

WE investigated the serum concentration of endostatin in 84 patients with multiple myeloma (MM) and in 13 healthy controls. The level of measured anti-angiogenic agent was correlated with the phase and stage of the disease, and most importantly with clinical and laboratory parameters depicting the disease activity (haemoglobin, creatinine, albumins, calcium, M-component, C-reactive protein, β 2-microglobulin, lactate dehydrogenase, stage of bone disease) as well as serum levels of pro-angiogenic cytokines such as vascular endothelial growth factor, hepatocyte growth factor, fibroblast growth factor and transforming growth factor- β . The median serum level of endostatin in MM patients was 58 ng/ml and was statistically significantly higher than in the control group (median, 40 ng/ml; $p=0.015$). MM patients in phase I (at diagnosis) had higher levels of endostatin (median, 69 ng/ml) than those in phase II (plateau phase after treatment) (median, 49 ng/ml; $p=0.044$). We did not find any statistical correlation between the level of endostatin and stage of MM according to the Durie and Salmon system. The serum concentration of endostatin in MM patients with a normal level of albumins was significantly higher than in others with hypoalbuminaemia (median, 62 ng/ml versus 39 ng/ml; $p=0.033$). Also, patients with a normal value of lactate dehydrogenase had a higher concentration of endostatin than those with values > 425 U/l (median, 70 ng/ml versus 39 ng/ml; $p=0.019$). We did not show any statistical correlation between the concentration of endostatin and level of haemoglobin, creatinine, calcium, C-reactive protein, β 2-microglobulin and stage of bone disease. We failed to find positive or negative correlations between the level of endostatin and vascular endothelial growth factor, hepatocyte growth factor, fibroblast growth factor and transforming growth factor- β . The concentration of endostatin did not influence the probability of survival in MM patients in our study.

In conclusion, our data indicate that endostatin has a higher level in MM patients than in healthy controls. Highest values were stated in active phases of the disease (at presentation and in progression). Different clinical and laboratory parameters generally do not influence the concentration of endostatin (except albumins and lactate dehydrogenase).

Key words: Multiple myeloma, Endostatin, Angiogenic cytokines, Serum levels, Clinical significance

High serum level of endostatin in multiple myeloma at diagnosis but not in the plateau phase after treatment

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Introduction

Angiogenesis is the key process in growth and metastatic spread of neoplasms. In normal tissues blood vessel growth is minimal and angiogenesis is controlled by a balance of angiogenic stimulators and inhibitors. This balance is perturbed in tumours to favour angiogenesis either by overproduction of angiogenesis inducers or by lack of inhibitors.¹ The

shift in balance between the production of anti-angiogenic and pro-angiogenic factors is a process called angiogenic switch and it marks the onset of neovascularization, which is probably a key step during tumour progression.^{1,2} In earlier data it was suggested that the generation of anti-angiogenic compounds in the presence of primary tumour suppresses the growth of distant metastases.³

Recently, several naturally occurring inhibitors of angiogenesis have been identified. The most potent

of them appears to be endostatin, the 20 kDa C-terminal proteolytic fragment of the basement membrane component collagen XVIII, isolated by O'Reilly *et al.*⁴ Endostatin is implicated in the regulation of physiological and pathological angiogenesis. Its precise mechanism of action is still unclear. Endostatin inhibits endothelial cell proliferation *in vitro*.^{5,6} Different investigators have proposed the interference of endostatin with such pro-angiogenic cytokines as vascular endothelial growth factor (VEGF) and fibroblast growth factor (FGF) (basic fibroblast growth factor (bFGF)) pathways,⁷ induction of endothelial cell apoptosis,^{8,9} inhibition of matrix metalloproteases,¹⁰ and inhibition of endothelial cell migration by modulating *c-myc* levels.¹¹

Endostatin possesses a prominent heparan sulphate binding domain, although it is not clear whether this domain is required for anti-angiogenic activity.^{6,12} According to MacDonald *et al.*, endostatin binds tropomyosin *in vitro* and to tropomyosin-associated microfilaments in a variety of endothelial cell types.¹³ The authors postulate that the interaction of endostatin with tropomyosin results in the disruption of microfilament integrity, leading to the inhibition of cell motility, induction of apoptosis and inhibition of tumour growth. Endostatin levels liberated into culture media and administered exogenously are decreased by hypoxia, the principal cause of angiogenesis.¹⁴

Recent successes in producing active human recombinant endostatin in yeast have allowed testing this protein in an animal model,^{15,16} *in vitro*,¹⁷ and in clinical studies.¹⁸ Endostatin was shown to induce tumour stabilization after chemotherapy or anti-CD20 immunotherapy in a mouse model of human high-grade non-Hodgkin lymphoma. Tumour growth was prevented in endostatin-treated mice as long as the drug was administered. Endostatin administered on days 25–29 after tumour re-growth still induced significant tumour regression, whereas chemotherapy and anti-CD20 immunotherapy were not effective.¹⁵ Fujii *et al.* demonstrated that endostatin inhibits multiple myeloma (MM) growth and tumour burden in the SCID-hu host system. It was reflected by a reduction in serum levels of human monoclonal immunoglobulins. Furthermore, mice bone density was preserved, as demonstrated by X-ray evaluation.¹⁹ This fact may have therapeutical implications.²⁰

There is evidence that different diseases such as connective tissue diseases, solid tumours, sarcomas and even Down's syndrome play a role in the generation of endogenous anti-angiogenic proteins, including endostatin.^{21–26} Bertolini *et al.* first reported plasma levels of endostatin in hematologic malignancies (non-Hodgkin lymphoma patients). The authors did not notice any difference between these levels in complete remission and progression of

the disease, as well as no correlation being found between endostatin levels and event-free survival.¹⁵ Kay *et al.* detected mRNA for endostatin in chronic lymphocytic leukemia (CLL) patients.²⁷

MM cells are known to secrete pro-angiogenic cytokines such as VEGF and FGF *in vitro* and *in vivo*. VEGF expression is correlated with the severity of the disease, and circulating VEGF is a prognostic factor for the survival of MM patients.²⁸ Increased angiogenesis in MM should result in high endostatin value. The role of this most potent inhibitor of angiogenesis is established on *in vitro* and animal models also in MM,^{16,19} but its clinical significance is not elucidated at present.

Recent data demonstrate that MM cells can produce anti-angiogenic as well as pro-angiogenic factors. In the present study we compare endostatin serum level in different phases and stages of MM using the enzyme-linked immunosorbent assay and correlate its concentration with pro-angiogenic cytokines such as VEGF, hepatocyte growth factor (HGF), FGF and transforming growth factor- β (TGF- β).

Patients and methods

Patients

The study group comprised 84 patients with MM and 13 healthy controls comparable for median age and gender distribution to the patient population. The patients' characteristics are presented in Table 1.

There were 43 women and 41 men with mean age 66.5 years (range, 32–88 years) in the patient group. The control group comprised seven women and six men with mean age 65.9 years (range, 47–80 years).

Table 1. Clinical and laboratory characteristics of MM patients

Clinical/laboratory feature	Number of patients (%)
Total	84 (100)
Sex (male/female)	45/43
Age (years) [median (range)]	68 (32–88)
Phase I	57 (68)
Phase II	16 (19)
Phase III	11 (13)
Stage I	20 (24)
Stage II	16 (19)
Stage III	48 (57)
Bone disease	29/77 (38)
M-protein IgG	56 (67)
M-protein IgA	13 (15.5)
M-protein light chain	13 (15.5)
Non-secretory MM	2 (2)
Creatinine > 2 mg/dl	66 (79)
Haemoglobin < 10 g/dl	39 (46)
Albumin < 30 g/l	16 (19)
Calcium < 9 mg/dl	23 (27)
Calcium > 11 mg/dl	11 (13)
LDH > 425 U/l	26 (31)
LDH < 210 U/l	10 (12)
CRP > 5 mg/l	29 (34.5)
β 2-microglobulin > 2.5 mg/l	59 (70)

Immunoglobulin (Ig)G myeloma was diagnosed in 69 patients, IgA in 13 patients, light chain disease in four patients and non-secretory myeloma in two cases. Fifty-seven patients were studied at diagnosis (phase I), 16 in the plateau (phase II) and 11 in the relapsed disease (phase III). The plateau phase was stated after 3 months of stable disease and achieving complete (disappearance or decrease of M-component > 90%) or partial (M-component decrease > 50%) remission after chemotherapy. Twenty patients were diagnosed in clinical stage I (IA, 20 patients; IB, 0 patients), 17 patients in clinical stage II (IIA, 14 patients; IIB, three patients) and 47 patients in clinical stage III (IIIA, 32 patients; IIIB, 15 patients) according to the Durie and Salmon system.²⁹ Renal failure (substage B) was diagnosed when the level of creatinine was > 2 mg/ml, and was observed in 18 patients. Advanced bone disease was stated in 29 out of 77 patients with at least multiple lytic lesions found in X-ray examination. MM patients were treated with different chemotherapy protocols adjusted to their age and clinical status. One patient received high-dose chemotherapy.

Laboratory examinations

All laboratory tests were performed on the day of blood sampling for endostatin assay. Each patient's blood sample was examined for the following parameters: complete hemogram, serum protein electrophoretogram, immunoglobulins, urea nitrogen, creatinine, calcium, lactate dehydrogenase (LDH), C-reactive protein (CRP), β 2-microglobulin, VEGF, HGF, FGF and TGF- β . Serum β 2-microglobulin levels were measured by means of a radioimmunoassay kit. Correction for renal function was not calculated. Levels of immunoglobulins, albumin and CRP were measured by nephelometry. Normal values of CRP were considered as below 5.0 mg/l. Bone marrow examination was performed in all cases, and X-ray survey of flat bones in 77 patients.

Cytokine determination

Venous blood samples were collected on the day of physical examination and laboratory tests. They were collected in pyrogen-free tubes, allowed to clot for 1 h at 4°C and centrifuged at 2000 x g for 10 min. The obtained sera were aliquoted into separate vials and stored at -80°C until assayed for endostatin and other cytokines. Sera from each patient were randomly coded and the measurement of cytokines was carried out without the knowledge of the patient's clinical status and laboratory data. The obtained sera were assayed for the concentration of endostatin (also for VEGF, HGF, bFGF and TGF- β 1). The commercially available enzyme-linked immunosorbent assay kit produced by Oncogene Research Products (Boston,

MA, USA) was used for endostatin detection, and Quantikine, R & D Systems Inc. (Minneapolis, MN, USA) products were used for the determination of the remaining cytokines. All manufacturers' instructions were followed. The absorbance was read at 492 nm. The appropriate recombinant human cytokine was used to generate the standard curve for each assay. The concentration of cytokines in the samples was determined by the interpolation from the standard curve. This procedure has been described precisely in our previous works.^{30,31} The sensitivity limit for endostatin was 1.95 ng/ml, for VEGF was 5.0 pg/ml, for HGF was 40 pg/ml, for TGF- β 1 was 7 pg/ml and for bFGF was 3 pg/ml.

Statistical analysis

Statistical analysis was performed using the procedures of Statistica for Windows package on the IBM-compatible computer. The significance of cytokine levels in different subsets of patients was assessed by Mann-Whitney U, Kruskal-Wallis, Cochran-Cox and Student tests where appropriate. *p* values obtained from pair-wise comparisons were corrected with the Bonferroni method. Zero values indicating undetectable levels of cytokines were included in all analyses. Correlations of analysed cytokines with laboratory parameters and between cytokines were calculated with Spearman's rank sum correlation coefficient. All values quoted are two sided and designated as statistically significant at the level < 0.05. The overall survival was estimated using the Kaplan-Meier method from the beginning of the disease. All endpoints were updated on 31 August 2002. The survival period was analysed in two groups of patients, below and above the median concentration value of endostatin, and compared using the F-Cox test.

Results

The serum concentration values of endostatin in MM patients and healthy controls are presented in Table 2. Serum levels of endostatin were detectable in all patients and in 12 out of 13 controls. The mean concentration in the MM group was 72 ng/ml (range, 11-402 ng/ml). The mean concentration of this inhibitor in controls was 38 ng/ml (range, 0.0-81 ng/ml; *p* = 0.015). The mean level of endostatin was highest in phases I and III of MM (mean, 77 ng/ml and 80 ng/ml, respectively). The concentration of this agent in phase II was lower at 48 ng/ml, and there was a statistically significant difference between the level of endostatin in phases I and II of the disease (*p* = 0.044). The stage of MM according to Durie and Salmon

Table 2. Serum levels of endostatin in MM patients at different phases

MM patients	Serum level of endostatin (ng/ml)
a. All ($n = 84$)	72 ± 63 [58 (11–402)]
b. Phase – 1 ($n = 57$)	77 ± 65 [69 (11–402)]
c. Phase – 2 ($n = 16$)	48 ± 20 [49 (21–87)]
d. Phase – 3 ($n = 11$)	80 ± 85 [50 (27–296)]
e. Control group ($n = 13$, $n_1 = 12$)	38 ± 22 [40 (0–80)]
Statistically significant comparison	b versus c, $p = 0.04$ b versus e, $p = 0.008$

Data presented as mean \pm standard deviation [median (range)]. Phase 1, at the beginning; phase 2, plateau; phase 3, progression. n , number of investigated individuals; n_1 , number of individuals with detectable endostatin.

classification as well as stage of bone disease did not influence the endostatin concentration (Table 2).

The mean concentration of endostatin in MM patients with a normal level of albumins (> 30 g/l) was 78 ng/ml, and was significantly higher than in those with hypoalbuminaemia (46 ng/ml; $p = 0.033$). Similar results were obtained in correlation of endo-

Table 3. Serum level of endostatin in MM patients correlated with clinical and laboratory parameters

Laboratory/ Clinical parameter	Serum level of endostatin (ng/ml)	Statistical significance
Haemoglobin		
> 10 g/dl	68 ± 55	Not significant
< 10 g/dl	77 ± 70	
Creatinine		
> 2 mg/dl	78 ± 91	Not significant
< 2 mg/dl	71 ± 54	
Albumins		0.033
> 30 g/l	78 ± 67	
< 30 g/l	46 ± 25	
Calcium		
> 11 mg/dl	73 ± 61	Not significant
9–11 mg/dl	66 ± 42	
< 9 mg/dl	85 ± 97	
M-component		
IgG	75 ± 59	Not significant
IgA	83 ± 107	
Light chain	49 ± 23	
CRP		
> 5 mg/l	68 ± 68	Not significant
< 5 mg/l	76 ± 58	
β 2-microglobulin		
> 2.5 mg/l	74 ± 68	Not significant
< 2.5 mg/l	67 ± 49	
LDH		
a. > 425 U/l	71 ± 87	a versus b, $p = 0.019$
b. 210–425 U/l	77 ± 51	
c. < 210 U/l	52 ± 33	
Stage of disease		
Ia	68 ± 62	Not significant
Iiia	71 ± 60	
Iib	46.0 ± 15	
IIia	72 ± 48	
IIib	85 ± 99	
Bone disease		
0–1 stage	67 ± 57	Not significant
2–3 stage	82 ± 80	

Data presented as mean \pm standard deviation.

statin with LDH. In patients with a normal concentration of LDH (< 210 and > 425 U/l), the mean level of this factor was significantly higher than in patients with elevated LDH values (77 pg/ml versus 71 pg/ml, $p = 0.019$). The level of endostatin was lowest in light chain disease patients (mean, 49 ng/ml) in comparison with IgG MM (mean, 75 ng/ml) and IgA MM (mean, 83 ng/ml). The light chain type did not influence the level of this inhibitor. Endostatin concentration did not correlate with other analysed laboratory parameters such as haemoglobin, creatinine, total protein, calcium, CRP and β 2-microglobulin (Table 3).

In two patients with non-secretory MM, the endostatin concentrations were 35 and 68 ng/ml.

The endostatin serum level was correlated with some pro-angiogenic cytokines such as VEGF, HGF, FGF and TGF- β (Table 4). We did not find any statistically significant correlation between endostatin and these cytokines (Fig. 1).

The serum concentration of endostatin higher or lower than its median value did not influence the probability of survival of MM patients (Fig. 2).

Discussion

The aim of our study was to evaluate the serum concentration of an anti-angiogenic agent (endostatin) in patients with MM, and to correlate it with disease activity and advancement, the most important clinical and laboratory parameters as well as known pro-angiogenic cytokines such as VEGF, HGF, FGF and TGF- β . The level of endostatin was detectable in all 84 analysed MM patients and in 12 out of 13 healthy controls. Most authors report the detection of endostatin in serum of the vast majority of patients with solid tumours, soft tissue sarcomas, autoimmune diseases and haematologic malignancies.^{21–23,26,27,32}

In our study, the concentration of endostatin in MM patients was significantly higher than in healthy individuals in comparable age. Higher values of this agent were found in patients with MM before treatment (phase 1 of the disease) than after therapy (phase 2). We found no significant increase of endostatin in advanced stages — IIIA and IIIB of the disease according to the Salmon and Durie system — as well as in advanced stages of bone disease. The aggressiveness of MM in our data has no association with the level of endostatin. Higher values of that inhibitor were found in MM patients with a normal level of albumins in comparison with those with hypoalbuminaemia. Similarly, in cases of MM with normal values of LDH, endostatin had higher concentrations than in other patients with decreased or elevated levels of LDH. We found no correlation between the level of endostatin and the

Table 4. Serum levels of VEGF, HGF, FGF and TGF- β in MM patients

Serum level/cytokine	VEGF (pg/ml)	HGF (pg/ml)	FGF (pg/ml)	TGF- β (ng/ml)
Mean \pm standard deviation	324 \pm 305	1940 \pm 1400	8 \pm 19	37 \pm 15
Median	232	1270	2	36
Range	23–1668	579–4674	0–108	3–81

remaining analysed laboratory parameters (haemoglobin, creatinine, total protein value, calcium, CRP, β 2-microglobulin, immunoglobulin and light chain isotype). Similar results were reported by Bertolini *et al.* in non-Hodgkin lymphoma patients.¹⁵ These authors also stated lack of correlation between endostatin levels with the grade of tumour malignancy. They also found no difference in endostatin concentration between patients in complete remission and progressive disease. Our data suggest that the serum level of endostatin is lower in cases after therapy and highest before treatment and in progression of MM. Feldman *et al.* measured the level of endostatin in soft tissue sarcoma patients and stated that the high pre-operative serum level predicted poorer outcome.²¹ Lai *et al.* showed that endostatin has prognostic value in predicting complete remission and overall survival in patients with acute

myeloid leukaemia and myelodysplastic syndromes.³²

In our previous study we showed positive correlations between pro-angiogenic cytokines (VEGF and TGF- β , bFGF and TGF- β , VEGF and bFGF) and our data indicated a strong relationship between the serum levels of these cytokines and clinical course, as well as selected laboratory parameters of patients with MM.²⁸ In this study we failed to prove the correlation of the most potent anti-angiogenic factor, endostatin, with these most clinically relevant pro-angiogenic cytokines. Probably their interaction is not direct, and further research is needed to elucidate this problem.

We found no influence of endostatin level on the probability of survival in our patients with MM. Previously we stated that VEGF and FGF concentrations have an effect on MM patients' survival.²⁸ The

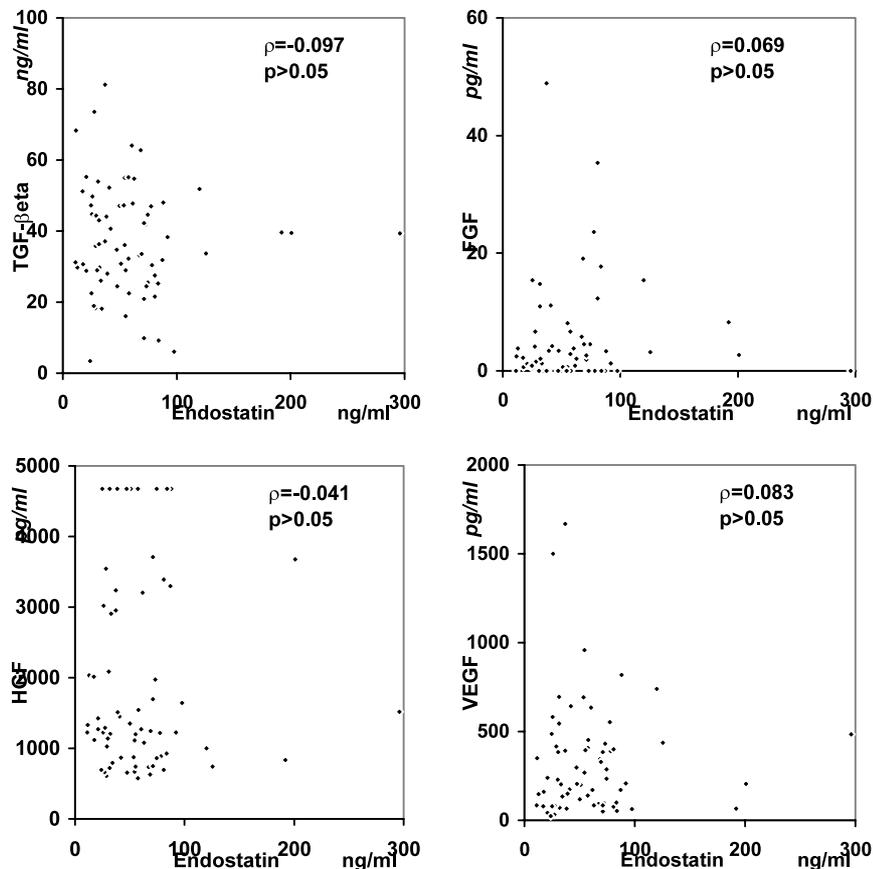


FIG. 1. Correlation between serum levels of endostatin and VEGF, HGF, TGF- β 1 and FGF.

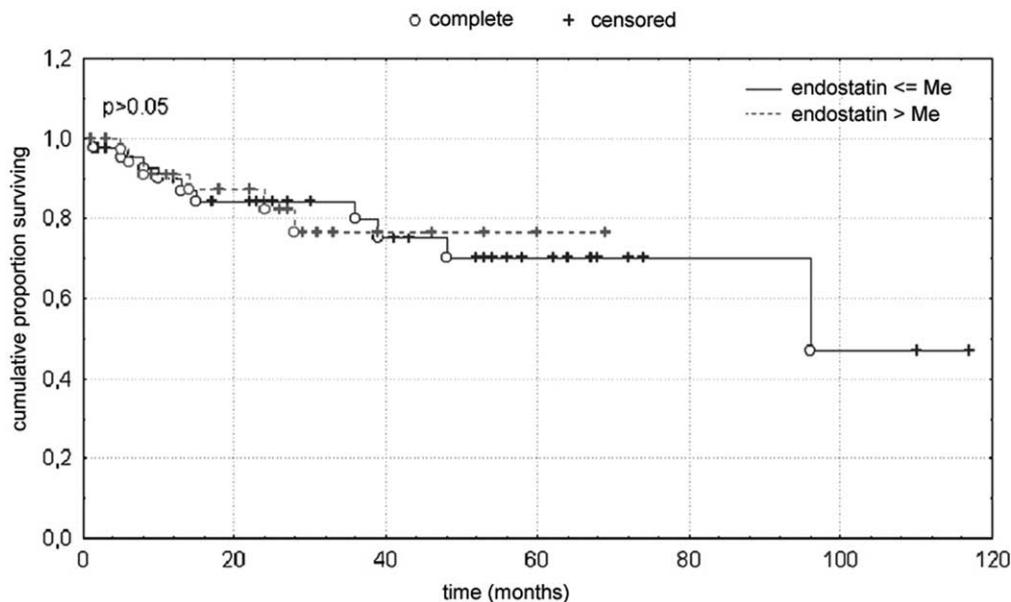


FIG. 2. The probability of survival for MM patients with high and low (> median and < median) concentrations of endostatin.

latter group was composed of 167 patients whereas the former was two times smaller, and probably these proportions might influence the obtained results, so further studies are needed in this field.

In conclusion, the present study is to our knowledge the first report analysing the serum concentration and clinical significance of endostatin in a large group of MM patients. Our data suggest that serum endostatin levels are elevated in MM patients. The elevated serum values of this agent are especially relevant in patients before treatment and this is caused by the high tumour mass at the beginning of the disease. After treatment the level of this inhibitor falls, and perhaps enables in that way the intensification of angiogenesis during progression of the disease. The plateau phase of MM seems then to be the best time to apply therapy with endostatin.

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References

- Hanahan D, Folkman J. Patterns and emerging mechanisms of the angiogenic switch during tumorigenesis. *Cell* 1996; **86**: 353–364.
- Kerbel R. Tumor angiogenesis: past, present and the near future. *Carcinogenesis* 2000; **21**: 505–515.
- Prehn R. The inhibition of tumor growth by tumor mass. *Cancer Res* 1991; **51**: 2–4.
- O'Reilly MS, Boehm T, Shing Y, *et al.* Endostatin: an endogenous inhibitor of angiogenesis and tumor growth. *Cell* 1997; **88**: 277–285.
- Dhanabal M, Volk R, Ramchandran R, Simons M, Sukhatme VP. Cloning, expression and in vitro activity of human endostatin. *Biochem Biophys Res Commun* 1999; **258**: 345–352.
- Yamaguchi N, Anand-Apte B, Lee M, *et al.* Endostatin inhibits VEGF-induced endothelial cell migration and tumor growth independently of zinc binding. *EMBO J* 1999; **18**: 4414–4423.
- Taddei L, Chiarugi P, Brogelli L, *et al.* Inhibitory effect of full-length human endostatin on in vitro angiogenesis. *Biochem Biophys Res Commun* 1999; **263**: 340–345.
- Dhanabal M, Ramchandran R, Waterman MJ, Lu H, Knebelmann B, Segal M, Sukhatme VP. Endostatin induces endothelial cell apoptosis. *J Biol Chem* 1999; **274**: 11721–11726.
- Dixelius J, Larsson H, Sasaki T, *et al.* Endostatin induces tyrosine kinase signaling through the Shb adaptor protein regulates endothelial cell apoptosis. *Blood* 2000; **95**: 3403–3411.
- Kim YM, Jang JW, Lee OH, *et al.* Endostatin inhibits endothelial and tumor cellular invasion by blocking the activation and catalytic activity of matrix metalloproteinase. *Cancer Res* 2000; **60**: 5410–5413.
- Shichiri M, Hirata Y. Antiangiogenesis signals by endostatin. *FASEB J* 2001; **15**: 1044–1053.
- Hohenester E, Sasaki T, Olsen BR, Timpl R. Crystal structure of the angiogenesis inhibitor endostatin at 1.5 Å resolution. *EMBO J* 1998; **17**: 1656–1664.
- Mac Donald NJ, Shivers WY, Narum DL, *et al.* Endostatin binds tropomyosin. A potential modulator of the antitumor activity of endostatin. *J Biol Chem* 2001; **276**: 25190–25196.
- Wu P, Yonekura H, Li H, *et al.* Hypoxia down-regulates endostatin production by human microvascular endothelial cells and pericytes. *Biochem Biophys Res Commun* 2001; **288**: 1149–1154.
- Bertolini F, Fusetti L, Mancuso P, *et al.* Endostatin, an antiangiogenic drug, induces tumor stabilization after chemotherapy or anti-CD20 therapy in a NOD/SCID mouse model of human high-grade non-Hodgkin lymphoma. *Blood* 2000; **96**: 282–287.
- Kisker O, Becker CM, Prox D, *et al.* Continuous administration of endostatin by intraperitoneally implanted osmotic pump improves the efficacy and potency of therapy in a mouse xenograft tumor model. *Cancer Res* 2001; **61**: 7669–7674.
- Jin X, Bookstein R, Wills K, *et al.* Evaluation of endostatin antiangiogenesis gene therapy in vitro and in vivo. *Cancer Gene Ther* 2001; **12**: 982–989.
- Mundhenke Ch, Thomas JP, Wilding G, *et al.* Tissue examination to monitor antiangiogenic therapy: a phase I clinical trial with endostatin. *Clin Cancer Res* 2001; **7**: 3366–3374.
- Fujii R, Yaccoby S, Epstein J. Control of myeloma growth with the antiangiogenic agent endostatin. *Blood* 2000; **96**: 360a.
- Tosi P, Tura S. Antiangiogenic therapy in multiple myeloma. *Acta Haematol* 2001; **106**: 208–213.
- Feldman AL, Pak H, Yang JC, Alexander Jr HR, Libutti SK. Serum endostatin levels are elevated in patients with soft tissue sarcoma. *Cancer* 2001; **91**: 1525–1529.
- Feldman AL, Tamarkin L, Paciotti GF, *et al.* Serum endostatin levels are elevated and correlate with serum vascular endothelial growth factor levels in patients with stage IV clear cell renal cancer. *Clin Cancer Res* 2000; **6**: 4628–4634.
- Nagashima M, Asano G, Yoshino S. Imbalance in production between vascular endothelial growth factor and endostatin in patients with rheumatoid arthritis. *J Rheumatol* 2000; **10**: 2339–2342.
- Talks KL, Harris AL. Current status of antiangiogenic factors. *Br J Haematol* 2000; **109**: 477–489.
- Zorick TS, Mustacchi Z, Bando SY, Zatz M, Moreira-Filho CA, Olsen B, Passos-Bueno MR. High serum endostatin levels in Down syndrome: implications for improved treatment and prevention of solid tumors. *Eur J Human Genet* 2001; **11**: 811–814.

26. Robak E, Woźniacka A, Sysa-Jędrzejowska A, Stępień H, Robak T. Circulating angiogenesis inhibitor endostatin and positive endothelial growth regulators in patients with systemic lupus erythematosus. *Lupus* 2002; **11**: 348–355.
27. Kay NE, Bone ND, Tschumper RC, *et al.* B-CLL cells are capable of synthesis and secretion of both pro- and anti-angiogenic molecules. *Leukemia* 2000; **16**: 911–919.
28. Urbańska-Ryś H, Wierzbowska A, Robak T. Circulating angiogenic cytokines in multiple myeloma and related disorders. *Eur Cytokine Network* 2003; **14**: 40–51.
29. Durie BGM, Salmon SE. A clinical staging system for myeloma: correlation of measured myeloma cell mass with presenting clinical features, response to treatment and survival. *Cancer* 1975; **36**: 842–854.
30. Urbańska-Ryś H, Wierzbowska A, Stępień H, Robak T. Relationship between circulating interleukin-10 (IL-10) with interleukin-6 (IL-6) type cytokines, interleukin-11 (IL-11), oncostatin M (OSM), and soluble interleukin-6 receptor (sIL-6R) in patients with multiple myeloma. *Eur Cytokine Network* 2000; **11**: 443–451.
31. Wierzbowska A, Urbańska-Ryś H, Robak T. Circulating IL-6 type cytokines and sIL-6R in patients with multiple myeloma. *Br J Haematol* 1999; **105**: 412–419.
32. Lai R, Estey E, Shen Y, *et al.* Clinical significance of plasma endostatin in acute leukemia/myelodysplastic syndrome. *Cancer* 2002; **94**: 14–17.

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