Effects of Age on Responsiveness to Adjunct Hypnotic Analgesia During Invasive Medical Procedures

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Objectives: To assess the effects of age on responsiveness to self-hypnotic relaxation as an analgesic adjunct in patients undergoing invasive medical procedures. **Material and Methods:** Secondary data analysis from a prospective trial with 241 patients randomized to receive hypnosis, attention, and standard care treatment during interventional radiological procedures. Growth curve analyses, hierarchical linear regressions, and logistic regressions using orthogonal contrasts were used for analysis. Outcome measures were Hypnotic Induction Profile scores, self-reported pain and anxiety, medication use, oxygen desaturation ≤89%, and procedure time. **Results:** Hypnotizability did not vary with age ($p = .19$). Patients receiving attention and hypnosis had greater pain reduction during the procedure ($p = .02$), with trends toward lower pain with hypnosis ($p = .07$); this did not differ by age. As age increased, patients experienced more rapid pain control with hypnosis ($p = .03$). There was more rapid anxiety reduction with attention and hypnosis ($p = .03$). Trends toward lower final anxiety were also observed with attention and hypnosis versus standard care ($p = .08$), and with hypnosis versus attention ($p = .059$); these relationships did not differ by age. Patients requested and received less medication and had less oxygen desaturation ≤89% with attention and hypnosis ($p < .001$); this did not differ by age. However, as age increased, oxygen desaturation was greater in standard care ($p = .03$). Procedure time was reduced in the attention and hypnosis groups ($p = .007$); this did not vary by age. **Conclusions:** Older patients are hypnotizable and increasing age does not appear to mitigate the usefulness of hypnotic analgesia during invasive medical procedures. **Key words:** monitored anesthesia care, hypnosis, behavioral analgesia, older adults, surgery, interventional radiology.

ln = natural log; **REML** = restricted maximum likelihood; **mg** = milligram; **μg** = microgram; **ASA Class** = American Society of Anesthesiologists Physical Status Classification; **HIP** = Hypnotic Induction Profile.

INTRODUCTION

One third of surgeries in the United States are performed on patients age ≥65 years (1), with the trend to increase in an aging population. The risk of peri- and postoperative complications (2,3), cognitive impairment (4,5), and mortality is much greater among older than younger adults (2–5), in part due to their reduced tolerance for anesthetic medications. Some risk can be reduced by the use of percutaneous image-guided, "minimally invasive" surgical procedures that are replacing more traditional open surgery when possible. These procedures are less invasive than open surgery, typically do not require general anesthesia, and customarily involve intravenous conscious sedation using narcotics and sedatives. These drugs, indicated for management of pain and anxiety, can also induce untoward effects including cardiovascular depression, hypoxia, apnea, delirium, and death, even in therapeutic dosages (6). Thus, a nonpharmacologic analgesic method that could provide comfort and reduce the need for sedating drugs is expected to diminish procedural morbidity and mortality.

Hypnosis has proven to be a beneficial adjunct for procedures including breast biopsy (7), general surgery (8), open heart surgery (9), and plastic surgery (10). It has been associated with reductions in postoperative hospital stay (11), analgesic use (10), pain and anxiety (12), and nausea and vomiting during and after surgery (10). Surgical hypnosis studies have generally included patients with wide age ranges (8,13); however, age effects have not been specifically addressed.

Little is known about the ability of older adults to respond to hypnosis in the procedural setting, although it has been popularly conjectured that older adults are less able to be hypnotized (14). Hypnotizability is a trait-like characteristic involving suggestibility and capacity to dissociate, and has been related to success of hypnosis (15). Intact cognitive function and the ability to concentrate are considered prerequisites for hypnosis (16). Although early studies reported age-related declines in hypnotizability (17), recent research showed stability of hypnotizability over a 25-year period (18).

This study was performed to clarify the effect of age on responsiveness to a self-hypnotic relaxation intervention during invasive medical procedures in the vasculature and kidneys. It is a secondary analysis of data derived from the Nonpharmacological Analgesia for Invasive Procedures trial (19). The purpose of the present study was to investigate a) if hypnotizability is preserved in older adults and b) if they can benefit from hypnosis as an analgesic adjunct during invasive medical procedures as well younger patients. We hypothesized that advanced age does not prevent the benefit of re-

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duced pain, anxiety, medication use, oxygen desaturation, and procedure time with hypnosis.

METHODS

This study was approved by the Institutional Review Board of the University of Iowa. Patients >18 years of age awaiting percutaneous diagnostic and therapeutic peripheral vascular and renal interventions were eligible for the study. Patients were excluded for severe chronic obstructive pulmonary disease, psychosis, intolerance of midazolam or fentanyl, pregnancy, and inability to hear or understand English. Patients were recruited between 1997 and 1998. Of 336 consecutive patients who were eligible for the study, 66 declined participation, 13 did not pass the Mini-Mental State Exam, and 16 became ineligible because their procedures were canceled, leaving a study group of 241 patients. Slightly over half (53%) of the participants were women, with an age range from 18 to 92 years (median = 56 years). There were no patient withdrawals from the study. A flowchart of patient assignment is presented in the study by Lang et al. (19).

Procedure

Full details of the procedure have been previously discussed by Lang et al. (19). The patients were invited to participate in a study to assess if relaxation would enhance comfort during invasive procedures. The participants signed a written informed consent and were then screened with the Mini-Mental State Exam (20). Those passing the cut-off point of 26 were randomized to hypnosis, structured empathic attention, or standard care treatments. Standard care patients were attended by special procedure nurses from the Interventional Radiology department trained in conscious sedation according to hospital guidelines. The nurses were instructed to behave normally, to provide comfort when necessary, and to abstain from hypnosis or imagery. Empathic attention providers used specific procedures outlined below, with the goal of controlling for social interaction but not inducing hypnotic relaxation. Hypnosis providers utilized structured empathic attention procedures along with a standardized self-hypnotic relaxation induction. To ensure that the operating team was blind to patient condition, the same trained clinicians provided either hypnosis or attention, wearing scrubs, and sitting close to the patient's head throughout the procedure. The surgical team could not hear conversations between clinician and patient, thus minimizing the likelihood that the medical team would be aware of which experimental condition (attention or hypnosis) was being used. Hypnotizability was measured with the Hypnotic Induction Profile (HIP) after recovery from the interventional radiology procedures to avoid biasing the experimental treatments.

All patients had access to patient-controlled analgesia/sedation using a dosage regimen customary for these types of procedures. For each request, 0.5 mg of midazolam plus 25 μg of fentanyl was provided up to four times, with a lockout time of 5 minutes between requests. After the fourth request, a lockout time of 15 minutes was used. Pulse oximetry, heart rate, and electrocardiac tracing was performed continuously and blood pressure measurement was obtained every 15 minutes during and after the procedure. Any cardiovascular reaction that needed treatment or interruption of the procedure was defined as hemodynamic instability. Adverse effects, such as prolonged new-onset bradycardia, new-onset cardiac arrhythmia, and oxygen desaturation $\leq$89% that persisted beyond a few breaths despite oxygen per nasal prongs, were recorded.

Structured attention and hypnosis interventions were manualized (21) and have been previously described (19). Eleven specific provider behaviors were prescribed for the structured attention and hypnosis conditions. Components used in both conditions included matching the patient's verbal and nonverbal communication patterns; listening; providing the perception of control; responding rapidly to patient requests; encouraging; using emotionally neutral descriptors; and avoiding negative suggestions. In addition, patients in the hypnosis condition were read a standardized induction script involving an eye-roll induction accompanied by self-generated imagery to assist patients in focusing on a safe and pleasant experience during the procedure. The script also included provisions for addressing anxiety and pain if needed. All procedures were videotaped, and 55 tapes (23%) were randomly selected and rated for provider adherence to protocol (19).

Assessments

Hypnotizability was measured by the Hypnotic Induction Profile (HIP) (22). This 5- to 10-minute screening tool measures a range of hypnotic phenomena after a standardized hypnotic induction. Test items include eye roll, hand levitation, an experience of dissociation of the levitated hand, tingling, amnesia, and a sensory alteration of floating (16,22). The total HIP score was used in analyses. Hypnotizability was tested after the patients had recovered from the procedure to avoid bias and exposure to hypnotic experiences before the procedure. This assessment was completed on 207 patients.

The Mini-Mental State Exam (20), a common screening tool for cognitive disorders and mental status, was used to screen for adequate mental ability for trial inclusion.

Pain and anxiety were assessed by verbal self-report on numerical scales of 0 to 10 before the procedure and every 15 minutes during the procedure. Descriptive anchors were 0 = "no pain at all" and 10 = "worst pain imaginable," and 0 = "no anxiety at all" and 10 = "terrified." These validated verbal analog scales are highly correlated with visual analog anxiety and pain scales (23). Analog scales correlate well with other pain measures, are sensitive to change, and have demonstrated success with older adults (24).

Disease status, type and technical complexity of procedures, American Society of Anesthesiologists Physical Status Classification (ASA Class), procedural time, and adverse effects were documented from medical records. Medication use was calculated in medication units by designating 1 mg of midazolam = 1 U and 50 μg of fentanyl = 1 U. Summed scores representing total medication requested and received during the procedure were used.

Statistical Analysis

The main effects of the interventions were reported in our initial publication (19).[1] The current analyses report on the effects of age on these data.[2] Before analysis, logarithmic transformations were applied where necessary to remove skewness from the data ($ln(x + 1)$, or $ln(x)$ if x could not be 0); however, all results are presented in terms of the original scales (25). Residuals appeared normally distributed and no outliers were identified. χ^2 tests and analyses of variance were used to establish equivalence between experimental conditions at baseline on possible confounding variables. Pearson correlations tested the relationship between hypnotizability and age with the other outcome variables.

For pain and anxiety, analyses were designed to examine the effects of age and treatment group on a) the rate of change in pain and anxiety over time during the procedure and b) pain and anxiety outcomes at the end of the procedure, as pain is known to increase over time during the procedures (19). To test changes in pain and anxiety over time, a growth curve analysis examined pain scores over the course of treatment (Proc Mixed, SAS Institute, Cary, NC). For each dependent variable, two orthogonal contrasts were modeled after the pattern of analyses in the original Lancet paper. Contrast 1 tested for differences between standard care and the two experimental treatment conditions. Contrast 2 tested for differences between the two experimental treatment conditions (attention versus hypnosis). Age was used as a covariate in all analyses. To minimize the correlation between the main and interaction effects involving age, the standardized score for age (mean = 0, standard deviation (SD) = 1.0) was employed in all analyses. Analyses were conducted using the following predictors: standardized age, time of assessment, the two orthogonal contrasts, and the following two-way interactions: time of assessment and the two orthogonal contrasts, age and time of assessment, and age and each contrast. Three-way interactions between age, time of assessment, and the two contrasts were also added. For significant interactions, simple effects were tested within each of the three treatment conditions. Based on the possible relationship between hypnotizability and pain and anxiety reduction in the literature (15), hypnotizability was tested for inclu-

[1]One patient in the original Lancet study was misidentified as hypnosis but was actually in the standard group. None of the conclusions of the original study are affected in the reanalysis.

[2]They differ from those reported in the Lancet study because they are based on preprocedural reports of pain and anxiety, rather than the report at 15 minutes into the procedure used in the Lancet paper.

sion as a covariate for all models and included as a covariate where it contributed at least marginally ($p < .10$) to the variance of the equations.

To determine the effects of age on pain and anxiety outcomes at the end of the procedures, hierarchical linear regression analyses were performed to model the contributions of standardized age as a continuous variable, treatment, and the interaction of age with treatment condition to pain and anxiety at the end of the procedure. Baseline scores in pain or anxiety were used as covariates in these models. These analyses were performed in SPSS version 14.0 (Statistical Package for the Social Sciences, Chicago, IL). For each dependent variable, the two orthogonal contrasts and interactions between age and each contrast were modeled. Similar models were used for medication given, medication received, and procedure time. For oxygen desaturation ≤89%, a logistic regression was performed, entering the standardized age score, treatment group (Contrast 1 or Contrast 2), and the interactions of the standardized age score by the contrasts as predictors.

For illustrative purposes in figures, a cut point of ≥60 as "older" is used. This is based on reports of increasing perioperative and postsurgical morbidity and mortality in adults after age 60 (26,27), and to provide a relatively equal distribution of patients for graphing.

RESULTS

Patients

Mean subject age, disease status, ASA Class, type of procedure, baseline pain, and anxiety levels did not differ significantly between the treatment conditions (all p values $>.60$) (Table 1).

Relationship Between Age and Hypnotizability

The average level of hypnotizability was moderate, falling in the middle range of the HIP scale (mean HIP score = 5.40, SD 2.81, range 0–10). There was no relationship between age and hypnotizability, $r = -0.09$, $p = .19$ (Figure 1). Furthermore, there was no significant relationship between hypnotizability, final pain scores, final anxiety scores, medication requested, medication received, or oxygen desaturation for the group as a whole (all p values $>.43$). Hypnotizability also did not moderate the impact of the treatment conditions on pain or anxiety over time ($p \geq .38$).

TABLE 1. Patient Characteristics

Subject Characteristics	Standard Care	Attention	Hypnosis
Patients, *n*	80	80	81
Age (years), median	56.5	56.5	54.0
Range	18–92	18–84	19–82
Weight (kg), median	73	78	78
Range	43–116	40–140	45–144
Male, %	44	48	47
Procedure (%)			
Arterial	60	69	63
Venous	24	21	21
Nephrostomy	16	10	16
Disease category[a]			
Category 1	24	34	25
Category 2	42	37	43
Category 3	12	8	10
Category 4	2	1	3
ASA Class, mean	2.20	2.23	2.25
Baseline pain (mean ± SD)	2.15 ± 3.05	1.84 ± 2.63	1.84 ± 2.44
Baseline anxiety (mean ± SD)	3.48 ± 2.58	3.83 ± 3.05	3.81 ± 2.70

ASA Class = American Society of Anesthesiologists Physical Status Classification: 1 = healthy patient; 2 = mild systemic disease; 3 = severe systemic disease; 4 = threat to life. Pain: 0 = "no pain at all" and 10 = "worst pain imaginable." Anxiety: 0 = "no anxiety at all" and 10 = "terrified."

[a] Disease categories: 1 = benign, no threat to limb or life; 2 = benign, threat to limb or organ, no threat to life; 3 = malignant; 4 = acutely life-threatening.

Pain Changes Over Time

A growth curve analysis examined pain scores over the treatment course. The independent variables were time of assessment, treatment (Contrast 1: standard care versus the two experimental interventions; Contrast 2: attention versus hypnosis), age, the two-way interactions of the contrasts and age with time of assessment, and the three-way interaction of the contrasts with age and time of assessment. As shown in Table 2, for pain, there was a significant main effect of time of assessment ($\beta = 0.147$, $p < .001$) and a significant main effect of age ($\beta = -0.11$, $p = .01$), indicating that pain overall increased with the length of procedures, and decreased as age increased. The Contrast 1 by time ($\beta = -0.06$, $p = .08$) and the Contrast 2 by time interactions ($\beta = -0.06$, $p = .08$) were not significant but showed trends for differential pain over time in the experimental groups. The slope for pain over time in the standard care group was 0.24 ($p < .001$), in the attention group was 0.20 ($p < .001$), and in the hypnosis group was 0.05 ($p = .48$), indicating that there were significant increases in pain over time in both the standard care and attention groups but not in the hypnosis group. The three-way interaction between time of assessment, age, and Contrast 2 was significant ($\beta = -0.09$, $p = .01$). Analyses of simple effects indicated a significant interaction between time of assessment and age in the hypnosis condition ($\beta = -0.16$, $p = .03$), with the negative slope indicating that in this group as age increased, pain declined more rapidly over time. This suggests that the efficacy of hypnosis for pain reduction increases with age. In contrast, the age by time interactions were nonsignificant in the other two conditions ($p \geq .27$) indicating that the rate of pain reduction during the procedure was not affected by age in either the standard care or attention conditions. The three-way interaction between time of assessment, age, and Contrast 1 was not significant ($p = .92$). Figure 2 illustrates the trajectories of pain scores as a function of procedure time for older (≥60 years) and younger (<60 years) patients in each group. The procedures for all patients receiving hypnosis were completed by 150 minutes; the trajectories for attention and standard care are erratic thereafter as they are based on a smaller number of cases.

Pain Outcomes

A hierarchical linear regression examined pain scores at the end of the procedure, adjusting for baseline pain, with independent variables as the two orthogonal contrasts, age, and the interaction of these contrasts with age. There was no significant main effect of age ($\beta = -0.04$, $p = .54$). However, baseline pain ($\beta = 0.33$, $p < .001$) and Contrast 1 ($\beta =$

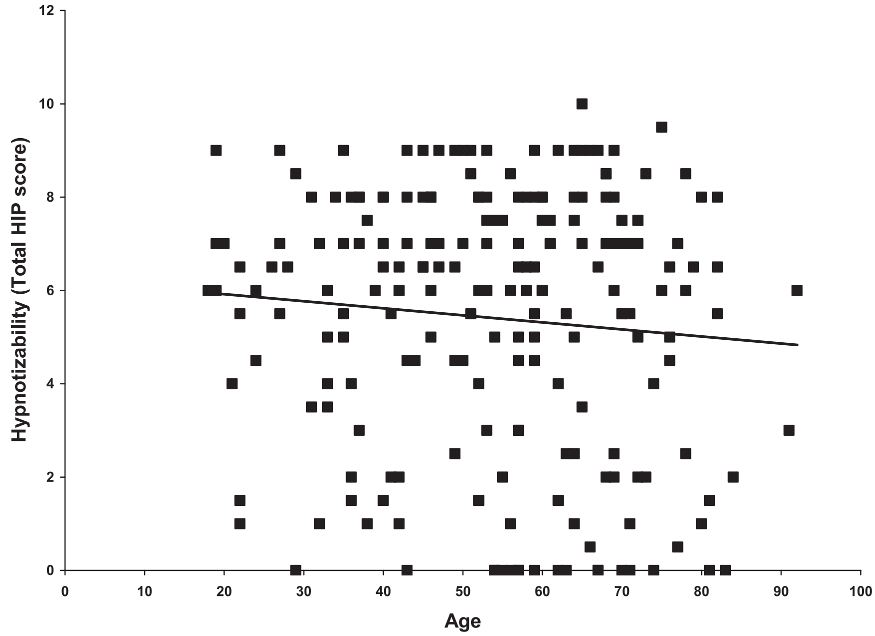

Figure 1. Scatterplot of hypnotizability by age. The slope of the regression line is −0.09, suggesting that there is a minimal relationship between age and hypnotizability.

TABLE 2. Summary of Growth Curve Analysis for Variables Predicting Pain Over Time

	Unstandardized B	SE B	Standardized β	p
Time	0.012	0.003	0.170	<.001
Age	−0.155	0.153	−0.116	.01
Contrast 1	−0.002	0.106	−0.068	.14
Contrast 2	0.179	0.186	−0.020	.67
Time × age	−0.004	0.003	−0.051	.16
Contrast 1 × age	−0.012	0.105	−0.010	.83
Contrast 2 × age	0.278	0.194	−0.027	.57
Time × Contrast 1	−0.003	0.002	−0.060	.08
Time × Contrast 2	−0.006	0.003	−0.063	.08
Time × Contrast 1 × age	0.000	0.002	−0.003	.92
Time × Contrast 2 × age	−0.009	0.004	−0.094	.01

Contrast 1 = Standard care versus attention and hypnosis; Contrast 2 = attention versus hypnosis. With this type of growth curve analysis, there is a measure of explained variance (R^2) at both the within-patient (time of assessment) and between-patient levels. (49) For the present model, the explained variance at both of these levels was 0.12.

−0.14, p = .02) significantly predicted final pain, with lower levels of final pain in attention and hypnosis groups as compared with standard care. Contrast 2 was not significant, although there was a trend toward lower final pain with hypnosis ($\beta = -0.11$, $p = .07$). There was no interaction of age with either contrast in predicting pain outcomes (both p values >.30), indicating that these findings did not differ by age (Table 3).

Anxiety Changes Over Time

Anxiety outcomes were modeled in a similar fashion. As seen in Table 4, there was a significant main effect of time of assessment ($\beta = -0.27$, $p < .001$), age ($\beta = -0.13$, $p = .009$), and a significant interaction between time of assessment and Contrast 1 ($\beta = -0.07$, p=.03). This indicates that anxiety decreased for all patients over time and that overall anxiety was significantly lower with age. Patients in the attention group ($\beta = -0.27$, $p < .001$) and patients in the hypnosis group ($\beta = -0.39$, $p < .001$) had more rapid decreases in anxiety over time than patients in the standard care group ($\beta = -0.18$, $p = .001$). The interaction between the time of assessment and Contrast 2 was not significant ($\beta = -0.05$, $p = .16$), indicating that there was not a significant difference between the hypnosis and attention groups in the rate of anxiety reduction over time. The patient's age did not interact significantly with either time of assessment, treatment, or the time of assessment by treatment effects, indicating that the age did not moderate the impact of these variables on anxiety. Figure 3 illustrates the trajectories of anxiety scores as a function of procedure time.

Anxiety Outcomes

Final levels of anxiety were modeled similarly to those for pain. As seen in Table 5, age did not contribute significantly to the model ($p = .31$), but baseline anxiety was a highly significant predictor of final anxiety ($\beta = 0.34$, $p < .001$). Contrasts 1 and 2 were not significant (Contrast 1: $\beta = -0.10$, $p = .086$; Contrast 2: $\beta = -0.11$, $p = .06$), but indicated a trend for patients receiving attention or hypnosis to have less final anxiety as compared with standard care, and a trend for patients receiving hypnosis to have lower anxiety outcomes than those receiving attention. Neither age by contrast interaction was significant, indicating that these findings did not differ by age.

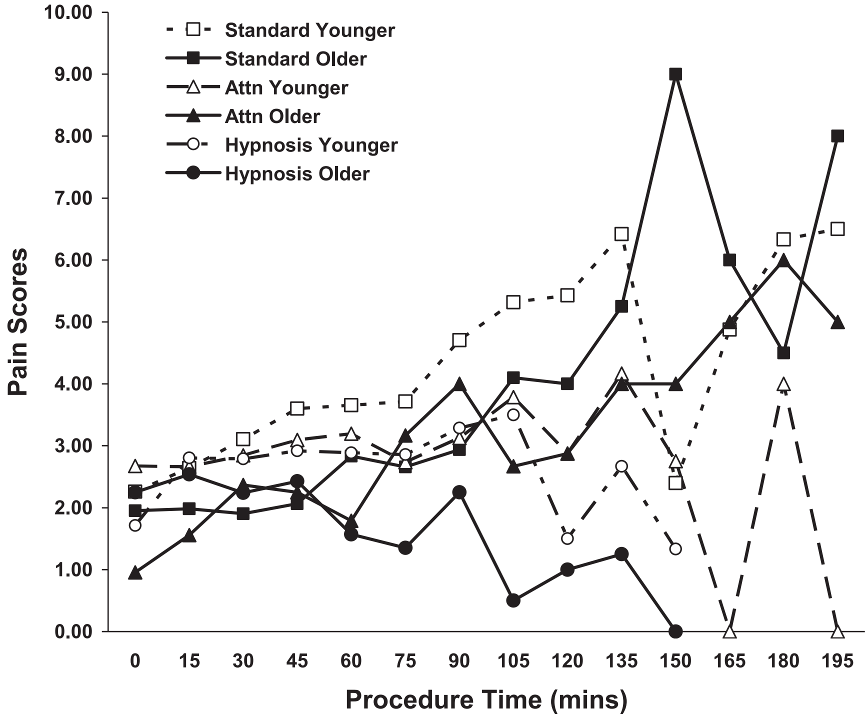

Figure 2. Mean pain score (range 1–10) as a function of procedure time for younger (<60) and older (>60) patients in standard care, attention, and hypnosis treatments. All procedures for the hypnosis group were completed by 150 minutes. Mean scores for data points after 105 minutes are based on <10 patients per group.

TABLE 3. Summary of Hierarchical Regression Analysis for Variables Predicting Final Pain Levels

	Unstandardized B	SE B	Standardized β	p
Step 1				
Age	−0.12	0.19	−0.038	.54
Pain at baseline	0.38	0.07	0.34	<.001
Step 2				
Age	−0.14	0.18	−0.05	.45
Pain at baseline	0.37	0.07	0.33	<.001
Contrast 1	−0.30	0.13	−0.14	.02
Contrast 2	−0.41	0.22	−0.11	.07
Step 3				
Age	−0.16	0.19	−0.05	.39
Pain at baseline	0.38	0.07	0.34	<.001
Contrast 1	−0.31	0.13	−0.14	.02
Contrast 2	−0.42	0.23	−0.11	.06
Contrast 1 × age	0.04	0.13	0.02	.75
Contrast 2 × age	−0.23	0.24	−0.06	.34

$R^2 = 0.12$ for Step 1 ($p < .001$); $\Delta R^2 = 0.03$ for Step 2, ($p = .013$); $\Delta R^2 = 0.004$ for Step 3 ($p = .58$).

TABLE 4. Summary of Growth Curve Analysis for Variables Predicting Anxiety Over Time

	Unstandardized B	SE B	Standardized β	p
Time	−0.020	0.003	−0.269	<.001
Age	−0.414	0.155	−0.130	.008
Contrast 1	0.024	0.107	−0.071	.82
Contrast 2	−0.080	0.187	−0.078	.67
Time × age	0.001	0.003	0.014	.62
Contrast 1 × age	−0.136	0.105	−0.008	.20
Contrast 2 × age	0.058	0.200	0.015	.77
Time × Contrast 1	−0.004	0.002	−0.074	.03
Time × Contrast 2	−0.004	0.003	−0.049	.16
Time × Contrast 1 × age	0.003	0.002	0.056	.10
Time × Contrast 2 × age	0.000	0.003	−0.002	.96

Contrast 1 = Standard care versus attention and hypnosis; Contrast 2 = attention versus hypnosis. Explained variance (R^2) was 0.19 at the within-patient level and 0.12 at the between-patient level.

Medication Requested and Received

Hierarchical linear regressions were conducted for medication requested and received. Medication requests were significantly lower with age ($\beta = -0.23$, $p < .001$). Patients in the attention and hypnosis groups requested significantly less medication compared with the standard care group (Contrast 1; $\beta = -0.24$, $p < .001$) but there was no difference between attention and hypnosis groups in medication requests ($\beta = 0.009$, $p = .89$). There were no significant interactions of age with either contrast ($p > .34$), indicating that the effects of these interventions on medication requests did not differ with age.

A similar inverse relationship was seen between age and medication received ($\beta = -0.22$, $p = .001$). For every increase of 16.51 (1 SD) years in age, the medication received decreased by 0.22 units. Additionally, patients in the attention and hypnosis groups received less medication than those in standard care (Contrast 1; $\beta = -0.26$, $p < .001$) but there was no difference in medication received between the attention

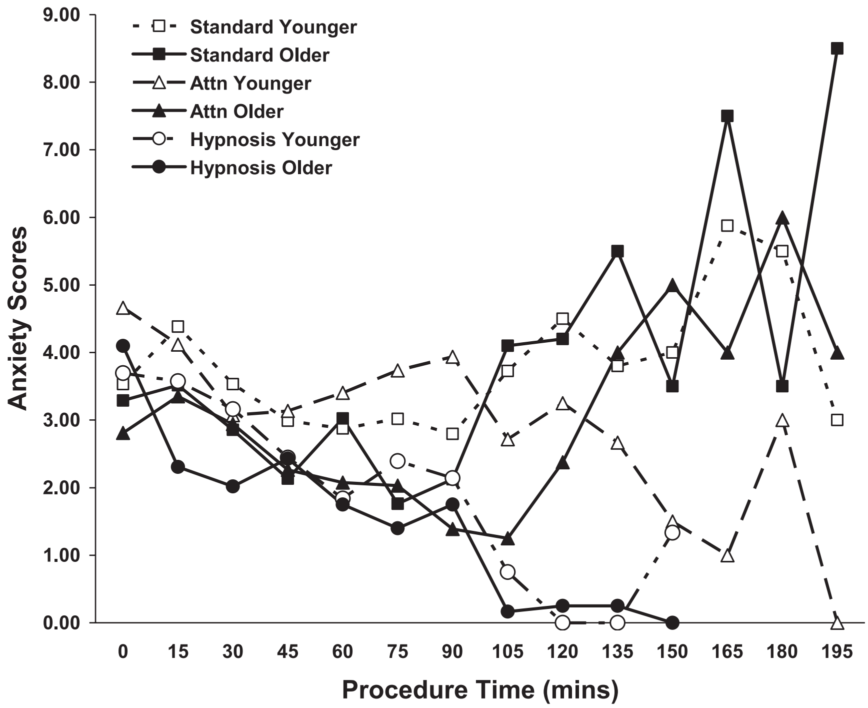

Figure 3. Mean anxiety score (range 1–10) as a function of procedure time for younger (<60) and older (>60) patients in standard care, attention, and hypnosis treatments. (range 1–10). All procedures for the hypnosis group were completed by 150 minutes. Mean scores for data points after 105 minutes are based on <10 patients per group. For illustrative purposes, we use a cut point of 60 and above as "older" for the purposes of illustration.

TABLE 5. Summary of Hierarchical Regression Analysis for Variables Predicting Final Anxiety

	Unstandardized B	SE B	Standardized β	p
Step 1				
Age	−0.17	0.16	−0.06	.31
Anxiety at baseline	0.32	0.06	0.34	<.001
Step 2				
Age	−0.18	0.16	−0.07	.26
Anxiety at baseline	0.33	0.06	0.34	<.001
Contrast 1	−0.19	0.11	−0.10	.09
Contrast 2	−0.37	0.19	−0.11	.06
Step 3				
Age	−0.16	0.16	−0.06	.34
Anxiety at baseline	0.33	0.06	0.35	<.001
Contrast 1	−0.20	0.11	−0.11	.08
Contrast 2	−0.36	0.20	−0.11	.06
Contrast 1 by age	0.14	0.11	0.08	.20
Contrast 2 by age	0.07	0.21	0.02	.75

$R^2 = 0.12$ for Step 1 ($p < .001$); $\Delta R^2 = 0.02$ for Step 2, ($p = .039$); $\Delta R^2 = 0.006$ for Step 3 ($p = .43$)

and hypnosis groups ($\beta = -0.01$, $p = .85$), and there was no contrast by age interaction for medication received ($p > .53$). Although it might be argued that the reason that older patients use less medication is that they weigh less and therefore need less medication, these analyses were repeated treating weight as a covariate, and the same age-related differences in medication requested and received remained significant at the $p < .001$ level.

Procedure Duration

There was no main effect of age on procedure duration ($p = .54$). Patients in the attention and hypnosis groups had significantly shorter procedures than those in the standard care group (Contrast 1; $\beta = -0.17$, $p = .007$) but there was no difference in procedure time between the attention and hypnosis groups ($p = .18$). There was no contrast by age interaction for procedure time ($p > .86$), indicating that effects of the interventions on procedure time did not vary with age.

Oxygen Desaturation

Among the older adults, age was not significantly related with oxygen desaturation at levels ≤89%. Oxygen desaturation was significantly more frequent in standard care than in the attention or hypnosis groups (Wald statistic = 16.91, $p < .001$) but there were no differences between the attention and hypnosis groups ($p = .34$). There was a trend toward an interaction between age and Contrast 1 ($p = .063$). A follow-up simple effects test indicated that as age increased in the standard care condition, oxygen desaturation also increased ($p = .03$). In the standard care condition, for each increase in 16.51 years in age, the odds of having oxygen desaturation increased by 7.6%. There was no interaction between age and Contrast 2. To further illustrate these relationships, oxygen desaturation was examined in older (≥60 years) and younger (<60) patients. Among the older patients, the relationship of treatment condition and oxygen desaturation was statistically significant, χ^2 (2, $n = 91$) = 19.29, $p < .001$. Thirteen (41%) of the 32 patients experienced oxygen desaturation in standard care as compared with two (5%) of 37 patients in the attention and one (4%) of 27 patients in the hypnosis groups. Among the younger patients, this relationship was nonsignificant (p = .10). Nine (20%) of the 46 patients experienced oxygen desaturation <89% in standard care as compared with two (5%) of 42 and six (11%) of 53 patients in attention and hypnosis groups, respectively.

DISCUSSION

The findings of this study extend available literature by demonstrating that age does not appear to diminish the benefits from hypnotic analgesia during a percutaneous medical procedure. Specifically, hypnotic analgesia helps control pain and anxiety, reduces medication requested and received, reduces oxygen desaturation, and shortens the procedure time in all patients, independent of age. Furthermore, as age increases, the pain reduction with hypnosis is achieved more rapidly. As several of these factors contribute to perioperative complications in the elderly (6), our findings suggest that hypnotic analgesia can potentially reduce the risk of procedural complications among the older adults.

As anxiety is known to increase the perception of pain (28), blood pressure, and heart rate (29) and highly anxious patients generally require greater amounts of anesthesia (30), these findings have implications for standard medical practice among the elderly. In addition, patients with greater preoperative anxiety tend to have longer hospitalizations, greater postoperative complications, and poorer adherence to postoperative treatment regimens (31). Higher levels of distress can also impede wound healing, suggesting a specific pathway by which perioperative distress may contribute to postsurgical morbidity (32). Therefore, interventions such as hypnosis or empathic attention that can decrease perioperative pain and anxiety have substantial potential to affect psychological as well as physiological postoperative recovery in the elderly.

Despite a trend toward superiority in pain control in the hypnosis versus attention group, the use of pain medication decreased with both interventions and did not differ between them. Therefore, both interventions serve the important clinical function of reducing the use of pain medication, but only hypnosis provided a trend toward differential comfort and provided more rapid comfort as age increased.

In standard care, 41% of older patients experienced oxygen desaturation ≤89%. Although this may not necessarily be immediately threatening, greater prevalence of cerebrovascular occlusive disease puts older patients at higher risk for adverse cerebral effects with oxygen desaturation (33,34). Reduction of episodes of oxygen desaturation to 5% with attention and to 4% with hypnosis is thus a highly desirable outcome for this age group. All patients, regardless of age, experienced similar benefits of reduced procedure time from hypnosis. Financial and safety implications of reduced procedure time have been previously discussed (19,35).

Hypnotic analgesia is thought to work by inducing a state of heightened and focused concentration (16). Pathways underlying hypnotic analgesia may include both cortical mechanisms (36–39) as well as descending inhibitory mechanisms associated with the spinal cord (40). Some researchers cite analogies between hypnotic experience and the disinhibition associated with reduced frontal lobe function that can accompany aging (41), although hypnotic performance is more often associated with flexibility in activation or suppression of perception and cognition (16,37,42,43) as well as concentration and information processing strategies (44–46). Although some diminution in these cognitive abilities in the elderly has been reported (47), our findings suggest that in a population that includes elderly individuals who receive medical procedures with minimal cognitive screening for eligibility, these capacities were sufficiently preserved for the induction of hypnotic analgesia.

The reasons for more rapid pain decline with age among patients receiving hypnosis are unclear. This may involve greater compliance or responsiveness to the demand characteristics of the setting among older adults. To our knowledge, this has not previously been observed, and potential mechanisms underlying this effect are worth exploring. Given our observation of the independence of hypnotizability and age, this finding would not appear to be secondary to age-related changes in hypnotizability. Reports of declines in hypnotizability with age were derived from early studies among hospitalized or nursing home patients (17) and may have reflected physical or cognitive debility. Our findings are consistent with more recent observations of stability of hypnotizability over time (18).

Hypnotizability was not related to pain reduction. This finding contrasts with the meta-analysis by Montgomery and colleagues, who reported a link between hypnotizability and pain reduction; however, this connection was strongest when individuals highest in hypnotizability were compared with those lowest in this trait (15). Patients in the current study were moderate in hypnotizability, which may account for the differences in findings. In addition, a more recent meta-analysis by Montgomery and colleagues showed that patients can benefit from hypnotic analgesia during surgery regardless of their level of hypnotizability (48). The present study involved acute pain and anxiety control in a medical setting that likely evokes maximal concentration from subjects, who are undergoing invasive procedures in a potentially life-threatening situation. Other studies of hypnosis in pain control tend to involve chronic pain or milder acute pain under less anxiety-provoking circumstances, which may allow trait differences in hypnotizability to emerge in relation to treatment response.

Limitations

It should be noted that patients were not totally blind to the experimental condition. Attempts were made to minimize demand characteristics of the intervention by using the word "relaxation" rather than "hypnosis" to describe the experimental intervention and by using the same professionals for both the attention and hypnosis conditions. However, patient expectations for "relaxation" cannot totally be ruled out as influencing these results. Although attention and hypnosis did not differ markedly in their effects, the superiority of hypnosis for pain control in older adults is noteworthy even in light of both interventions effecting decreased medication usage.

Many findings of this study are interpreted as "affirming the negative"—that is, lack of interaction effects are used to support the contention that age does not moderate the effectiveness of hypnosis as an analgesic adjunct in the interventional radiology setting. Although it could be argued that, with a larger sample, some age-related moderation might appear, it should be noted that most of the interaction effects were negligible. Moreover, this is one of the largest studies of its kind to date, using 241 subjects; thus, if moderation effects were substantial, we would expect to have detected them here.

Another limitation of this study may be the inclusion of only patients with a Mini-Mental State Exam score >25. However, only 13 (5%) of 270 otherwise eligible candidates were excluded from the study on this basis. Although this may limit the generalizability of our findings to settings with a larger percentage of mentally impaired individuals, these findings will likely hold true for the tertiary care setting.

Findings of this large-scale study indicate that age does not appear to be a factor influencing hypnotizability in the procedural setting and that older adults are hypnotizable in the procedural setting at levels comparable to those of younger adults. Furthermore, age does not seem to influence the usefulness of hypnotic analgesia in reducing anxiety, pain, medication use, oxygen desaturation, and length of surgery. Hypnosis may offer older adults benefits like controlling pain and anxiety beyond what can be offered by attention and may actually offer more rapid pain control to older adults. Given the adverse effects of analgesia and anesthesia in the elderly, these findings suggest a novel strategy that may serve as an analgesic adjunct for procedural interventions among the elderly.

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