to estimate the differences in costs and effects, and to account for their possible correlation.[27] The incremental cost-effectiveness ratio (ICER) was calculated by dividing the difference in costs by the difference in effect. Uncertainty surrounding the ICER and 95% CI for costs was estimated using bias-corrected and accelerated bootstrapping (5000 replications). Uncertainty around the ICER was graphically illustrated using CE planes.[21] A summary measure of the joint uncertainty surrounding costs and effects was provided using CE acceptability curves (CEACs). These curves give an indication of the possibility that reduced imaging is cost effective compared with usual care, at different values of willingness to pay.

Sensitivity analyses

Six sensitivity analyses were planned: (1) a complete-case analysis (SA1); (2) the measured EQ-5D-3L score at baseline (i.e. prior to the fracture) was used for estimating the average utility value during the first 6 weeks of follow-up (SA2); (3) the Human Capital Approach

Table 1 Patient characteristics by treatment allocation

	Usual care (n=172)	Reduced imaging (n=169)
Male sex, n (%)	41 (23.8)	41 (24.3)
Age, mean (SD)	56.2 (18.3)	56.3 (17.9)
BMI, mean (SD)	24.9 (4.5)	24.8 (4.9)
Alcohol >10 U/week, n (%)	18 (10.5)	10 (5.9)
Smoking >10/day, n (%)	8 (4.7)	7 (4.1)
Operative treatment, n (%)	21 (12.2)	20 (11.8)
Fracture to dominant wrist, n (%)	66 (38.4)	69 (40.8)
AO classification, n (%)		
A	111 (64.5)	118 (69.8)
B	19 (11.0)	18 (10.7)
C	42 (24.4)	32 (18.9)
Missing	0 (0)	1 (0.6)
ASA classification, n (%; derived from med. history)		
1	71 (41.3)	78 (46.2)
2	84 (48.8)	75 (44.4)
≥3	12 (7.0)	12 (7.1)
Missing	5 (2.9)	4 (2.4)

AO, Arbeitsgemeinschaft für Osteosynthesefragen; ASA, American Society of Anesthesiologists; BMI, body mass index.

was used to calculate productivity losses instead of the Friction Cost Approach (SA3)[28]; (4) costs were calculated from a healthcare perspective (SA4); (5) only patients with non-operative treatment were included (SA5); and (6) only patients with operative treatment were included (SA6). In a post-hoc sensitivity analysis, we excluded the costs of unpaid productivity losses (SA7). This was done because of a very low response rate for this cost category (5.2%).

Patient and public involvement

No patients were involved in the study's design.

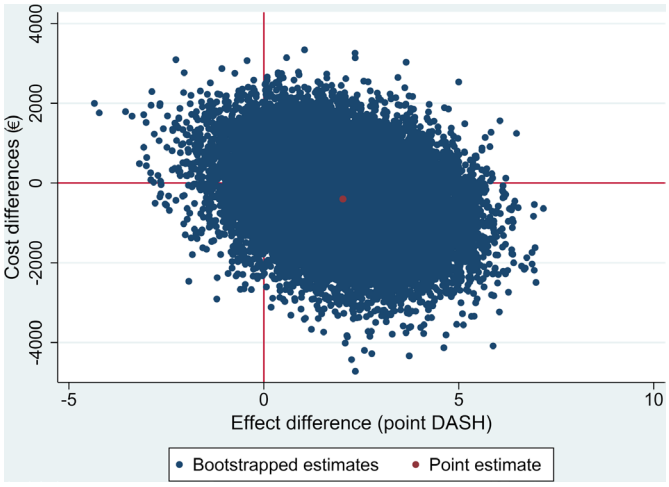

Figure 2 Cost-effectiveness plane for Disabilities of the Arm, Shoulder and Hand (DASH), representing the results from the 5000 bootstrapped replications, and the point estimate. Higher on the Y-axis corresponds to more costly than control, more right on the X-axis corresponds to more effective than control.

RESULTS

Participants

In total, 386 patients were enrolled in the study (figure 1). Of them, three were excluded because of an error in the randomisation procedure, and three were excluded because an exclusion criterium was discovered after randomisation had occurred. Additionally, 39 patients did not return any of the questionnaires, including baseline and were regarded lost to follow-up. Of the remaining 341 patients, 169 were randomised to reduced imaging and 172 to usual care. Forty-one patients (12%) received operative treatment. In total, 337 participants (99%) returned their baseline questionnaire. Respectively, 304 (89%), 289 (85%), 272 (80%) and 264 (77%) participants returned their week 6, week 12, week 26 and week 52 questionnaires. In total, 86 patients had no missing values on any of the outcomes. At baseline, there were no

Table 2 Mean cost (in euros) per participant in the intervention and control groups and mean cost differences between groups during follow-up

Cost category	Reduced imaging n=169, mean (SEM)	Usual care n=172, mean (SEM)	Cost difference crude, mean (95% CI)	Cost difference adjusted, mean (95% CI)
Intervention	164 (7)	212 (7)	−49 (−68 to −28)	−48 (−68 to −27)
Primary care	555 (90)	547 (85)	7 (−237 to 214)	13 (−237 to 223)
Secondary care	661 (123)	949 (410)	−288 (−2159 to 198)	−294 (−2371 to 225)
Medication	17 (4)	25 (7)	−8 (−25 to 4)	−9 (−26 to 3)
Informal care	301 (135)	141 (39)	159 (−8 to 539)	170 (0 to 535)
Absenteeism	532 (185)	627 (174)	−95 (−558 to 376)	−109 (−557 to 349)
Presenteeism	3017 (472)	3426 (613)	−410 (−1845 to 848)	−269 (−1531 to 878)
Unpaid productivity loss	246 (61)	104 (35)	142 (30 to 281)	144 (30 to 284)
Total	5491 (663)	6033 (783)	−542 (−2581 to 1225)	−401 (−2453 to 1251)

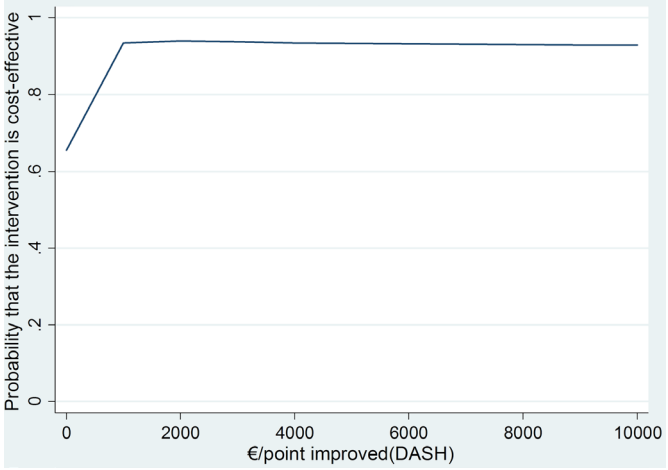

Figure 3 Cost-effectiveness acceptability curve for Disabilities of the Arm, Shoulder and Hand (DASH), showing the probability of the intervention being cost effective at a certain willingness to pay value per point DASH.

significant differences in patient demographics between the groups (table 1).

Effects

The difference between the reduced imaging and usual care group was −2.03 points for DASH (95% CI −4.83 to 0.77) and 0.025 for QALYs (95% CI −0.01 to 0.06).

Costs and resource usage

Participants in the reduced imaging group received on average 3.3 (SD 1.9) radiographs, while participants in the usual care group received on average 4.2 (SD 1.9) radiographs. This resulted in significantly lower costs for the intervention in the reduced imaging group(-€48 per patient, 95% CI −68 to −27). Participants randomised to reduced imaging, however, had significantly higher costs due to unpaid productivity losses than in the usual care group (€144 per patient, 95% CI 30 to 284). All other disaggregate and aggregate costs (−€401, 95% CI −2453 to 1251) were not significantly different between the groups (table 2).

Cost effectiveness

Reduced imaging was dominant over usual care. The CE plane shows that most of the bootstrapped cost-effect pairs were in the south-east quadrant, indicating that reduced imaging had lower total costs and was more effective than usual care (figure 2). The CEAC indicates that the maximum probability that reduced imaging was cost effective compared with the control was 0.88 (figure 3) and was achieved at a willingness to pay of €1100 to improve functional outcome by 1 point on the 0–100 points DASH score.

The ICER for HRQoL was −15 872. The CE plane again shows that most cost-effect pairs were in the south-east quadrant (figure 4). The probability of CE of reduced imaging was 0.8 at a willingness to pay of €20 000/QALY, increasing to 0.9 at a willingness to pay of €80 000/QALY (figure 5).

Sensitivity analyses

Results of the sensitivity analyses are presented in table 3.

SA6 (only including operatively treated patients) is not reported because a much smaller than expected percentage of participants (41/341 patients=12%) received operative treatment, so this analysis was underpowered. SA1 (complete cases only) showed larger differences in both costs and effects. To determine if response bias potentially influenced our results, we compared the baseline characteristics of respondents with complete and incomplete data. Respondents with complete data were more likely to consume over 10 units of alcohol a week, were slightly older (59 vs 55 years) and more frequently had an American Society of Anesthesiologists (ASA)[30]

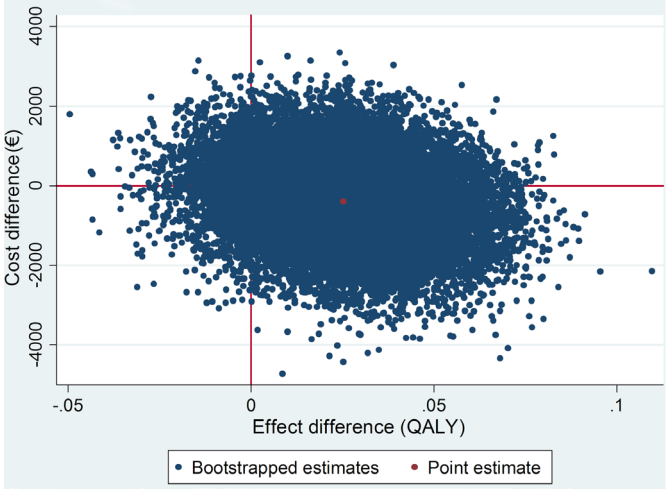

Figure 4 Cost-effectiveness plane for quality-adjusted life years (QALYs), representing the results from the 5000 bootstrapped replications, and the point estimate. Higher on the Y-axis corresponds to more costly than control; more right on the X-axis corresponds to more effective than control.

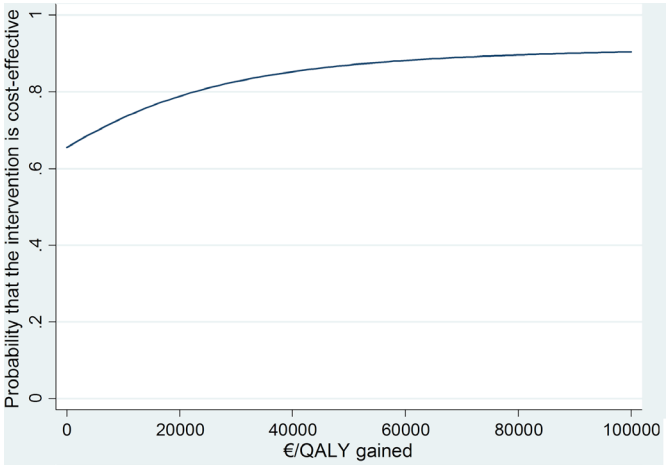

Figure 5 Cost-effectiveness acceptability curve for quality-adjusted life years (QALYs), showing the probability of the intervention being cost effective at a certain willingness to pay value per QALY.

Table 3 Differences in pooled mean costs and effects (95% CIs), incremental cost-effectiveness ratios (ICERs) and the distribution of incremental cost-effect pairs around the quadrants of the cost-effectiveness (CE) planes for reduced imaging compared with usual care

	Sample size			ΔC (95% CI)	ΔE (95% CI)	ICER	Distribution CE plane (%)			
Analysis	Reduced imaging	Usual care	Outcome measure	€	Points	€/point	NE[1]	SE[2]	SW[3]	NW[4]
Main analysis: imputed dataset	169	172	QALYs (range: 0–1)	−401 (−2393 to 1310)	0.025 (−0.01 to 0.06)	−15 872	31.4	60.7	3.8	3.8
	169	172	DASH (range: 0–100, lower is better)	−401 (−2393 to 1310)	−2.03 (−4.83 to 0.77)	198	30.9	60.4	3.4	5.1
SA1: complete cases	49	37	QALYs (range: 0–1)	−1184 (−4128 to 1207)	0.071 (0.02 to 0.13)	−16 914	28.9	70.7	0.2	0.2
	49	37	DASH (range: 0–100, lower is better)	−1184 (−4128 to 1207)	−3.8 (−9.1 to 1.4)	312	25.0	68.3	2.6	4.1
SA2: QALY 1 versus QALY 2	169	172	QALYs (range: 0–1)	−401 (−2393 to 1310)	0.025 (−0.01 to 0.06)	−16 180	31.5	60.7	4.0	3.8
SA3: human capital approach	169	172	QALYs (range: 0–1)	−360 (−2369 to 1385)	0.025 (−0.01 to 0.06)	−14 271	32.9	59.4	3.7	3.9
	169	172	DASH (range: 0–100, lower is better)	−360 (−2369 to 1385)	−2.03 (−4.82 to 0.76)	178	32.4	60.1	3.0	4.5
SA4: healthcare perspective	169	172	QALYs (range: 0–1)	−338 (−2289 to 292)	0.025 (−0.01 to 0.06)	−13 377	26.9	65.5	4.3	3.3
	169	172	DASH (range: 0–100, lower is better)	−338 (−2289 to 292)	−2.03 (−4.82 to 0.76)	167	27.0	65.7	4.2	3.2
SA5: conservative treatment	149	151	QALYs (range: 0–1)	−602 (−2695 to 1137)	0.018 (−0.02 to 0.06)	−33 528	21.8	60.7	10.5	6.9
	149	151	DASH (range: 0–100, lower is better)	−602 (−2695 to 1137)	−1.30 (−4.28 to 1.67)	462	20.0	61.0	10.3	8.7
SA7: no unpaid productivity	169	172	QALYs (range: 0–1)	−545 (−2514 to 1119)	0.025 (−0.01 to 0.61)	−21 597	26.4	65.9	4.4	3.3
	169	172	DASH (range: 0–100, lower is better)	−545 (−2514 to 1119)	−2.03 (−4.82 to 0.76)	269	25.8	66.7	3.6	3.9

NE[1]: North-east part of the CE plane (representing an intervention that is more costly and more effective).
SE[2]: South-east part of the CE plane (representing an intervention that is cheaper and more effective).
SW[3]: South-west part of the CE plane (representing an intervention that is cheaper and less effective).
NW[4]: North-west part of the CE plane (representing an intervention that is more costly and less effective).
ΔC, difference in cost; DASH, Disability of Arm Shoulder and Hand; ΔE, difference in effect; ICER, incremental cost-effectiveness ratio; QALYs, quality-adjusted life years; SA, sensitivity analysis.

Table 4 Patient characteristics complete cases versus incomplete cases

	Complete cases (n=86)	Incomplete cases (n=255)
Male sex, n (%)	21 (24.4)	61 (23.9)
Age, mean (SD)	59.1 (16.1)	55.6 (18.5)
BMI, mean (SD)	25.5 (4.8)	24.6 (4.7)
Alcohol >10 U/week, n (%)	12 (14.0)	16 (6.5)
Smoking >10/day, n (%)	2 (2.3)	13 (5.3)
Operative treatment, n (%)	11 (12.8)	30 (11.8)
Fracture to dominant wrist, n (%)	36 (41.9)	99 (41.3)
AO classification, n (%)		
A	52 (60.5)	177 (69.4)
B	11 (12.8)	26 (10.2)
C	23 (26.7)	51 (20.0)
Missing	0 (0)	1 (0.4)
ASA classification, n (%; derived from med. history)		
1	43 (50.0)	106 (41.5)
2	33 (38.4)	126 (49.4)
≥3	10 (11.6)	14 (5.4)
Missing	0 (0.0)	9 (3.5)

AO, Arbeitsgemeinschaft für Osteosynthesefragen; ASA, American Society of Anesthesiologists; BMI, body mass index.

score of "1" as opposed to an ASA score of " 2" (respectively, 50% vs 42% and 38% vs 49%) in comparison to respondents with incomplete data (table 4).

Thus, non-response may have slightly biased the results of SA1, making the results of the main analysis (for which data were multiply imputed) more valid. SA5 (only including non-operatively treated patients) and the SA7 (excluding unpaid productivity costs) showed larger societal cost savings in the reduced imaging group. The results of all other sensitivity analyses were comparable with the main analysis.

DISCUSSION

The use of a reduced imaging protocol led to significantly lower costs (€−49; 95% CI −68 to −27) than the usual care protocol for radiographic imaging per patient in the follow-up of distal radius fractures. This reduction in the number of radiographs also led to a small (0.003 mSv) reduction in ionising radiation dose. Clinical outcomes were comparable. The number of QALYs showed no statistically significant difference between the groups. The calculated difference of 0.025 was smaller than the minimal important difference of 0.04 (US algorithm) or 0.08 (UK algorithm).[31] The reduced imaging group was non-inferior for DASH[15] since both the calculated difference, as well as the 95% CI were smaller than the margin of non-inferiority.[9 32] Costs for unpaid productivity losses were significantly higher in the reduced imaging group. This difference was most distinct in the first 6 weeks. This is not likely to be a result of the intervention, since follow-up was similar for both groups until this point. Moreover, unpaid productivity costs were reported in very few of the returned questionnaires (5.2%, n=76/1461). This low response rate may have introduced bias. We, therefore, decided to perform an additional sensitivity analysis, in which we disregarded this uncertain cost category. This showed an increase in ICER for both QALYs and DASH, leading to a more favourable result for the reduced imaging group in comparison to the main analysis. This indicates that bias might have played a role in the main analysis.

Other cost categories and total societal costs did not differ between groups. Since CIs were rather wide for total societal costs, we assume that the study might be underpowered to detect a meaningful difference in aggregate costs between the groups. This is due to the sample size calculation of the primary trial, which was aimed at demonstrating non-inferiority for the DASH.[15]

For both outcomes (i.e. HRQoL and upper extremity function), the maximum probability of reduced imaging being cost effective compared with usual care is relatively high. For HRQoL, the probability of reduced imaging being cost effective when compared to usual care was 0.8 at a willingness to pay of €20 000/QALY, which is deemed acceptable in the Netherlands.[33] Based on these results, we consider the intervention cost effective for QALYs. As a willingness to pay threshold is lacking for functional outcome, we cannot draw any conclusions about the intervention's CE; however, functional outcome seem unaffected by the intervention.[15]

Strengths and limitations

These results are based on a large, multicentre randomised study; therefore, the results may be considered generalisable to similar populations as ours.[21] For other settings or regions than the one studied, generalisability may be lower. Additionally, the use of seemingly unrelated regression analyses of the cost and effect differences can be considered a strength because this method diminished the influence of a possible correlation between effects and costs.[27] This study, however, had some limitations. First, effect measures and some cost measures were gathered through questionnaires with a maximum recall period of 26 weeks, therefore potentially introducing recall bias. However, the recall period was similar in both groups, and therefore, this is likely to be non-directional. A second limitation may have been introduced through missing data; that is, in 75% (255/341) of the patients, one or more cost and/or effect measure items were missing from one of the follow-up moments. This limitation was dealt with using multiple imputation. This is considered the gold standard in dealing with missing data in economic evaluations, as it deals with uncertainty about the missing data by the creation of multiple imputed data sets.[26] Moreover, a sensitivity analysis showed no noteworthy difference in ICER values when only the 86 cases with complete

data were analysed. A third limitation concerns the fact that we used the estimated value for the EQ-5D-3L utility score in the first 6 weeks. We used this because we asked participants for their utility score prior to the fracture instead of the utility score immediately following the fracture. As a result, the measured utility score would have overestimated the patients' functionality in the first 6 weeks following the trauma. The utility score at week 6 was deemed to be a more accurate reflection of the patients' actual utility during the first 6 weeks, since most patients were immobilised in a cast for 4–6 weeks. We do not expect this estimation to have biased our results because a sensitivity analysis using the measured values for the baseline utility score showed similar results as the main analysis.

CONCLUSION

Implementing a reduced imaging protocol in the follow-up of distal radius fractures has a high probability of being cost effective. Moreover, reduced imaging did not lead to a decreased functional outcome for patients with a distal radius fracture. We, therefore, recommend imaging when clinically indicated, and not according to a rigid protocol.

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Contributors PvG: acquisition of data, analysis of data, interpretation of data, drafting of the primary manuscript and revising the manuscript based on coauthor's comments. JMvD: analysis and interpretation of data, revising the manuscript. SMR, MFT, MEM, WZ and IBS: conceptualisation and design of the study, revising the manuscript. PK and MWvt: conceptualisation and design of the study, interpretation of data and revising the manuscript. All authors approved the final version, and agree to be accountable for the accuracy and integrity of the work.

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